ECOWEIGHT - a C program for modelling the economic efficiency of cattle production systems

Jochen Wolf[a*], Marie Wolfová[a], Emil Krupa[b], Dana Peškovičová[b]

[a]*Research Institute of Animal Production, Department of Genetics and Biometrics, P.O.Box 1, CZ 10400 Praha-Uhříněves, Czech Republic*
[b]*Research Institute of Animal Production, Hlohovská 2, SK 94992 Nitra, Slovak Republic*

[*]Corresponding author. Tel.: +420 267009573, fax: +420 267710779.
E-mail address: wolf.jochen@vuzv.cz (J. Wolf)

Abstract
A program in C was 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 cow herd and the growth performance of offspring born in the herd. An integrated cow-calf and feedlot system was assumed. The Markov chain approach was used to simulate herd dynamics. The herd was described in terms of states animals can be in and the probabilities of transitions between these states. 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 15 (beef cattle) or 20 (dairy cattle) economically important traits. The program runs under LINUX and Windows and possibly under further operational systems and is freely available on request with a detailed manual in pdf format.

Keywords: Beef cattle; production systems; bio-economic model; economic weights; computer program; C language

1. Introduction
In the framework of sustainable agriculture, beef cattle farming has become an important factor in a great part of Europe. The large variety of nature and marketing conditions for beef farming 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 cattle has 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) 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 crossbred 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 cattle is worked out well (Davis et al., 1994; Koots and Gibson, 1998; Tess and Kolstad, 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 (purebreeding, crossbreeding with beef or dairy cattle) (Wilton and Danell, 1981; Amer at 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. This largely involved the use of published methodologies that were adapted and generalised to be in accordance with the general character of the model.

2. Description of the modelled production systems

The model covers the most important production systems in which beef bulls are assumed to operate. They can be divided into four main groups:

System 1: Purebred beef cow-calf pasture systems producing females and males for own replacement and for other systems. Both breeding and purebred commercial herds are included.

System 2: Crossbred beef cow-calf pasture systems (rotational crossing) producing their own female replacement but buying breeding bulls or their semen.

System 3: Crossbred cow-calf pasture systems (terminal crossing) supplying their female replacement from dairy, dual purpose cow herds or cow herds of beef dam lines and buying beef bulls or their semen for terminal crossing.

System 4: Dairy or dual purpose cow herds with milk production (indoor system) applying partly terminal crossing with beef bulls.

System 1 is the only one which is closed and can therefore exist independent on the other production systems. The remaining three systems are open and form usually a part of a more complex vertically combined integrated production system.

A part of the male calves from System 1 (from breeding herds) is performance tested on station or in the field and selected as breeding bulls. These bulls are expected to be a component of the herds till selling to AI stations or to other herds for natural mating.

Within each production system, up to four possible marketing strategies of surplus calves and/or heifers are involved: (i) selling (export) of weaned calves outside the system, (ii) fattening of weaned calves, (iii) selling of surplus breeding heifers before mating and (iv) selling of surplus pregnant heifers. The last two strategies are allowed for in Systems 1 and 4 only. A combination of these strategies is possible.

An intensive indoor feedlot is assumed for bulls throughout whereas an intensive indoor or an extensive feedlot on pasture can be chosen for heifers and castrates in Systems 1 to 3. In System 4, an intensive indoor feedlot is expected. Fattening of heifers, bulls or castrates is performed to a fixed optimal slaughter weight that depends on the maturity type (mature weight) of the parents.

The management of the cow-calf pasture production systems is modelled according to the typical situation in Central Europe. The length of the pasture period depends on the climatic conditions, the beginning and the end of the pasture period can be freely chosen. All females (heifers and cows) in Systems 1 to 3 are expected to be mated to beef bulls in the same breeding season. The length of the breeding season is held constant covering about three oestrus cycles of females because the length of the reproduction cycles (intervals between two subsequent calvings) is assumed to be fixed to one year.

Replacement heifers are put on the same regime as cows and are bred according to the breed type that determines the optimal weight at breeding. The maximal number of mating periods for heifers after their weaning is restricted to three in the model. The fraction of heifers which can be mated already in the first mating period after weaning is calculated on the base of the average weight of heifers at the beginning of the mating period and its phenotypic standard deviation assuming a normal distribution of the weight. Non-pregnant heifers are slaughtered not later than after the third mating period.

Non-pregnant cows are generally slaughtered after weaning, but the option to stay in the herd to the next mating period is included in the model. All calves are expected to be weaned at the same date.

System 4 is modelled as a traditional dairy production system in which a part of cows is mated with beef bulls to improve the fattening performance of progeny. Crossbred heifers suitable for breeding can be sold to a cow-calf pasture system (to System 3).

The user of the program has the opportunity to define his/her own production system including his/her mating and marketing policy to a great extend. Though the starting point for working out the model was the situation in temperate climatic zones, the program can also manage production systems in the tropics. The main prerequisites are that the reproduction cycle is one year and that there are no more than two different feeding periods.

Deterministic models are used for all systems. Fractions of animals are allowed (non-integer model), but the number of cows entering all reproduction cycles during one year (both calving and not calving cows) is fixed. Only when applying limitations to the input of production factors or output of products, the number of cows is rescaled when calculating the economic values of traits.

The structure of the cow herd is derived using Markov chains in all systems. The herd dynamics is described in terms of categories animals can belong to and probabilities of possible transitions between these categories. The procedure is similar to those described by Jalvingh et al. (1992) or Reinsch and Dempfle (1998). 58 categories of cows are described altogether. These 58 categories are used for calculating the stationary state of the cow herd. Each young animal born in the herd can belong to one of 24 progeny categories. In the dairy system, two groups of progeny are differentiated, dairy and crossbred (beef x dairy). The total number of cattle categories is then 82 in Systems 1 to 3 and 106 in System 4.

The profit, i.e. the difference between the present values of revenues and costs per cow and year at the stationary state of the structure of the cow herd, is calculated and used as criterion of the economic efficiency for all production systems. The program allows to calculate the economic values and economic weights of 16 economically important traits in beef cattle and 20 traits in dairy cattle. The economic value of a trait is defined as the partial derivation of the profit function in respect to the given trait and is expressed in currency units per cow and year and per unit of the trait. The economic weight for maternal and direct effects of a trait for the given selection group (e.g. beef sires, dams of sires) is calculated multiplying the economic values by the number of discounted expressions for maternal and direct effects of the trait transmitted by the corresponding breeding animal in the given production system during a certain investment period. A detailed description of the calculation of revenues, costs, profit, economic values and economic weights can be found in two papers submitted for publication to Livestock Production Science (Wolfová et al., 2004a-b).

3. Technical description and availability of the program

The program was written in C under Red Hat LINUX. It was tested under different versions of Red Hat Linux (versions 5.1 to 9) and under different versions of Microsoft Windows® in the Cygwin environment on personal computers with 32 to 512 MB RAM. The program is controlled by the parameter file PARA.TXT which contains the most important options for running the program. The data are read from 17 input files which are text files and all organized in the same way. A short comment on the content of the file is followed by the input parameters, always organized in three parts (mostly one part is situated on one line). The first part contains the value of the parameter, the second part the description of the parameter and the third part the units the parameter is given in.

All input files can be edited with any text editor. The numbers are read in free format, double or triple spaces between numbers do no harm. All texts can be changed (for example translated to another language) as long as you do not change the slashes at the beginning and at the end of the comment and the quotation marks. Do not change the units besides of the currency unit which is Kc (Czech crowns) for Czechia.

Not all input files are needed in all runs; the input files needed for a concrete run are determined by the parameters in the file PARA.TXT. A further text file (TEXT_OUT.TXT) contains text which is needed for writing the results to file.

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.

The program is freely available on request and comes with an 80-page documentation in PDF format. In its present version (1.0.22), the production systems 1 to 3 are worked out. The version that includes the dairy system with terminal crossing (System 4) is almost ready and will be available in the next future.

4. Use of the software: an example

```
"Comment:
    Calculation for Charolais, 16 Aug 2003"
1
"Production System
  (1 Closed purebred beef cow herd with pasture system producing males and
     females for replacement
   2 Closed crossbred cow herd with pasture system producing its own female
     replacement but buying the breeding bulls
   3 Open beef x dairy or beef x dual purpose crossbred cow herd with pasture
     system with purchase of cow and bull replacement)"
1
"Feedlot
  (1 Intensive feedlot of bulls, heifers or castrates
   2 Intensive feedlot of bulls, extensive feedlot of heifers and castrate
     on pasture)"
2
"Housing technology in feedlot
  (1 Bind technology
   2 Free technology
   3 Pasture)"
3
"Maturity type of progeny
  (1 Early
   2 Medium
   3 Late)"
1
"Quota
  (keep always value 1 in the given version of the program)"
2
"Way of calculating parameters for lactation curve
  (1 The values are read from the input file INPUT20.TXT
   2 The parameters are calculated in the program)"
2
"Utilization of female calves which are not needed for replacement
  (1 Export
   2 Fattening
   3 Selling before mating
   4 Selling of pregnant heifers)"
2
"Way of calculating feeding cost
  (1 on the base of energy and protein content in feeding rations
   2 only on the base of energy content in feed)"
1
"Mating type for heifers
  (1 Artificial insemination is used in the first oestrus at least within
     one mating period
   2 Natural mating is used throughout)"
1
"Mating type for cows
  (Same options as above)"
1
"Sex for which gene flow is calculated
  (1 Sires
   2 Dams)"
```

Fig. 1. File PARA.TXT

A purebred breeding herd producing heifers and breeding bulls, both of them for own replacement and for commercial herds or crossing systems, was modelled as an example (production system was set 1 in the file PARA.TXT - see Fig. 1). The marketing policy for surplus female and male calves was intensive fattening (values 1 for feedlot and 2 for the utilization of surplus female calves) with free housing technology (value 2). A combination of insemination and natural mating (mating type 1) and a late maturity type of progeny (value 3) were assumed. The example was calculated for a situation without quota (value 1). The algorithm of Fox at al. (1990) was applied to the calculation of the parameters of the lactation curve (value 2). Feeding costs were determinated on the base of net energy requirement only (value 2). The gene flow and the economic weights were calculated for bulls (sex 1).

Table 1
Survey of data input files for the example

Input file	Short description
INPUT01.TXT	All date variables that describe the seasonal events in the herd (date of starting pasture, date of weaning etc.)
INPUT02.TXT	Vectors of variables that characterise cows in reproduction cycles 1 to 10
INPUT03.TXT	Parameters describing the cow herd in the pasture system
INPUT04.TXT	Parameters for breeding bulls used in natural mating
INPUT05.TXT	Parameters for bulls in the performance test
INPUT06.TXT	Parameters describing the progeny test
INPUT08.TXT	Parameters for fattening heifers and castrates used both in intensive and extensive feedlot
INPUT10.TXT	Parameters for fattening heifers and castrates exclusively used in intensive feedlot
INPUT13.TXT	Parameters for replacement heifers
INPUT16.TXT	Parameters on commercial classes for fleshiness and fat covering for both intensive and extensive feedlot
INPUT17.TXT	Parameters on commercial classes for fleshiness and fat covering used exclusively in intensive feedlot
INPUT19.TXT	Parameters needed for calculating the lactation curve
INPUT26.TXT	Parameters for the gene flow

The options in the file PARA.TXT determine which of the data input files INPUTxx.TXT are needed, where ‘xx’ stands for two digits. These data input files contained the biological, management and economic input parameters describing the production system more in detail. All default input parameters in the example were defined for the Charolais breed. Altogether, several hundred numbers were read in from these files. For the example, 13 of totally 17 data input files were necessary. They are summarized in Table 1. To give an idea of the structure of the data input files, the files INPUT01.TXT, INPUT02.TXT and INPUT16.TXT are presented in Fig. 2 to 4 in a shortened form.

At the beginning of each data input file, a short description of the content of the file is given. Furthermore, there are some hints concerning the range of options the file is needed for (mostly limitations according to the production system or feedlot). In data input file INPUT01.TXT (Fig. 2), dates are read in which describe the seasonal events in the herd. The dates are given in the format month-day and are internally recalculated to the number of days from January 1st. For calculating time intervals, there are some logical checks in the program which automatically recognize if both dates are from the same year or from two successive years.

```
/* This file is necessary for production systems 1 to 3, the last parameter only
   for production system 1.
   It includes input parameters describing the reproduction cycle in pasture
   systems through a year.
   The input data are arranged in the following way:
       each parameter takes three rows,
       in the first row stands its value given in the
         format 'month [SPACE] day' (the program will recalculate
         the date into the number of days since January 1st),
       the string expression in the second row describes the parameter and
       the last string in the third row contains the units of the parameter.
   For changing input data, change the number(s) in the first row.
    ...
   All default inputs are for the breed Charolais estimated for the year 2002
   in the Czech Republic*/
5  1
"Date of beginning pasture"
"month day"
11 30
"Date of ending pasture"
"month day"
...
...
12 1
"Starting date for the test of bulls (only needed for production system 1)"
"month day"
```

Fig. 2: Part of the data input file INPUT01.TXT

```
/* This file is necessary for production systems 1 to 3.
   It includes input parameters describing reproduction cycles of the cow herd
   in pasture systems. For each reproduction cycle, cows entering this cycle are
   differentiated in pregnant cows and cows not being pregnant. Losses of cows,
   culling etc. can be different in both groups. Two groups of cows are
   differentiated according to calving performance: cows with easy calving and
   cows with dystocia. Input parameters for losses of cows and calves, for
   insemination etc. can differ in both groups.
   All input data are arranged in the following way:
       each parameter takes three rows,
       in the first row stands the vector of its values for reproduction
       cycles 1 to 10 or 1 to 9,
       the string expression in the second row describes the parameter and
       the last string in the third row contains the units of the parameter.
       If there is no unit given, [SPACE] is enclosed into quotation
       marks. */
0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01
"Vector of cow losses within reproduction cycles 1 to 10 as proportion of cows
entered the reproduction cycle as pregnant cows"
" "
0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01
"Vector of cow losses within reproduction cycles 2 to 10 as proportion of cows
entered the reproduction cycle as not pregnant cows"
" "
...
...
0.03 0.015 0.015 0.015 0.015 0.015 0.015 0.015 0.015 0.015
"Vector of probabilities of calving score 4 when male is born in reproduction
cycles 1 to 10"
" "
```

Fig. 3. Part of data input file INPUT02.TXT

Data input file INPUT02.TXT (Fig. 3) is an example for input files which read vectors of data. The data describe the reproduction cycle of the cow herd in pasture systems. Cows with easy calving and cows with dystocia are differentiated. Data input file INPUT16.TXT which is reproduced in part in Fig. 4 is connected with the commercial classes for fleshiness and fat covering and reads the distribution of animals and prices over these classes in matrix notation. The numbers of classes for fleshiness and fat covering are input parameters and can be changed therefore.

```
/* Input parameters for production systems 1 to 3 and both feedlots 1 and 2.
   ...
   The rows represent the commercial classes for fleshiness, the columns the
     classes for fat covering.
   The matrix of coefficients of carcass prices shows the ratio of the price per
   kg carcass in the given class to the price in the class with the highest
   price.*/
0      0    0      0      0
0.6    4    2.4    0.8    0.2
4.8    30   18     6      1.2
2.4    15   9      3      0.6
0.2    1    0.6    0.2    0
0      0    0      0      0
"Matrix Pb - proportions of bull carcasses in commercial classes for fleshiness
and fat covering"
" "
...
...
...
1      0.985  0.97   0.94  0.875
0.96   0.945  0.925  0.89  0.82
0.925  0.91   0.89   0.86  0.79
0.875  0.86   0.84   0.805  0.73
0.775  0.785  0.795  0.76  0.685
0.655  0.665  0.675  0.64  0.565
"Matrix Prb - coefficients of carcass prices in commercial classes for fleshiness
and fat covering for bulls relative to the best class"
" "
...
...
...
```

Fig. 4. Part of the data input file INPUT16.TXT

The output file which prints the results and the name of which is specified by the user copies all data input files in its first part (the form of the data presentation is slightly changed). The structure of the cow herd in the stationary state is then printed out followed by reproduction and growth characteristics of cows in each reproduction cycle. Structure, growth and reproduction characteristics of progeny are the next outputs. Net energy and protein requirement, amount of fresh feed matter, water and minerals and total feeding cost per animal are listed in each of the 82 defined animal categories. Fig. 5 shows this part of the output for the category of replacement heifers. Next a list of veterinary, housing, fixed, other and total cost as well as of revenues per animal is printed out for all categories. The numbers of discounted expressions for revenues and costs express the number of animals in each cattle category per standard female unit (SFU - one cow that entered the calving period in the herd in one year). The numbers are discounted to the birth of progeny to take into account the time delay between calving and the occurrence of revenues and costs.

The final results (see Fig. 6) show the total revenues, costs, governmental subsidies and total profit per standard female unit and the marginal economic values of 16 traits (four of them are expressed in two alternative ways). The economic weights of the direct and maternal components of the included traits are also printed out for the selected group of animals that is defined in file PARA.TXT (bulls in the default example) and for which the numbers of expressions for direct and maternal traits are calculated using the gene flow method.

```
...
3.5 Nutrition costs
-------------------
Comment:
The following parameters are expressed per animal and time period:
- requirements of net energy (in MJ NE)
- requirements of digestible protein (in g PDI)
- requirements of minerals (in kg)
- requirements of water (in liters)
- amount of fresh matter of summer and winter feed ratio (in kg)
- costs for summer and winter feed (in Kc)
The time periods are:
- for calves (categories 1,2,3,8 and 9):
  * from birth to weaning
- for animals of categories 4, 5, 6, 7, 10 to 24:
  * from weaning to slaughter
  * from weaning to culling
  * from weaning to death or to selling
- for cows (categories 25 to 82):
  * from calving to death
  * from calving to culling
  * from calving to the end of the given reproduction cycle
...
...
...
3.5.13. Replacement heifers entering the first reproduction cycle (category 22)
-------------------------------------------------------------------------------
Length of period for which the feed costs are calculated:  851.6
Net energy requirement for pregnancy:     1424
Protein requirement for pregnancy:    16000
Net energy requirement in summer period:    21655
Net energy requirement in winter period:    19649
Total net energy requirement:    41305
Protein requirement in summer period:   218284
Protein requirement in winter period:   213953
Total protein requirement:   432237
Amount of fresh feed matter required in summer period:    17606
Amount of fresh feed matter required in winter period:     8749
Cost for summer feeding:     5502
Cost for winter feeding:     7000
Costs for minerals:  1839.5
Cost for water:   596.1
...
```

Fig. 5. Part of the program output - nutrition data for replacement heifers entering the first reproduction cycle

5. Discussion

The program package ECOWEIGHT is intended after all for the calculation of economic values of economically important traits in livestock. At the given stage, in its first version, several pasture production systems for beef cattle without production limitation are treated within the program. In the next step, dairy cattle systems will be integrated including terminal crossing of dairy cows with beef bulls. Simultaneously, the option to calculate with production limitations (quota) should be included.

In most models used in the literature, only marginal economic values are calculated which do not take into account the different time delay between the utilisation of selected animals and the expression of various traits in revenues and costs. These values are then applied for selection decisions. In species as cattle with a long interval between mating and obtaining revenues or incurring cost connected to special traits (dystocia, milk production, meat quality traits), this methodology seems not to be well-founded any more. The incorporation of the discounting procedure into the program ECOWEIGHT makes it possible to take into account the influence of time on the economic efficiency of a production system and on economic values.

```
...
3.10. Profit
------------
Total revenues (Kc per SFU):   21381.3
Governmental support (Kc per SFU):    9699.1
Total costs (Kc per SFU):   27752.4
Total profit (Kc per SFU):    3327.9

3.11. Marginal economic values
------------------------------
Mean class of calving performance (Kc per changing the mean class by 0.01
  and per SFU):  -28.29
Losses of calves at calving (Kc per % and SFU):   -218.15
Losses of calves from 48 hours after calving till weaning (Kc per % and SFU):
   -205.22
Mature weight of cows (Kc per kg and SFU):   -6.39
Birth weight of calves (Kc per kg and SFU):   -0.34
Average daily gain of calves from birth to 1st weighing (Kc per 10 g and SFU):
      6.60
...
Average lifetime of cows (Kc per year and SFU): 1487.43

3.12. Economic weights for direct (1st number) and maternal (2nd number)
      components of the trait for selection group chosen (see Manual)
      (For traits without a maternal component, only the economic weights
      for the direct component are given)
-------------------------------------------------------------------------
Mean class of calving performance (Kc per changing the mean class by 0.01
  and per SFU):  -24.88   -14.44
Losses of calves at calving (Kc per % and SFU):   -191.88  -111.34
Losses of calves from 48 hours after calving till weaning (Kc per % and SFU):
   -180.52  -104.74
Mature weight of cows (Kc per kg):   -5.62
Birth weight of calves (Kc per kg):   -0.30    -0.17
Average daily gain of calves from birth to 1st weighing (Kc per 10 g and SFU):
      5.80     3.37
Average daily gain of calves from 1st to 2nd weighing (Kc per 10 g and SFU):
      5.09     2.95
Average daily gain of calves from 2nd to 3rd weighing (Kc per 10 g and SFU):
      5.89     3.42
Average daily gain in fattening (Kc per 10 g and SFU):   37.47
Dressing percentage (Kc per % and SFU):  189.53
Cow losses (Kc per % and SFU): -102.54
Conception rate of heifers (Kc per % and SFU):    7.50     4.35
Conception rate of cows (Kc per % and SFU):   32.06    18.60
Mean class of fleshiness (Kc per changing the mean class by 0.01 and per SFU):
      8.23
Mean class of fat covering (Kc per changing the mean class by 0.01 and per
  SFU):    5.46
Weight of calves at 1st weighing (Kc per kg and SFU):    4.84     2.81
Weight of calves at 2nd weighing (Kc per kg and SFU):    5.65     3.28
Weight of calves at 3rd weighing (Kc per kg and SFU):    3.80     2.20
Average lifetime of cows (Kc per year and SFU): 1308.36
```

Fig. 6. Part of the program output printing economic values and economic weights

It was also shown in several studies (Wuensch et al., 1999, Wolfová and Nitter, 2004) that the breed utilisation in the linked crossing systems should be taken into account when calculating economic weights for traits in the breeding objective for purebred animals. This is done in the program by including the gene-flow procedure which makes it possible to calculate relative economic weights for maternal and direct components of traits as well as for different selection paths in various production systems.

The economic weights obtained with the program ECOWEIGHT can be directly used to construct selection sub-indices for beef bulls utilised in a specific production system (pure-breeding, cross-breeding) if the appropriate breeding values estimated by multi-trait animal models are available. Economic weights for the overall breeding objective of a certain beef breed can be obtained as well by a similar approach proposed by Phocas et al. (1998) or Amer et al (2001). For this purpose, the economic values derived for the individual production, management and marketing systems are to be weighted by the proportion of cows in each system in which the evaluated beef breed will operate.

Beef bulls are generally used in a high variety of marketing alternatives. Different economic values were obtained for cow-calf production systems producing weaned calves and for integrated systems with fattening (Hirooka et al. 1998). This holds also for specific programs applying fattening to a different slaughter age or weight (Amer et al. 1996, Phocas et al., 1998). Differences in the performance level of beef breeds are another source for the inequality of economic values of the same trait. The program ECOWEIGHT makes it easy to define a subset of breeding objectives for beef bulls that are applied in farms with specific marketing programs.

Besides of the calculation of economic weights, the program will be useful for economic analyses of different production systems and for the economic comparison of breeds and breed crosses. The model does not simulate heterotic effects for the crossbred progeny, but the realised heterosis can be readily included by inserting the real performance of crossbred animals. The economic efficiency of pure-bred and cross-bred cow-calf production systems can be investigated as done for example by Davis at al. (1994) or Tess and Kolstad (2000); in addition, the intensive or extensive feedlot of weaned calves can be integrated as well.

Furthermore, the program makes it possible to study the impact of changes of production, management and economic circumstances on the economic efficiency of a given production system and allows the optimisation of replacement, management and marketing strategies. The mostly deterministic approach applied in the model makes it easy to change the values of a huge number of biological, economical and management variables and to adapt them to concrete situations. Stochastic simulation models often used for modelling the reproductive performance and culling strategy in beef cattle (Azzam et al., 1990, Amer et al. 2002) are more exact but require many variables which usually are not at disposal at the commercial level.

6. Conclusion

The program ECOWEIGHT in its first version can match with a great variety of production systems for beef cattle. By incorporating the discounting and the gene flow procedures, the time factor and the distinct utilization of animals in the cross-breeding program are taken into account. Furthermore, the program can handle the impact of changes in a great spectrum of input parameters on the economic efficiency of the given production system. The program is expected to be extended for dairy cattle including systems of terminal crossing with beef bulls in near future, the inclusion of pigs and possibly further species of farm animals as sheep and goats in the program package is taken into consideration. Offers for a cooperation in the further development of the program will be welcome.

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