Table S1. Detailed calculation of the profit function

The profit function was created as the difference between income and costs per young animal slaughtered per year as shown in Figure 1. Profit per young animal slaughtered per year (*PROFa*) was obtained as:

$$PROFa = n \times \left(I_S - FAT - PROD \right)$$

where *n* is the rate of slaughtered young animals per year; *Is* is income per young animal slaughtered; *FAT* are fattening costs; and *PROD* are production costs.

Number of young animals slaughtered per year (n)

The rate of young animals slaughtered per year depends on age at slaughter, and is affected by age at weaning and fattening time per year, and was calculated as:

$$n = \frac{365}{\left(AW + FL_{sla} \right)}$$

where AW is age at weaning and FL_{sla} is the length of the feedlot period for a young animal slaughtered.

Income per young animal slaughtered (I_s)

Income per young animal slaughtered was calculated as:

$$I_s = CW_a \times p_a$$

where CW_a is carcass weight (in kg) of a young animal, and p_a is the average price per kg of carcass of a young animal. If carcass weight data is available it is used in the calculation, otherwise, carcass weight is calculated as the weighted sum of male and female carcass weights, such that:

$$CW = \sum_{S=1}^{2} (SW_S \times CD_S) \times f_s$$

where *SW* is the slaughter weight of each sex (subscript *s* refers to sex where *s*=1 is male and *s*=2 is female); *CD* is the carcass dressing rate; and *f* is the proportion of animals slaughtered by sex.

Slaughter weight is the weighted sum of the slaughter weights of males and females and was calculated as:

$$SW = \sum_{s=1}^{2} \left(BW_s + ADGw_s \times AW + ADGf_s \times FL_{\text{sla}} \right) \times f_s$$

where BW is birth weight; *ADGw* is average daily gain until weaning; *AW* is age at weaning; *ADGf* is average daily gain in fattening; FL_{sla} is length of feedlot period; and *f* is the proportion of animals slaughtered by sex (*s*=1, male; *s*=2, female).

The average young animal carcass price per kg was calculated as:

$$p_a = \sum_{s=1}^{2} p(CCS) \times f_s$$

where *p(CCS)* is the price depending on the carcass conformation score as per the EUROP classification and sex (*s*=1, male; *s*=2, female); and *f* is the proportion of animals slaughtered by sex.

The ratio of slaughtered females and males depends on the female replacement rate in the herd. The ratio by sex was assumed to be 50% at calving with equal calving mortality and the proportion of animals slaughtered of each sex (f_1 =males and f_2 =females) was calculated as:

$$f_1 = 0.50 \times (1 + RR)$$

$$f_2 = 0.50 \times (1 - RR)$$

where *RR* is replacement rate per calving and was calculated as the percentage of heifers in the herd per cow per calving. This rate depends on the longevity of adult cows and is expressed as the number of daughters retained per calving for replacement to maintain constant herd size, in accordance with the number of dead or culled cows:

$$RR = \frac{1}{Nc}$$

where *Nc* is the number of calvings per cow, calculated as:

$$\mathrm{Nc} = \left(\frac{ALC - AFC}{CI} \right) + 1$$

where *ALC* is age at last calving; *AFC* is age at first calving; and *CI* is calving interval.

Fattening costs per young animal slaughtered (FAT)

The fattening cost per young animal slaughtered was calculated as the sum of meeting daily energy requirements for maintenance and growth multiplied by the price per unit of energy from weaning to slaughter. Daily energy requirements were estimated for maintenance and growth in accordance with NRC (2000). Energy requirements were expressed in UFC per animal per day (Vermorel, 1978) as a function of average daily gain and metabolic weight

(UFC: the unit of energy requirements for animals in fattening is equivalent to 1855 kcal of NE). The calculation of fattening costs is:

$$FAT = \sum_{i=AW}^{Sa} \left(p_{UFC} \times DER_i \right)$$

where p_{ufc} is price per UFC and *DER* is daily energy requirements, calculated as a function of the average live calf weight and average daily gain in feedlot weighted by the proportion of animals slaughtered by sex (*s*=1, male; *s*=2, female), *f*:

$$DER = \sum_{s=1}^{2} f_s \times DER_s$$

Production cost (PROD)

Production cost is the feeding cost required to satisfy the entire of energy requirements of the animals in the herd (suckler cows, heifers and fattening of culled cows) minus the incomes from fattened culled cows after culling decision. Production cost, expressed in euros per young animal slaughtered per year, was calculated as:

$$PROD = \frac{FC - Icc}{\mathbf{Pr}}$$

where *FC* is feeding cost; *Icc* is income from the sale of culled cows; and Pr is productivity. Below is the detailed explanation of each of these terms.

Feeding Cost (FC)

Feeding cost is the sum of the net energy needs of the animals in accordance with their different physiologic status (heifer, suckler cow, and culled cow) expressed per slaughtered young animal and year. Energy requirements for suckler cow, heifers and culled cows are estimated using INRA (1988) and Agabriel and D´Hour (2007) recommendations. If the cost of purchased feed is available *FC* are obtained directly. Feeding cost was calculated as:

$$FC = (SER + HER) \times p_{ufl} + CER \times p_{ufc}$$

where *SER* are yearly energy requirements per suckler cow; *HER* are yearly energy requirements per heifer expressed in UFL per suckler cow per year; (UFL: unit of energy requirements for animals in low growth, gestation, maintenance and lactation equivalent to 1730 kcal of NE); p_{ufl} is the price of one UFL; *CER* is fattening cost of culled cows; and p_{ufc} is the price per one UFC). The energy requirements were estimated as follows:

- The energy requirements of suckler cows (*SER*) Include maintenance, lactation, and gestation requirements. They are expressed in UFL per cow per year and were calculated as:

$$SER = F \times \left(MER_d \times \left(CI - 120 - AW \right) + \text{GER}_d \times 120 + LER_d \times AW \right)$$

where F is number of calvings per cow per year; MER_d, GER_d and LER_d are the average daily energy requirements for maintenance, gestation (last four months of gestation), and the lactation period, respectively; CI is the calving interval. The lactation period equals age at weaning, AW. These daily requirements were estimated using INRA (1988) and Agabriel & D'Hour (2007) equations and are described as:

- MER_d are the daily energy requirements per cow to meet total net energy requirements in the maintenance period (non-lactation and non-last third of gestation) as per Agabriel and D´Hour (2007) and depended on mature weight, grazing factor (which for intensive is 1.1 and for extensive is 1.2) and condition score (1-5). For this study we considered extensive conditions (grazing factor 1.2) and condition score of 3.

- GER_d are the daily energy requirements to meet total net energy requirements per suckler cow in the last third of the gestation period (maintenance plus gestation requirements) and is a function of mature weight, condition score, grazing factor and calf birth weight. Ddaily energy requirements are increased as a function of gestation month and BW of $0.5 \; x \; birth \; weight / 40$ UFL per day in the fifth month of gestation, $0.7 \; x \; birth \; weight / 40$ UFL per day in the sixth gestation, $1.7 \; x \; birth \; weight / 40$ UFL per day in the seventh month of gestation and $2.6 \; x \; birth \; weight / 40$ UFL per day in the eighth month, in the last month of gestation suckler cow is not supplemented. Values were obtained from Daza-Andrada (2014) and Agabriel and D´Hour (2007).

- LER_d are the daily energy requirements per suckler cow to meet energy requirements in the lactation period (maintenance plus lactation requirements) and it is a function of mature weight, condition score, grazing factor and milk yield.

- Energy requirements of heifers (HER): These are the average energy requirements per heifer considering yearly maintenance and growth requirements until the cow reaches first calving. It is expressed in UFL per suckler cow per year and was calculated as:

$$HER = RRy \times B \times \left(1 + \frac{M_H}{2}\right) \times HER_d \times 365$$

where *RRy* is the yearly replacement rate (number of heifers per suckler per year); *B* is the number of batches of contemporary heifers; M_H is heifer mortality (assumed to be the same as adult mortality); and HER_d are average daily energy requirements per heifer per day (Table 2). HER_d was calculated following Daza-Andrada recommendations (2014) and Agabriel and D´Hour (2007) and it depended on average daily gain of heifer. The yearly replacement rate was calculated as:

$$RR_y = RR \times F$$

where *F* is the number of calvings per cow per year and *RR* is the replacement rate per cow and calving and determines the daughters intended as replacements per cow per year, as explained previously. The number of batches of heifers in the herd was calculated as:

$$\mathrm{B} = \frac{\mathrm{AFC} - AW}{365}$$

where AFC is the age at first calving and *AW* is age at weaning.

- Culled cow energy requirements (*CER*): The requirements of fattening culled were expressed in UFC per suckler cow per year and were calculated as:

$$CER = Rc \times CER_d \times FL_c$$

where *Rc* is the culled cow rate; CER_d is average daily energy requirements per culled cow (Table 2) and Fi_{lc} is the length of the fattening period for culled cows. The rate of culled cows in the herd was calculated as:

$$Rc = RRy \times (1 - Mc)$$

where *RRy* is the yearly replacement rate and *Mc* is mortality from weaning to culling of cows, which is a function of age at last calving (*ALC*), age at weaning (*AW*) and adult mortality (*M*):

— Culled cow income (Icc). Income from the sale of fattened culled cows was calculated as:

$$Icc = Rc \times CW_c \times p_2$$

where *Rc* is the rate of culled cows; CW_c is the carcass weight of a culled cow; and p_c is the price per kg of a cow carcass. It is expressed in euros per cow per year. The carcass weight of

a culled cow was calculated from the dressing percentage and live weight at culling recorded after fattening.

— Productivity (Pr). Productivity is the number of calves slaughtered per cow per year and is calculated as:

$$\mathrm{Pr} = \mathrm{F} \times (1 - Mb - Mpw) \times (1 - RR) \times (1 - Mf)$$

where F is fertility expressed as number of calvings per cow per year; *Mb* is mortality within the first 48h after birth; *Mpw* is average pre-weaning mortality; *Mf* is average mortality during fattening; and *RR* is the average replacement rate per calving. Fertility is expressed as the rate of calves born per cow per year and calculated as the ratio between 365 (days) and the calving interval (*CI*).

$$F = \frac{365}{CI}$$