# Main sources of the economic efficiency of beef cattle production systems

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**ABSTRACT**: The economic efficiency of several beef production systems on pasture was investigated under different marketing strategies. All calculations were carried out with the computer program ECOWEIGHT. None of the considered production systems was profitable without government subsidies for the assumed economic input values. The subsidies granted when satisfying a set of conditions served for balancing the economic loss in systems selling all surplus weaned calves outside. A profitability of 10 to 25% was reached for this marketing strategy in dependence on the production system. When integrating feedlot, only the purebred system with mating female replacement at an early age (about 15 months) and selling breeding bulls showed profitability, but at a low level (5%). All other systems produced at a loss even when government subsidies were included. A detailed analysis showed a high variability of the profit and profitability of cow-calf production systems in dependence on breeding and marketing strategies and on the level of the biological and economic input parameters. When considering biological performance, reproduction of females was shown to be the main source of economic efficiency in herds producing calves for sale. When applying feedlot, the daily gain in fattening was even more important. Beef prices seem to be the most important economic factor influencing the profitability of all systems (prices for slaughtered animals in the variant with integrated feedlot, prices for calves in the variant with selling of weaned surplus progeny).

**Keywords**: beef cattle; production systems; marketing strategies; economic efficiency; profit

Beef cattle farming has always been an important part of agriculture in countries with a large area of pasture (e.g. USA, Canada, Australia, New Zealand, Russia, France and Great Britain). Many papers have been written dealing with biological and economic comparisons of different beef breeds and their crosses as well as with different breeding, replacement and management policies in beef cattle farming in these countries. Examples of most recent papers are Tess and Kolstad (2000), Roughsedge *et al*. (2001), Amer *et al*. (2002), Roughsedge *et al*. (2002) or Archer *et al*. (2002).

During the last decades beef cattle farming has become an important part of agriculture also in Central Europe (Schäfer *et al*., 1998; Albera *et al*., 2002; Fuerst-Waltl *et al*., 2002). The maintenance of various types of landscape was the first reason for keeping a wide spectrum of beef breeds. Improving carcass and meat quality of slaughter animals produced on dairy farms was the second important utilisation of beef bulls. To help the farmers in choosing the best breed for a specific landscape or marketing condition, the differences between economically important traits and their impact on economic efficiency of the given production system in different breeds and their crosses kept in Europe were investigated (Jakubec *et al*., 2003; Přibyl *et al*., 2003; Chambaz *et al*., 2003). Kahi *et al*. (1998) reported results of the influence of production conditions and economic evaluation criteria on the economic comparison of breeds and their crosses. For the economic conditions in the Czech Republic and in the Slovak Republic, some analyses were made concerning the profitability of beef cattle farming (Kvapilík *et al*., 1997; Kvapilík, 2000; Golda *et al*., 2001; Daňo *et al*., 2001). These analyses provided more or less general statements because they were not carried out for specific production systems

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within specific marketing conditions. Wolfová *et al*. (2004) developed a bio-economic model for a wide range of beef cattle production systems and various economic and marketing conditions. It was primarily established for the development of breeding goals for beef cattle of different breeds that are involved in pure breeding or crossbreeding systems. Moreover, the PC-program written on the basis of this model (Wolf *et al*., 2004) allows to calculate the profitability of beef cattle production systems for a given breed or for breed crosses.

The aim of this paper was to compare the economic efficiency of different production systems with specific management and marketing conditions. Furthermore, the most important sources of the economic efficiency of the systems were analysed differing in the main economic, management and biological input parameters.

## MATERIAL AND METHODS

A bio-economic model (Wolfová *et al*., 2004) of a beef cattle enterprise was used to simulate the economic efficiency of the following production systems, management and marketing strategies:

(S1) Purebred system producing breeding males and females for own replacement as well as for other crossing systems or for selling outside the investigated area (e.g. export to other countries). Two mating strategies were simulated within this system: the mating of heifers approximately at 15 months and at 27 months of age. Aberdeen Angus and French Charolais cattle, respectively, were taken as representatives of the early and late maturity types of breeds corresponding to these strategies.

(S2) Crossing system buying their crossbred female replacement from dairy herds (that apply terminal crossing with beef bulls) and mating them to beef bulls. The progeny born in the system used for the example calculation were of the combination Charolais × (Charolais × Holstein).

(S3) Crossing system producing breeding females for own replacement but buying bulls for crossing. Two-breed rotational crossing system with Charolais and Simmental beef cattle was used as an example for this production system.

The following two alternative marketing strategies of surplus progeny were applied to all systems:

(M1) Export of all surplus weaned calves.

(M2) Fattening of all surplus weaned calves.

For the pure breeding system, a third marketing strategy was allowed for:

(M3) Selling of surplus breeding heifers and fattening of surplus male calves.

The traditional pasture management system used in Central Europe with winter calving and autumn weaning was applied for all alternatives (for a detailed description see Wolfová *et al*., 2004). Pasture covered the period from May 1 to October 30. All calves were weaned at the same date (October 15). The reproduction cycle was of fixed length covering 365 days. The mating seasons for both cows and heifers started on April 10 or May 1 in purebred or cross-bred systems, respectively, and covered three oestrus cycles. In purebred herds, the mating season started with insemination by top-producing bulls to produce breeding animals with high ancestor breeding values.

Thirty per cent of cows and ten per cent of heifers were assumed to be inseminated. After a two-week break, natural mating followed. In crossbred herds, natural mating on pasture was performed throughout. Though the heifers of the early maturity type (Aberdeen Angus) were generally mated approximately at an age of 15 months and the heifers of the late maturity type (Charolais) at an age of 27 months, the proportion of heifers mated in the first or second mating period that followed their weaning depended on the growth rate of female calves and was calculated assuming the normal distribution of live weights of heifers at mating. The standard deviation for this weight was 50 kg for Charolais or Charolais × Simmental and 30 kg for Angus heifers. The minimal live weight for mating was set 480, 420 and 320 kg for the three genotypes, respectively.

Therefore, a small part of the heifers of both breeds was mated at an age not typical of the given breed (15 months for Charolais or 27 months for Aberdeen Angus). It was assumed that heifers not pregnant after their second mating period would be slaughtered. All cows not pregnant at calf weaning were culled. Crossbred heifers for terminal crossing were purchased at an age of 6 months and mated in the common mating period.

The main parameters used in the basic calculation for describing the cow herd are listed in Table 1. The structure of cow herds in all systems was calculated as stationary state of Markov chain as described by Wolfová *et al*. (2004). Calving performance was characterised by a scale of scores from

Table 1. Herd characteristics for four breeds (CH – Charolais, AA – Aberdeen Angus, H – Holstein, S – Simmental)

| Variable (unit) | Breed of cow | | | |
|---|---|---|---|---|
| | CH | AA | CH × H | CH × S |
| Cow losses within reproduction cycles – cycle 1 | 0.02 | 0.02 | 0.02 | 0.02 |
| – cycles >1 | 0.01 | 0.01 | 0.01 | 0.01 |
| Culling rate of cows due to health problems excluding dystocia | 0.02 | 0.02 | 0.02 | 0.02 |
| Dystocia rate[3] when female is born – cycle 1 | 0.054 | 0.026 | 0.043 | 0.037 |
| – cycles >1 | 0.027 | 0.013 | 0.022 | 0.017 |
| Dystocia rate[3] when male is born – cycle 1 | 0.162 | 0.064 | 0.090 | 0.111 |
| – cycles >1 | 0.081 | 0.033 | 0.044 | 0.057 |
| Abortion rate | 0.01 | 0.01 | 0.01 | 0.01 |
| Stillborn calves as proportion of cows having easy calving – cycle 1 | 0.05 | 0.05 | 0.05 | 0.05 |
| – cycles >1 | 0.04 | 0.04 | 0.04 | 0.04 |
| Stillborn calves as proportion of cows having dystocia | 0.2 | 0.2 | 0.2 | 0.2 |
| Calves died within 48 hours as proportion of calves born alive after easy calving – cycle 1 | 0.01 | 0.01 | 0.006 | 0.01 |
| – cycles >1 | 0.008 | 0.008 | 0.005 | 0.008 |
| Calves died within 48 hours as proportion of calves born alive after dystocia – cycle 1 | 0.5 | 0.5 | 0.5 | 0.5 |
| – cycles >1 | 0.2 | 0.2 | 0.2 | 0.2 |
| Conception rate of heifers after – 1st mating | 0.4[1] | 0.4[1] | 0.6[2] | 0.6[2] |
| – 2nd mating | 0.6[2] | 0.6[2] | 0.7[2] | 0.7[2] |
| – 3rd mating | 0.7[2] | 0.75[2] | 0.5[2] | 0.5[2] |
| Conception rate of cows not having dystocia after – 1st mating | 0.3[1] | 0.3[1] | 0.6[2] | 0.6[2] |
| – 2nd mating | 0.7[2] | 0.6[2] | 0.7[2] | 0.7[2] |
| – 3rd mating | 0.6[2] | 0.75[2] | 0.5[2] | 0.5[2] |
| Losses of calves from 48 hours after calving to weaning | 0.06 | 0.04 | 0.06 | 0.06 |
| Peak milk yield (kg/day) | 8 | 8 | 12 | 9 |
| Fat content in milk (%) | 4.0 | 4.0 | 4.0 | 4.0 |
| Protein content in milk (%) | 3.5 | 3.5 | 3.4 | 3.5 |
| Mature weight of cows (kg) | 750 | 600 | 700 | 720 |

[1]artificial insemination; [2]natural mating; [3]sum of calving scores 3 and 4

1 to 4: no assistance (1), assistance of 1 or 2 persons (2), veterinary assistance (3) and Caesarean section (4). Calving scores 3 and 4 are called dystocia.

The average calving scores were set 1.33, 1.08, 1.26 and 1.28 for Charolais (CH), Angus (AA), Charolais × Simmental (CH × S) and Charolais × Holstein (CH × H) cows, respectively, based on the investigation of Hradecká (2002). The mortality rate of cows with dystocia was assumed to be 10% and the mortality rate of calves at birth after dystocia 20% (Ruvuna *et al*., 1992). The conception rate of cows after dystocia was assumed to be decreased by 15% compared to cows without dystocia (Laster *et al*., 1973). Data whose origin is not cited were made available by the Beef Cattle Breeders Association of the Czech Republic (oral communication).

Table 2. Performance of progeny groups (CH – Charolais, AA – Aberdeen Angus, H – Holstein, S – Simmental)

| Variable (unit) | Progeny group | | | |
|---|---|---|---|---|
| | CH | AA | CH × (CH × H) | CH × S |
| Weight of female calves at birth (kg) | 37.5 | 32.2 | 37 | 37.5 |
| Weight of male calves at birth (kg) | 40.5 | 34.7 | 40 | 40.5 |
| Weight of females at 120 days of age (kg) | 167 | 159 | 160 | 168 |
| Weight of males at 120 days of age (kg) | 178 | 169 | 173 | 182 |
| Weight of females at 210 days of age (kg) | 256 | 246 | 246 | 257 |
| Weight of males at 210 days of age (kg) | 280 | 270 | 264 | 286 |
| Weight of females at 365 days of age (kg) | 358 | 323.5 | 336 | 365 |
| Weight of males at 365 days of age (kg) | 504 | 480 | 424 | 517 |
| Daily gain of heifers in fattening (kg/day) | 1.3 | 1.2 | 1.2 | 1.3 |
| Daily gain of bulls in fattening (kg/day) | 1.5 | 1.4 | 1.3 | 1.5 |
| Slaughter weight of heifers in fattening (kg) | 600 | 450 | 550 | 600 |
| Slaughter weight of bulls in fattening (kg) | 700 | 500 | 680 | 700 |
| Dressing percentage of heifers (%) | 63 | 60 | 58 | 63 |
| Dressing percentage of bulls (%) | 65 | 62 | 60 | 65 |
| Dressing percentage of cows (%) | 56.5 | 54 | 55 | 56.5 |
| Daily gain of bulls in test (kg/day) | 1.7 | 1.6 | – | – |
| Productive lifetime of breeding bulls (years) | 5.5 | 5.5 | 6 | 6 |
| Mature weight of bulls (kg) | 1 100 | 900 | 1 100 | 1 100 |

The structure of progeny born in the herds depended on the production system and marketing strategy. Twenty per cent of male calves from the breeding herds were tested and seventy per cent of them selected and sold for natural mating or to AI stations. It was assumed that tested bulls were the property of farmers till selling or till slaughter of negatively selected bulls. Therefore, all cost and revenues connected with these bulls were part of the incomes and expenses of the purebred herds. Table 2 shows the trait values for breeding bulls and progeny groups. Data were obtained mainly from the progeny test report of the Beef Cattle Breeders Association of the Czech Republic (Šeba, 2002).

The profit calculated as the difference between returns and costs per calving in the herd and year (both discounted to the birth year of progeny by a discount rate of 10%) was used as a criterion for the economic efficiency of all production systems and marketing alternatives.

The revenues came from fattened bulls and heifers or from sold weaned calves, culled cows and heifers and from government subsidies. In purebred herds, the revenues from sold breeding bulls or heifers were added.

Revenues from slaughtered animals depended on slaughter weight, dressing percentage and on the distribution of carcasses into commercial classes for conformation and fatness (payment on the basis of SEUROP grading system is assumed). When scaling classes S to P as 1 to 6, then the average classes for fleshiness were 3.26, 3.65, 3.29 and 3.88 for CH, AA, CH × S and CH × (CH × H) progeny, respectively; the appropriate values for fat covering were 2.48, 3.93, 2.51 and 3.04. The price differences between the classes were set as proposed by Vrchlabský and Golda (2000). Revenues from exported calves depended on breed, sex and live weight. The main input parameters necessary for calculating revenues are summarized in Table 3. They describe the market situation in the Czech Republic around the year 2002 (Polach, personal communication; Poděbradský, personal communication).

Table 3. Parameters used to calculate revenues

| Parameter (unit) | Value |
|---|---|
| Price per kg slaughter weight of the best quality in SEUROP grading system | |
| heifers (CZK/kg) | 58 |
| bulls (CZK/kg) | 78 |
| cows (CZK/kg) | 49 |
| Price per kg live weight of calves for export (CZK/kg) | |
| Charolais or Charolais × Simmental | |
| male | 60 |
| female | 56 |
| Aberdeen Angus | |
| male | 50 |
| female | 45 |
| Charolais × (Charolais × Holstein) | |
| male | 56 |
| female | 52 |
| Price for pregnant breeding heifers Charolais (CZK/animal) | 35 000 |
| Aberdeen Angus (CZK/animal) | 30 000 |
| Price for crossbred breeding heifers (beef x dairy) purchased at 6 months of age | 12 000 |
| Government subsidies per cow with calf in cow-calf pasture system (CZK) | 9 000 |
| Government subsidies per fattened animal (CZK) | 1 000 |
| Government subsidies per exported male calf (CZK) | 1 000 |
| Government subsidies per purchased breeding bull for natural mating (CZK) | 20 000 |
| Government subsidies per performance-tested cow (CZK/year) | 80 |
| Government subsidies per bull at test station (CZK/day) | 50 |

CZK is the Czech currency unit (Czech crowns); (1 € ≅ 30 CZK)

The costs were related to feeding, housing, health, breeding, labour and interest of investments. The costs of feeding were calculated on the basis of daily net energy and protein requirement of animals and from the price for feed with given dry matter, net energy and protein content (see Tables 4 and 5). The values were taken over from Vencl *et al*. (1991), Sommer *et al*. (1994), Kudrna (1998) and Teslík *et al*. (2001). Daily net energy and protein requirements for growth, maintenance and pregnancy were calculated according to Vencl *et al*. (1991), AFCR (1993), Sommer *et al*. (1994), NRC (2000) and Petrikovič and Sommer (2002) as shown in Wolfová *et al*. (2004). It was assumed that all investigated production systems were placed in similar regions, so that the same quality and price of feeding components were set for all production systems.

Milk production of cows in different reproduction cycles was modelled on the basis of Wood's lactation curve using the modification of Fox *et al*. (1990). Average peak milk yields of breeds were taken over from Fox *et al.* (1990). The total milk production per cow ranged from 1 000 to 1 560 kg per 240 days of lactation according to breed and age of cows. The energy and protein available from milk were compared with the energy and protein requirements of suckling calves. At an insufficient milk amount, calf requirements were supplied by an extra feed ration. The main cost components are summarised in Table 6. These input parameters were adapted

Table 4. Feeding rations in cow herds

| Season and animal category | Feed (fresh matter) | | Price (CZK/kg fresh matter) | Dry matter (kg/kg fresh matter) | Net energy (MJ/kg dry matter) | Protein (g PDI/kg dry matter) |
|---|---|---|---|---|---|---|
| | Component | Proportion | | | | |
| **Summer** | | | | | | |
| Cows, heifers, bulls | pasture | 1.00 | 0.25 | 0.20 | 6.15 | 95.1 |
| Calves | pasture | 0.67 | 0.25 | 0.20 | 6.15 | 95.1 |
| | mashed oats | 0.33 | 2.50 | 0.88 | 7.45 | 86.2 |
| **Winter** | | | | | | |
| Cows | lucerne hay | 0.30 | 0.70 | 0.85 | 5.07 | 112.4 |
| | maize silage | 0.58 | 0.50 | 0.24 | 6.13 | 58.9 |
| | mashed barley | 0.12 | 3.10 | 0.91 | 8.25 | 92.4 |
| Calves | mashed oats | 1.00 | 2.50 | 0.88 | 7.45 | 86.2 |
| Heifers | lucerne hay | 0.18 | 0.70 | 0.85 | 5.07 | 112.4 |
| | maize silage | 0.78 | 0.50 | 0.24 | 6.13 | 58.9 |
| | mashed barley | 0.04 | 3.10 | 0.91 | 8.25 | 92.4 |
| Bulls | lucerne hay | 0.10 | 0.70 | 0.85 | 5.07 | 112.4 |
| | mashed oats | 0.14 | 2.50 | 0.88 | 7.45 | 86.2 |
| | maize silage | 0.73 | 0.50 | 0.24 | 6.13 | 58.9 |
| | wheat straw | 0.03 | 0.20 | 0.87 | 3.15 | 24.3 |

Table 5. Feeding rations in fattening

| Animal category | Feed (fresh matter) | | Price (CZK/kg fresh matter) | Dry matter (kg/kg fresh matter) | Net energy (MJ/kg dry matter) | Protein (g PDI/kg dry matter) |
|---|---|---|---|---|---|---|
| | Component | Proportion | | | | |
| Bulls | maize silage | 0.56 | 0.50 | 0.24 | 6.13 | 58.9 |
| | legume haylage | 0.15 | 0.70 | 0.47 | 5.02 | 79.0 |
| | extracted soya cake | 0.07 | 12.0 | 0.88 | 8.38 | 352.8 |
| | winter barley | 0.22 | 3.10 | 0.88 | 8.30 | 77.8 |
| | dicalcium phosphate | 0.01 | 13.0 | 1.00 | 0.00 | 0.00 |
| Heifers | maize silage | 0.58 | 0.50 | 0.24 | 6.13 | 58.9 |
| | lucerne hay | 0.16 | 0.70 | 0.85 | 5.07 | 112.4 |
| | extracted soya cake | 0.07 | 12.0 | 0.88 | 8.38 | 352.8 |
| | winter barley | 0.18 | 3.10 | 0.88 | 8.30 | 77.8 |
| | dicalcium phosphate | 0.01 | 13.0 | 1.00 | 0.00 | 0.00 |

according to Kvapilík (1995, 2000), Kvapilík *et al*. (1997), Teslík *et al*. (2001) and Daňo (personal communication) taking into account the rate of inflation and expected price trends in the Czech Republic.

The impact of the production level on reproduction, growth and fattening traits and the impact of the most important economic input parameters (prices for beef and breeding animals, cost of feed-

Table 6. Main input parameters used to calculate costs

| Parameter (unit) | | Value |
|---|---|---|
| Costs for veterinary treatment | | |
| cow with calf till weaning in pasture system (CZK/year) | | 400 |
| heifers from weaning to calving in pasture system (CZK/animal) | | 300 |
| breeding bulls in pasture system (CZK/animal) | | 170 |
| animals in fattening (CZK/animal) | | 170 |
| Fixed costs[1] (CZK/day) | | |
| cow with calf till weaning in pasture system | – Aberdeen Angus | 14.50 |
| | – other breeds or crosses | 15 |
| heifers from weaning to calving in pasture system | – Aberdeen Angus | 12.50 |
| | – other breeds or crosses | 13 |
| breeding bulls in pasture system | | 10 |
| animals in fattening | | 10 |
| Veterinary costs connected with calving score 3 (CZK/calving) | | 800 |
| Veterinary costs connected with calving score 4 (CZK/calving) | | 1 980 |
| Cost of removing and damming of a dead cow (CZK/animal) | | 1 700 |
| Cost of removing and damming of a dead young animal (CZK/animal) | | 1 200 |
| Price per semen dose for AI (CZK/dose) | | |
| top-producing Charolais or Aberdeen Angus for pure breeding | | 1 000 |
| Charolais for crossbreeding | | 200 |
| Price per breeding bull for natural mating (CZK/animal) | | |
| top-producing Charolais or Aberdeen Angus bulls | | 70 000 |
| Charolais or Simmental bulls for crossbreeding | | 40 000 |
| Price of strew for housing (CZK/kg) | | 0.15 |
| Price of dung (CZK/kg) | | 0.16 |
| Prise of water (CZK/l) | | 0.02 |

[1]Fixed costs include labour, capital replacement (buildings and machinery), repairing, insurance, energy and overhead expenses

ing and fixed cost) on the profitability of the production systems and marketing strategies were studied by increasing or decreasing these levels by 20%.

## RESULTS

The calculated herd structures for the investigated production systems are shown in Table 7. These structures correspond to a high level of reproductive performance (total conception rate of cows and heifers from 0.88 to 0.94) and health status (average cow losses including involuntary culling after dystocia or disease from 2.1 to 4.2% per reproduction cycle). The somewhat higher proportion of cows in the first reproduction cycle in purebred herds is caused by the application of artificial insemination that lowers the total conception rate of females. The differences in herd structure between the systems are further caused by the various expression of dystocia.

The structure of progeny is listed in Table 8. The high number of calves weaned in all systems (85.9% to 87.3%) corresponds to good survival rates of calves. The lowest value in Charolais (85.9%)

Table 7. Proportions of cows (in %) at the beginning of the individual reproduction cycles and average lifetime of cows in years

| Production System[1] | S1 | S1 | S2 | S3 |
|---|---|---|---|---|
| Breed of cow[2] | CH | AA | CH × H | CH × S |
| Proportion of cows in reproduction cycle | | | | |
| 1 | 18.8 | 15.6 | 15.2 | 15.2 |
| 2 | 15.7 | 13.8 | 13.5 | 13.5 |
| 3 | 13.4 | 12.4 | 12.3 | 12.3 |
| 4 | 11.4 | 11.2 | 11.1 | 11.1 |
| 5 | 9.7 | 10.1 | 10.1 | 10.1 |
| 6 | 8.3 | 9.1 | 9.1 | 9.1 |
| 7 | 7.1 | 8.1 | 8.3 | 8.3 |
| 8 | 6.1 | 7.3 | 7.5 | 7.5 |
| 9 | 5.2 | 6.6 | 6.8 | 6.8 |
| 10 | 4.3 | 5.8 | 6.1 | 6.1 |
| Average lifetime of cows (years) | 4.16 | 4.58 | 4.63 | 4.63 |

[1]S1 – pure-breeding systems with beef breed producing male and female replacement; S2 – crossing system with terminal crossing buying female and male replacement; S3 – crossing system with rotational crossing producing female replacement
[2]for the abbreviations of breeds see Table 2

Table 8. Number of progeny per 100 calvings

| Progeny group | Breed of progeny | | | |
|---|---|---|---|---|
| | CH | AA | CH × (CH × H) | CH × S |
| Female calves born alive | 47.2 | 47.3 | 47.2 | 47.4 |
| Male calves born alive | 46.7 | 47.1 | 47.0 | 47.0 |
| Female calves weaned | 43.6 | 44.9 | 43.9 | 43.9 |
| Male calves weaned | 42.3 | 44.4 | 43.4 | 43.1 |
| Female calves available for fattening or selling | 22.1 | 28.9 | 43.9 | 27.9 |
| Male calves available for fattening or selling | 33.8 | 35.5 | 43.4 | 43.1 |
| Heifers for own replacement | 21.5 | 15.9 | – | 16.0 |
| Tested bulls | 8.5 | 8.8 | – | – |
| Selected bulls | 5.9 | 6.2 | – | – |

For the abbreviations see Table 2

is mainly caused by a higher rate of dystocia in comparison with Aberdeen Angus or crossbred cows.

In Table 9, the economic efficiency of all investigated production systems and marketing strategies is given in form of the present value of profit and of profitability calculated as the ratio of profit to costs either with or without government subsidies. It is obvious that no system would be profitable without government subsidies. For the assumed

Table 9. Present value[1] of economic characteristics per calving and year in different production systems and with alternative marketing strategies

| | Production system (genotype of progeny) and marketing strategy | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S1 (CH) | | | S1 (AA) | | | S2 (CH × (CH × H)) | | S3 (CH × S) | |
| | FAT[2] | EXP[3] | SELH[4] | FAT | EXP | SELH | FAT | EXP | FAT | EXP |
| Revenues (CZK) | 19 841 | 16 321 | 22 378 | 15 275 | 14 085 | 19 497 | 19 204 | 13 942 | 17 979 | 14 001 |
| Cost (CZK) | 28 896 | 21 704 | 30 561 | 23 439 | 18 369 | 24 244 | 31 827 | 20 175 | 28 208 | 18 966 |
| Subsidies[5] (CZK) | 8 814 | 8 626 | 8 606 | 9 243 | 8 978 | 8 964 | 8 685 | 8 299 | 8 516 | 8 279 |
| Profit without subsidies (CZK) | –9 055 | –5 383 | –8 183 | –8 164 | –4 284 | –4 747 | –12 623 | –6 233 | –10 229 | –4 965 |
| Profit with subsidies (CZK) | –241 | 3 243 | 423 | 1 079 | 4 694 | 4 217 | –3 938 | 2 066 | –1 714 | 3 314 |
| Profitability[6] (%) without subsidies | –31 | –25 | –27 | –35 | –23 | –20 | –40 | –31 | –36 | –26 |
| Profitability[6] (%) with subsidies | –1 | +15 | +1 | +5 | +25 | +17 | –12 | +10 | –6 | +17 |

[1]revenues, costs and government subsidies per cow and its progeny born per year, all discounted to the calving date; [2]fattening of surplus progeny; [3]export of surplus weaned calves; [4]selling of surplus pregnant heifers and fattening of surplus bulls; [5]total government subsidies; [6]profitability is calculated as profit per monetary unit of costs and given in per cent

For the abbreviations of systems and breeds see Tables 2 and 7

Table 10. Influence of economic parameters and production level on the profitability of a pure-breeding system with integrated feedlot of surplus progeny (Charolais breed)

| Parameters (change in relation to the base level) | | Profit[1] (CZK) | Profitability | |
|---|---|---|---|---|
| | | | 100*profit/cost (%) | Change[2] |
| Base level of all input parameters | | **–241.4** | **–0.8** | |
| Conception rate of heifers and cows | (–20%) | –1 196 | –4.1 | –3.2 |
| | (+20%) | 205.9 | 0.7 | 1.6 |
| Losses of calves from 48 hours to weaning[3] | (–20%) | –26.1 | –0.1 | 0.7 |
| | (+20%) | –456.8 | –1.6 | –0.8 |
| Weight at weaning (at 210 days of age)[3] | (–20%) | –201.3 | –0.7 | 0.1 |
| | (+20%) | –106.4 | –0.4 | 0.5 |
| Daily gain in fattening[3] | (–20%) | –1 554 | –5.2 | –4.3 |
| | (+20%) | 625.8 | 2.2 | 3.1 |
| Mature weight[4] | (–20%) | 481.2 | 1.9 | 2.7 |
| | (+20%) | –1 330 | –4.1 | –3.3 |
| Bulls in test as proportion of weaned males | (–20%) | –767.7 | –2.7 | –1.8 |
| | (+20%) | 284.9 | 1.0 | 1.8 |
| Price per breeding bull | (–20%) | –921.2 | –3.2 | –2.4 |
| | (+20%) | 438.3 | 1.5 | 2.3 |
| Price per kg slaughter weight[5] | (–20%) | –3 467 | –12.0 | –11.2 |
| | (+20%) | 2 985 | 10.3 | 11.2 |
| Price for feed from pasture | (–20%) | 735.5 | 2.6 | 3.5 |
| | (+20%) | –1 117 | –3.8 | –2.9 |
| Price for winter feeding and feed in fattening | (–20%) | 2 045 | 7.7 | 8.5 |
| | (+20%) | –2 528 | –8.1 | –7.3 |
| Fixed cost per day in all categories of cattle | (–20%) | 1 468 | 5.4 | 6.2 |
| | (+20%) | –1 951 | –6.4 | –5.5 |

[1]per calving and year including government subsidies; [2]changes of profitability in comparison with the base situation (in percentage points); [3]changes in both sexes; [4]mature weight of cows and bulls and slaughter weight of bulls and heifers; [5]for bulls, heifers and cows

economic parameters, the losses were between 0.17 and 0.40 CZK (Czech crowns) per 1.00 CZK of invested costs according to the production system and marketing strategy. Including government subsidies, the highest profitability (10 to 25%) in pure breeding as well as in crossbreeding was shown by the strategy with selling of surplus weaned calves outside the system (export). When fattening was applied for surplus calves, only enterprises with a pure-breeding system producing their own replacement and mating them approximately at an age of 15 months were profitable, but only at a low level of profitability (5%). Enterprises that mated their replacement at an age of approximately 27 months or that purchased their replacement produced with losses even with government subsidies.

Comparing both pure-breeding systems with selling of weaned calves, a higher profitability was achieved in the system with Aberdeen Angus breed. Using this breed of early maturity type, 93% of the

Table 11. Influence of economic parameters and production level on the profitability of a pure-breeding system with selling of surplus weaned calves outside the system (Charolais breed)

| Parameters (change in relation to the base level) | | Profit[1] (CZK) | Profitability | |
|---|---|---|---|---|
| | | | 100*profit/cost (%) | Change[2] |
| Base levels of all input parameters | | **3 243** | **14.9** | |
| Conception rate of heifers and cows | (–20%) | 834 | 3.5 | –11.5 |
| | (+20%) | 4 435 | 21.5 | 6.5 |
| Losses of calves from 48 hours to weaning[3] | (–20%) | 3 532 | 16.3 | 1.3 |
| | (+0%) | 2 954 | 13.6 | –1.3 |
| Weight at weaning (at 210 days of age)[3] | (–20%) | 1 744 | 8.3 | –6.6 |
| | (+20%) | 3 507 | 15.8 | 0.9 |
| Daily gain in fattening[3] | (–20%) | 3 243 | 14.9 | 0.0 |
| | (+20%) | 3 243 | 14.9 | 0.0 |
| Mature weight[4] | (–20%) | 3 563 | 17.0 | 2.1 |
| | (+20%) | 2 311 | 10.3 | –4.6 |
| Bulls in test as proportion of weaned male calves | (–20%) | 2 243 | 10.5 | –4.5 |
| | (+20%) | 2 883 | 13.2 | –1.7 |
| Price per breeding bull | (–20%) | 2 563 | 11.8 | –3.1 |
| | (+20%) | 3 923 | 18.0 | 3.1 |
| Price per kg slaughter weight[5] | (–20%) | 2 501 | 11.5 | –3.4 |
| | (+20%) | 3 985 | 18.4 | 3.4 |
| Price per kg live weight of weaned calves[6] | (–20%) | 1 463 | 6.7 | –8.2 |
| | (+20%) | 5 023 | 23.1 | 8.2 |
| Price for feed from pasture | (–20%) | 4 196 | 20.2 | 5.3 |
| | (+20%) | 2 374 | 10.5 | –4.4 |
| Price for winter feeding and feed in fattening | (–20%) | 4 449 | 21.7 | 6.8 |
| | (+20%) | 2 037 | 8.9 | –6.1 |
| Fixed cost per day in all categories of cattle | (–20%) | 4 686 | 23.1 | 8.2 |
| | (+20%) | 1 800 | 7.8 | –7.2 |

[1]per calving and year including government subsidies; [2]changes of profitability in comparison with the base situation (in percentage points); [3]changes in both sexes; [4]mature weight of cows and bulls and slaughter weight of bulls and heifers; [5]for bulls, heifers and cows; [6]changes for both sexes

heifers were mated in the first mating period after weaning causing lower rearing cost. In the system with Charolais breed, 90% of the heifers were mated as late as in the second mating period. Further costs in the early maturity-type breed were saved by the lower requirement for feed for maintenance as the Aberdeen Angus cows were by 150 kg lighter than Charolais cows. A smaller area of pasture per cow was needed for the herds with Aberdeen Angus cows that decreased the depreciation costs of the farms. Applying fattening, the differences in efficiency between both systems were small. Higher costs in the system with Charolais were well balanced by higher revenues from heavier slaughter animals with higher carcass quality than in the system with Aberdeen Angus.

The somewhat smaller profitability in crossing system S2 was mainly caused by the lack of revenues from breeding bulls and by a lower price obtained for slaughter animals or for exported calves. The slightly higher profitability in crossing system S3 compared to system S2 can be explained by the medium maturity type of replacement heifers, 53% of which were mated already at an age of 15 months, and by higher carcass quality of the crossbred combination CH × S in comparison with the combination CH × (CH × H).

To find the main sources of economic efficiency of beef cattle production systems and to show possible changes in profit and profitability of enterprises operating in different production and marketing conditions, the main biological and economic parameters were increased or decreased by ±20%. The results are shown only for the pure-breeding system with Charolais with integrated feedlot (Table 10) or export of weaned calves (Table 11) because the remaining systems showed a similar behaviour.

Daily gain in fattening was the most important trait in the variant with feedlot followed by conception rate of females and mature weight of cows. The dependence of profit and profitability on the three traits was non-linear. As the levels of all these traits were already very high in the base situation, a lower level can be presumed in most of the enterprises in the Czech Republic resulting in lower profitability.

Evaluating the economic input parameters, the most important one was the price for slaughter animals. Changing the price in both directions by 20% evoked a change in profitability by 11 percentage points (the last column of Table 10).

Important sources of the variability in profitability of enterprises were feeding and fixed costs. Feeding costs depend on the geographic region to a large extent and, mainly in intensive feedlot, also on the market prices for feed components. Fixed costs were influenced after all by the depreciation costs (interest rate on investment). Prices of feed and fixed costs were shown to be the second and third most important economic inputs for the profitability level (the last rows in Table 10).

In the marketing variant with selling (export) of weaned calves (Table 11), the ranking of economic input parameters according to their importance is slightly different from the variant with feedlot. Prices for weaned calves are of major importance, followed by the level of fixed costs and winter feeding costs.

Among the traits, conception rate seems to be the main source of economic efficiency of systems exporting weaned calves. As shown in Tables 10 and 11, reproduction traits are nearly four times more important for this marketing strategy than for integrated feedlot. Decreasing the weaning weight of calves (that means the daily gain of calves till weaning) or increasing the mature weight by 20% also evoked an important decrease in profitability whereas the impact of the changes in the opposite direction was much smaller.

## DISCUSSION

The results showed significant differences in cow-calf enterprise profitability between production systems and marketing strategies. The factors that affect returns and costs are complex, interdependent and not easily to predict from a single production or economic input. Therefore, the results of this study must always be evaluated in the context of the production system, breeding and marketing strategy, breed and used input parameters. It must be taken into account that the comparison of the systems is made for the cow herd of the same size (the same number of cows per farm is assumed). Recalculating the results per ha of pasture or per ha of farm land, the differences between the evaluated systems can change.

The values of all input parameters used for the base calculation were chosen in such a way that they reflected the conditions in a high-level enterprise. Most of the enterprises in the Czech Republic do not reach this level (Golda *et al*., 2001). A possibility of selling weaned calves or breeding animals outside of the evaluated system is limited and depends on the demand for beef calves (in 2002, about 50% of the calves of Charolais breed weaned in the Czech Republic were exported, whereas no export of Aberdeen Angus calves was realized). Under these circumstances the average profitability of an enterprise should be estimated as the weighted average of the profitabilities calculated for marketing strategy with fattening and selling of surplus weaned calves, the weighting factors being the contingents of sold or fattened calves, respectively.

A comparison of our results for the variant applying feedlot with the literature is possible to a certain extent only. Most of the economic calculations are made for cow-calf pasture systems with weaned calves as a product for sale. Fattening is generally treated separately. In this case, the economic efficiency of both systems depends on the price of weaned calves to a large extent that is determined by the market situation rather than by the cost expended for the calf till weaning. In a Bavarian study carried on the Bayerische Landesanstalt für Betriebswirtschaft und Agrarstructur (2002, not published), farms with the sale of weaned calves reach lower profit than farms with integrated extensive feedlot. In our study (with intensive feedlot) the opposite results were obtained. But these results are not fully comparable because government subsidies for sold calves were not assumed in the study mentioned above. On the other hand, an extensive premium was paid for extensively fattened animals in Bavaria. Kvapilík *et al*. (1997) analysed the economic results of nine enterprises with a cow-calf pasture system of different breeds and production levels. The enterprises ran on average at a loss of 3 728 CZK (Czech crowns) per cow/year that corresponded to the profitability of –32% (by average costs of 11 478 CZK per cow/year). Including government subsidies (in the range from 6 190 to 9 190 CZK per cow/year), the profitability of 21 to 32% was reached. Golda *et al*. (2001) obtained similar results in a more recent study where they analysed 35 enterprises differing in size, breed, climatic conditions and performance of animals. Without government subsidies, the average loss was 5 926 CZK per cow/year (profitability –36%). Including average government subsidies of 6 600 CZK per cow/year, the profitability rose to +4%. Including a special support to the landscape maintenance and ecological farming, the profitability of about 20% was reached. These results were supported by our study, however, differences occurred according to the breeding system and marketing strategy.

In the USA, many studies deal with biological and economic comparisons of breeds and breeding systems. Davis *et al*. (1994) or Tess and Kolstad (2000) investigated the performance and economic efficiency of purebred and crossbred cow-calf production systems. When ranking the breed groups for net profit per cow, crossbreeding systems were always more profitable than pure-breeding systems. The reason for this was after all the higher weaning rate of crossbred cows, which was found to be the most important factor for economic efficiency of systems producing calves for sale in our as well as other studies (Kvapilík, 2000). The higher profit in a purebred population in comparison with crossbred herds presented in this study was mainly due to the sale of breeding bulls (or also breeding heifers). As Golda *et al*. (2001) already stated, the enterprises producing breeding animals can obtain a net profit by more than 25% higher than enterprises producing calves for fattening. The higher profitability of systems with mating heifers approximately at an age of one year in comparison with systems mating heifers a year later is connected with lower replacement costs. Breeds used as an example for both systems (Aberdeen Angus and Charolais) also differ in the dystocia rate, survival rate of calves and mature weight of cows (maintenance cost), which is another reason for the profitability differences between both systems. The fact that Charolais calves have a higher growth rate (Říha *et al*., 2001) and that bulls or heifers can be slaughtered at higher slaughter weights and reach better carcass quality than Angus (Chambaz *et al*., 2003) cannot offset the above-mentioned advantages of the Angus breed. But the ranking of genotypes for economic performance can change when changing the production and economic conditions as shown in Kahi *et al*. (1998).

The detailed analysis in this study showed a high variability in the profit and profitability of cow-calf production systems in dependence on breeding and marketing possibilities and on the level of biological and economic input parameters. Reproductive performance of females was found to be the main biological and management sources of economic efficiency in cow-calf production systems applying the export of weaned calves. Average daily gain was even more important in systems with integrated feedlot. These results correspond to other Czech analyses (Kvapilík *et al*., 1997; Golda *et al*., 2001). Feuz and Umberger (2003) stated that the annual variations in cattle price account for a large portion of the variation in net returns to the cow-calf sector in the USA over time and that the major cost differences between high-cost and low-cost producers were attributed to differences in feed costs. Mintert (2003) concluded that as much as 80% of the variability in cattle feeding profits in the USA enterprises was explained by the variability in fattened cattle prices. In a study by Mark *et al*. (2002) it was shown that the monthly average profit per head for steers in two western Kansas commercial feed yards in the period from 1985 to 1999 ranged from $137.13 to $147.22. Mintert (2003) or Peel (2003) indicated cattle performance (growth rate) and interest rate (the main component of fixed cost) as the other most important factors for beef cattle profitability These findings are fully confirmed in the present study (see Tables 10 and 11).

## CONCLUSIONS

Beef cattle enterprises in the Czech Republic cannot operate without government subsidies as a rule**.** The subsidies at the level assumed in this study served for balancing the economic losses of the evaluated systems to a different extent. As expected, a high variability in the profitability of beef cattle enterprises can be caused by differences in biological performance of animals (breed differences), management strategies (pure breeding or crossing, mating type, feeding regime, housing technology), natural conditions (differences in feed quality and feed supply between regions) and in marketing possibilities (demand for breeding animals or calves for export, special marketing programs for beef meat). The program ECOWEIGHT can help to analyse and optimise a large variety of cattle production systems and is therefore a useful tool for beef cattle breeders and farmers.

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## ABSTRAKT

### Základní faktory ekonomické efektivnosti produkčních systémů s chovem masného skotu

Byla vypočtena ekonomická efektivnost různých produkčních systémů s pastevním chovem masného skotu pro alternativní strategie marketingu. K výpočtu byl použit program ECOWEIGT. Za předpokládané úrovně produkčních a ekonomických parametrů nebyl ani jeden ze zkoumaných systému bez započtení státní podpory rentabilní. Dotace poskytované při splnění stanovených podmínek vyrovnaly ekonomickou ztrátu u systémů, které mohly prodávat všechna odstavená telata nepotřebná k obnově stáda mimo hodnocený systém (export). Při této strategii marketingu byla dosažena rentabilita 10 až 25 %, v závislosti na produkčním systému. Při integrovaném výkrmu telat vykazoval rentabilitu pouze čistokrevný systém chovu s raným připouštěním jalovic (v 15 měsících) a prodejem plemenných býků, i když pouze na úrovni 5 %. Všechny ostatní zkoumané systémy vykazovaly při integrovaném výkrmu ztrátu i při započtení státní podpory. Podrobná analýza ukázala vysokou proměnlivost zisku a míry rentability systémů chovu krav bez tržní produkce mléka v závislosti na typu plemenitby a možnostech trhu a v závislosti na úrovni biologických a ekonomických vstupních parametrů. Z hlediska biologických znaků byla nejdůležitějším faktorem ovlivňujícím ekonomickou efektivnost chovů produkujících odstavená telata na prodej mimo daný systém shledána reprodukce plemenic. Ve variantě s výkrmem byl ještě významnější přírůstek zvířat ve výkrmu. Nejvýznamnějším ekonomickým faktorem pro míru rentability ve všech systémech se zdají být ceny produkce (ceny jatečných zvířat ve variantě s výkrmem a ceny odstavených telat ve variantě s prodejem telat).

**Klíčová slova**: masný skot; produkční systémy; strategie marketingu; ekonomická efektivnost; zisk

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