ECONOMIC CONSIDERATIONS IN DAIRY CATTLE BREEDING

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SUMMARY

In this contribution a general approach for the derivation of economic weights is given. Economic weights have been derived for two perspectives: maximizing profitability per cow (cow profitability) maximizing profitability per unit of product (product profitability). Product profitability is equal to costs per unit of product in a one product situation. The economic weights for the two perspectives are identical when product output is restricted. This also holds in a situation with multiple products and one with variation in herd life. Fixed enterprise costs only influence the economic weights when product profitability is used in a situation without a restriction on input or output. Influences of perspective and restrictions are illustrated for a situation where profitability is a function of lactation yield of fat and protein and herd life. Using product profitability the economic weight of fat or protein results from a reduction in costs per unit of product and a change in the ratio of fat to protein. It is concluded that product profitability should be taken as perspective in deriving economic weights.

INTRODUCTION

The goal of dairy breeding programmes is to improve economic merit of cows. When several traits contribute to economic merit a selection index can be used as proposed by Hazel (1943). The selection index combines the available information to maximize the expected genetic progress in economic merit. Economic merit in this case is a linear function of the additive genetic values of the component traits, with the weighting factors being the partial regression coefficients of economic merit on genetic level of the trait. The weighting factors are often referred to as economic weights. Economic weights are used to calculate revenues of a breeding programme and to combine estimated breeding values of components traits into an estimated breeding value for economic merit of animals for selection purposes.

Moav (1973) found that the economic weights depend on the perspective taken; whether it is based on a unit of product, the individual animal or production unit. Smith et al. (1986) showed that these differences disappear when it is assumed that resources are efficiently used, and changes in output will require proportional changes in input. This method, which is referred to as rescaling, assumes that fixed costs, like variable costs, can be expressed per unit of output, rather than as a fixed total enterprise costs. The latter assumption restricts the applicability of this result (Groen, 1989). Most studies on the influence of perspective and input or output restrictions on economic weights have been performed for a one product situation. Gibson (1989) determined economic weights of production traits when multiple output restrictions apply. Discussions on the derivation of economic weights have been focussed on production traits while little attention has been paid to secondary traits like herd life.

In this contribution a general approach for the derivation of economic weights will be given where emphasis will be on the influence of perspective and input or output restrictions. In addition to a one product situation, a situation with multiple products and one with variation in herd life will be studied.
METHOD TO DERIVE ECONOMIC WEIGHTS

Classifications of methods to calculate economic weights have been discussed by several authors (Brascamp, 1983; Elsen et al., 1986; Groen, 1989). In this paper a normative approach is used in which profitability is described by one equation. In this case, the economic weights of traits can be derived by partial differentiation. In some cases, one equation does not allow a very detailed description of profitability of a dairy cow or herd. For a more detailed description a set of equations, also referred to as a bio-economic model, can be used (e.g. Groen, 1989). A single equation, however, will be used in this paper because it is sufficient to illustrate which elements contribute to economic weights and to show consequences of different perspectives and restrictions.

GENERAL APPROACH

The total profitability of a dairy herd (T) can be described by the following general formula:

\[ T = -c_F + N_h (L (R-C) - 0) \]  

where:
- \( c_F \) = fixed costs of total enterprise;
- \( N_h \) = number of heifers entering the herd;
- \( L \) = average number of lactations per cow;
- \( R \) = average revenues during a lactation per cow;
- \( C \) = average costs during a lactation per cow;
- \( O \) = net rearing costs which is the difference between average rearing costs and average carcass value at time of disposal.

The number of cows in the herd is a function of average herd life \( L \) and the number of heifers entering the herd \( N_h \). Lactations are assumed to be of fixed length. Alternatively the herd size can be described by the number of lactating cows: \( N_c = N_h L \). So equation (1) can also be written as:

\[ T = -c_F + N_c (R-C-0/L) \]  

The variables \( L \), \( R \) and \( C \) are functions of the component traits for which economic weights are to be determined. The number of cows in the herd \( N_c \) can be influenced by some of these traits in case of a restriction on input or output. Economic weights of a trait \( x \) can be determined by partial differentiating equation (2) to that trait:

\[ \frac{\delta T}{\delta x} = N_c \left( \frac{\delta R}{\delta x} - \frac{\delta C}{\delta x} \right) L + \left( \frac{\delta L}{\delta x} \right) 0/L^2 \]  

The first part of equation (3) represents the change in profitability of each cow due to \( \delta x \). The second part represents the change in the number of cows as a result of \( \delta x \) which is multiplied by \( T_e = R-C-0/L \) which represents the average profit per cow. The fixed costs of the total enterprise \( c_F \) do not affect the weight. When the number of cows and the average herd life are not affected by \( \delta x \), i.e. \( \delta N_e/\delta x = \delta L/\delta x = 0 \), the economic weight of \( x \) on herd level is equal to:

\[ \frac{\delta T}{\delta x} = N_c \left( \frac{\delta R}{\delta x} - \frac{\delta C}{\delta x} \right) \]  

The economic value expressed per cow is then equal to:

\[ 1/N_c \frac{\delta T}{\delta x} = \frac{\delta R}{\delta x} - \frac{\delta C}{\delta x} \]  

This is the result that is traditionally used in a free market situation where there are no restrictions on input or output (Van Arendonk et al., 1985; Gibson, 1989; Groen, 1989). Influence of restrictions

The influence of input or output restrictions at the herd level on economic weights will be illustrated for a situation involving three traits: the lactation yield of milk-non-fat \( m \) and fat \( f \), and fat content \( f_c = f/(m+f) \). The average
revenues and costs in equation (2) are assumed to be linear functions of these traits:

\[ R = r_0 + p_m m + p_f f \]  
where \( r_0 \) is fixed revenues per lactation and \( p_m \) and \( p_f \) is price per unit of \( m \) and \( f \), respectively. Similarly, average costs per lactation can be described by:

\[ C = c_0 + c_m m + c_f f \]  
where \( c_0 \) is fixed costs per lactation and \( c_m \) and \( c_f \) is costs per unit of \( m \) and \( f \), respectively. Herd life of cows was assumed unaffected by production traits and therefore the net rearing costs \((O/L)\) are treated as part of \( c_0 \). In this example, the price and costs per unit of fat content \((fc)\) are equal to zero. Fixed revenues per lactation \((r_0)\) have a similar but opposite effect as the fixed costs per lactation \((c_0)\). They will can be subtracted from the fixed costs and will therefore be omitted.

The number of cows in the herd \((N_c)\) can be described by the following function:

\[ N_c = \frac{Q_t}{F} \]  
and \[ F = Q_0 + L(q_m m + q_f f + q_{fc} fc) \]  
where \( Q_0 \) is a constant representing the size of the herd and \( Q_0, q_m, q_f \) and \( q_{fc} \) are parameters representing the type of restriction on herd size. Equation (8) allows for multiple restrictions when all these restrictions are non-independent which means they can be converted onto the same base.

The economic weights using equations (3), (6), (7) and (8) will be derived for three different output restrictions. A restriction on the herd milk volume output can be represented by \( F_1=m+f-v \) and a restriction on herd fat production by \( F_2=f \). In the European Community non-independent restrictions on milk yield and fat% are used in which a change in fat% is converted into a change in milk yield. This multiple restriction can be represented by:

\[ F_3 = (m+f)q_{fc}(m+f)(fc-fc_r) - v(1+q_{fc}(fc-fc_r)) \]  
where \( q_{fc} \) represents the scaling of the output of milk with fat content \( fc \) to that of milk with a fat content equal to the reference level \((fc_r)\). Currently in The Netherlands \( q_{fc} \), the penalty in milk output, is .18% when the fat content \((%)\) is .01 above the reference level, which means that in equation (9) \( q_{fc} \) is 18.

The economic weights for the three output restrictions are given in Table 1. By substituting \( T_a 's \) components (see (8) and (9)) in Table 1, it can be shown that the economic weight of fat yield in case of a fat quota \((F_3)\) does not contain the price and costs per unit of fat (Groen, 1989b; Gibson, 1989b).

Table 1 Economic weights expressed per cow for milk non fat yield \((m)\), fat yield \((f)\) and fat content \((fc)\)* when restrictions** on herd level apply based on milk volume output \((F_1-v)\), fat output \((F_2)\) and a combination of milk output and fat content \((F_3)**

<table>
<thead>
<tr>
<th>Quota**</th>
<th>Milk</th>
<th>Fat content</th>
<th>Fat yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_1 )</td>
<td>( p_m - c_m - (1/v)T_a )</td>
<td>( v(p_f - p_m - c_f + c_n) )</td>
<td>( p_f c_f - (1/v)T_a )</td>
</tr>
<tr>
<td>( F_2 )</td>
<td>( p_m - c_m )</td>
<td>( v(p_f - p_m - c_f + c_m) - (1/fc)T_a )</td>
<td>( p_f c_f - (1/f)T_a )</td>
</tr>
<tr>
<td>( F_3 )</td>
<td>( p_m - c_m - \frac{T_a}{F_3} )</td>
<td>( v(p_f - p_m - c_f + c_m) - \frac{q_{fc}vT_a}{F_3} )</td>
<td>( p_f c_f - \frac{(1+q_{fc})(fc-fc_r)}{F_3} )</td>
</tr>
</tbody>
</table>

* \( p_{fc} \) and \( c_{fc} \) are equal to zero.
** \( F_1=m+f-v; F_2=f; F_3=v(1+q_{fc}(fc-fc_r)) \).
*** \( T_a \) is the average profitability per cow, excl. fixed enterprise costs.
The weights for milk and fat yield in the situation of a combined quota \( Q_3 \) depend on the penalty \( q_{fc} \), the average fat content \( (fc) \) and the reference level \( (fcr) \). The reduction in economic weight for milk with a volume restriction \( T/v \) is equal to that with a multiple quota if the population average is taken as the reference level \( (fc=fcr) \). The reduction in weight for fat yield in the latter case equals \((1+q_{fc})/v\), which is equal to \((1/v)+(1/f)\) if \( q_{fc} \) is equal to the inverse of the fat content. In other words when \( q_{fc}=1/fc \) the reduction in economic weights due to output restrictions in case of the multiple quota is equal to the sum of the reduction with a single quota on milk and fat yield. This agrees closely with Gibson(1989b) who stated that the weight for fat with the multiple quota was equal to that in case of a fat quota.

**Perspective**

In deriving economic weights the perspective in this paper so far has been: maximizing profit per cow (cow profitability). In literature (Dickerson, 1970; Smith et al., 1986) economic weights have also been estimated from changes in economic efficiency defined as costs per unit of output. In a one product situation this is equivalent to profit per unit of product. The latter definition of economic efficiency will be used in this paper because it can be used in a multiple product situation. It will be referred to as product profitability. First, results for cow and product profitability will be compared for a one product situation where herd profitability is:

\[
T = -c_F + N_c(p_y-c_y-c_o)
\]

Product profitability per unit of product \( y \) is:

\[
T_p = 1/(N_c y)T = p_y-c_y-c_F/(N_c y)-c_o/y
\]

\[
\delta T_p/\delta y = (c_F/N_c+c_o)/y^2
\]

Expressed per cow:

\[
y \frac{\delta T_p}{\delta y} = (c_F/N_c+c_o)/y
\]

Table 2 gives the economic weight of \( x \) obtained from cow and product profitability with and without a restriction on output. The economic weight obtained from product profitability does not contain the marginal revenues or costs. The weight is a result of spreading the fixed costs per farm \( (c_F) \) and cow \( (c_o) \) over more product. In case of a output restriction the economic weight is only a function of the fixed costs per animal. This weight is equal to the weight in case of cow profitability and a restriction on output. Without a restriction, however, the economic weights are completely different.

**Table 2 Economic weight expressed per cow of production \( y \) when the objective is maximization of cow or product profitability in a situations with and without restriction of output**

<table>
<thead>
<tr>
<th>Profitability</th>
<th>No restriction</th>
<th>Output restriction**</th>
</tr>
</thead>
<tbody>
<tr>
<td>cow</td>
<td>( p_y-c_y )</td>
<td>( c_o/y )</td>
</tr>
<tr>
<td>product</td>
<td>( (c_F/N_c+c_o)/y )</td>
<td>( c_o/y )</td>
</tr>
</tbody>
</table>

* Herd profitability equals: \( T = -c_F + N_c(p_y-c_y-c_o) \) where \( N_c \) is number of cows; \( p_y \) and \( c_y \) is marginal revenues and costs per unit of product, respectively; \( c_F \) and \( c_o \) are fixed costs for herd and cow, respectively.

** \( N_c = Q/y \)**
Multiple product situation

The dairy cow produces among others milk, fat and protein. This implies that in case of an output restrictions it has to be specified which component trait or combination of component traits is restricted. Similarly the unit of product has to be defined when product profitability is taken as the perspective. In case of two component traits \((x,y)\) herd profitability can be described by the following function:

\[
T = -c_F + N_c (p_x x + p_y y - c_x x - c_y y - c_0)
\]

(14)

When the profit is expressed per unit of \(x\) the weight of \(y\) is equal to the marginal profit of an additional unit of \(y\) (Table 3). The weight of \(x\), however, results from a change in fixed costs per unit of \(x\) and an associated loss in marginal profit from \(y\). The situation where profit is expressed per unit of \(x\) is a special case of the more general case where a combination of the two traits is taken as unit of expression (Table 3). The economic weights obtained from maximizing product profitability are the same as those obtained for cow profitability when the output is restricted.

Table 3 Economic weights expressed per cow for two component traits \((x,y)\) when different perspectives are taken (in italics) with or without an output restriction

<table>
<thead>
<tr>
<th>restriction</th>
<th>(x)</th>
<th>(y)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>product profitability per unit of (x)</strong></td>
<td>(c_o + c_F/N_c \cdot (p_y - c_y) y)</td>
<td>(x(p_y - c_y))</td>
</tr>
<tr>
<td>no</td>
<td>(c_o - (p_y - c_y) y)</td>
<td>(x(p_y - c_y))</td>
</tr>
<tr>
<td>on (x)</td>
<td>(a(c_0 + c_F/N_c) \cdot y\cdot (a(p_y - c_y) - b(p_x - c_x)))</td>
<td>(b(c_0 + c_F/N_c) \cdot x\cdot (b(p_x - c_x) - a(p_y - c_y)))</td>
</tr>
<tr>
<td>(x(p_x - c_x))</td>
<td>(b(p_x - c_x)\cdot (p_y - c_y))</td>
<td>(b(c_0 + c_F/N_c) \cdot x\cdot (b(p_x - c_x) - a(p_y - c_y)))</td>
</tr>
<tr>
<td>(a(p_y - c_y)\cdot b(p_x - c_x))</td>
<td>(b(p_x - c_x)\cdot a(p_y - c_y))</td>
<td>(b(c_0 + c_F/N_c) \cdot x\cdot (b(p_x - c_x) - a(p_y - c_y)))</td>
</tr>
<tr>
<td><strong>cow profitability</strong></td>
<td>((p_x - c_x)(ax+by))</td>
<td>((p_y - c_y)(ax+by))</td>
</tr>
<tr>
<td>no</td>
<td>((p_x - c_x)(ax+by))</td>
<td>((p_y - c_y)(ax+by))</td>
</tr>
<tr>
<td>on (ax+by)</td>
<td>((p_x - c_x)\cdot (ax+by))</td>
<td>((p_y - c_y)\cdot (ax+by))</td>
</tr>
<tr>
<td>(b(p_x - c_x)\cdot a(p_y - c_y))</td>
<td>(b(p_x - c_x)\cdot a(p_y - c_y))</td>
<td>(b(c_0 + c_F/N_c) \cdot x\cdot (b(p_x - c_x) - a(p_y - c_y)))</td>
</tr>
</tbody>
</table>

* \(T = -c_F + N_c \cdot y\cdot (p_y - c_y)\cdot c_0 - 0/L\)

** *** economic weights per cow are multiplied by \(x\) and \(ax+by\), respectively

Changes in herd life

Till now, consequences of changes in average production traits have been studied assuming a constant herd life of cows. The economic weights of herd life and production will be derived using the following equation for herd profitability:

\[
T = -c_F + N_c \cdot y\cdot (p_y - c_y)\cdot c_0 - 0/L
\]

(15)

Using this equation the economic weight of herd life expressed per cow equals:

\[
1/N_c \cdot \delta T/\delta L = 1/N_c [N_c O/L^2 + (\delta N_c/\delta L)\cdot y\cdot (p_y - c_y)\cdot c_0 - 0/L]
\]

(16)

What happens to \(N_c (-\delta N_c/L)\) as a result of a change in herd life is not so clear. The number of cows can be assumed fixed, which is implicitly assumed in calculations on a cow level. In that case \(\delta N_c/\delta L\) equals zero and the economic weight of herd life equals \(0/L^2\). Alternatively the number of heifers entering the herd can be taken as fixed in which case \(\delta N_c/\delta L\) is no longer zero but equal to \(N_h\).
The economic weight when \( N_h \) is fixed equals:

\[
\frac{1}{N_c} \delta T / \delta L = \frac{1}{N_c} \left[ N_c \left( \frac{0}{L^2} + N_h (y(p_y - c_y) - c_o - \frac{0}{L}) \right) \right] = (y(p_y - c_y) - c_o) / L
\] (17)

The value of herd life results from a change in lifetime production due to a change in herd life and does not depend on the net rearing costs. Using product profitability as the objective, the economic weight of herd life when \( N_c, N_h \) or product output is fixed, respectively, only differs in the term involving fixed costs \( c_F \) (Table 4). These costs are only included when \( N_h \) is fixed. Comparing the weight for herd life when maximizing cow or product profitability, there is only a difference when \( N_h \) is fixed. The economic weight of the production trait \( y \) is the same for \( N_c \) and \( N_h \) fixed (Table 4). The relative weights for production and herd life using cow and product profitability are equal when product output is restricted. The relative weights with the other restrictions differ considerably.

Table 4 Economic weight expressed per cow for production \((y)\) and herd life \((L)\) when the objective is maximization of cow profitability* or product profitability (profit per unit of product) with different restrictions**.

<table>
<thead>
<tr>
<th>Restriction</th>
<th>Cow profitability</th>
<th>Product profitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>( N_h ) fixed</td>
<td>((y(p_y - c_y) - c_o) / L)</td>
<td>((c_F/N_h + c_0 + 0/L) / y)</td>
</tr>
<tr>
<td>( N_c ) fixed</td>
<td>(0/ L^2)</td>
<td>(0/ L^2)</td>
</tr>
<tr>
<td>Product fixed</td>
<td>(0/ L^2)</td>
<td>(0/ L^2)</td>
</tr>
<tr>
<td>( N_h ) fixed</td>
<td>(p_y - c_y)</td>
<td>((c_F/N_c + c_o + 0/L) / y)</td>
</tr>
<tr>
<td>( N_c ) fixed</td>
<td>(p_y - c_y)</td>
<td>((c_F/N_c + c_o + 0/L) / y)</td>
</tr>
<tr>
<td>Product fixed</td>
<td>((c_o + 0/L) / y)</td>
<td>((c_o + 0/L) / y)</td>
</tr>
</tbody>
</table>

* cow profitability: \(1/N_c \delta T = -c_F/N_c + (y(p_y - c_y) - c_o - \frac{0}{L})\)

** \( N_h, N_c \) is number of heifers and cows respectively.

A longer herd life results in a greater proportion of cows in lactations with a higher production which implies a higher average production. This can be included in the economic weight of herd life given in Table 4 by adding \( \delta y / \delta L \) times the economic value of production \((y)\) in the corresponding situation.

INFLUENCE OF VARIATION

The derivation of the economic weights has so far been based on evaluating changes in the performance of an average cow. Van Arendonk (1985) determined the economic value of a 20% reduction in involuntary disposal rates using dynamic programming. When variation in production between cows was accounted for, the economic weight was 50% higher than in a situation without variation in production. This increase was caused by an increase in voluntary culling of low producing cows or, in other words, an adaption of the optimum culling strategy of the farmer. The increase in voluntary culling resulted in a smaller change in average herd life. Similar results were found by Rogers et al. (1988). These studies demonstrate that the economic weight of herd life is seriously underestimated when changes in optimum management strategies as a result of changes in potential herd life are not accounted for. Changes in optimum management strategies also occur when conception rates of dairy cows are improved (Van Arendonk and Dijkhuizen, 1985; Boichard, 1987).

ILLUSTRATION

The influences of the perspective taken and output restrictions on economic weight are illustrated in Table 5 for a situation where profitability is a function of lactation yield of fat \((F)\) and protein \((P)\) and herd life \((L)\). To calculate the
Table 5 Economic weights* for lactation yield of fat (F), protein (P) and herd life (L) to illustrate influence of perspective and output restrictions**

<table>
<thead>
<tr>
<th></th>
<th>cow profitability</th>
<th>product profitability per unit of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rest F P L</td>
<td>F+P F P L</td>
</tr>
<tr>
<td>Nh</td>
<td>4.75 9.50 .22</td>
<td>.81 5.55 .22</td>
</tr>
<tr>
<td>F+P</td>
<td>-.31 4.44 .12</td>
<td>-.31 4.44 .12</td>
</tr>
<tr>
<td>F</td>
<td>-4.35 9.50 .12</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>4.75 -1.88 .12</td>
<td></td>
</tr>
</tbody>
</table>

* Economic weight for fat and protein expressed in Dfl.cow⁻¹kg⁻¹ and herd life in Dfl.cow⁻¹d⁻¹.

** T=\frac{c_FN_h}{p_F+p_P-c_EF-c_P-P-O/L}; Fixed costs used in Dfl.cow⁻¹: c_F/N_h=600, c_E=800, O=700; Prices and costs in Dfl.kg⁻¹: p_F=7.75, p_P=11.0, c_F=3.0, c_P=1.5; production level: F=300 kg cow⁻¹yr⁻¹, P=240 kg cow⁻¹yr⁻¹, L=4 yr.

Economic weights the results in Table 3 and 4 were combined. The economic weight for herd life differs greatly between number of heifers (Nh) fixed and number of cows or product output fixed. The economic weight of fat or protein when there is a restriction on F+P is a result of a reduction in fixed costs (c_F/O/L=975) per unit of product and a change in the ratio of fat to protein. The latter effect equals Dfl -2.64 and Dfl 2.11 per additional kg of fat and protein produced, respectively. The economic weight (Dfl/kg/cow) ranges from -4.35 to 4.75 and -1.88 and 9.50 for fat and protein, respectively.

DISCUSSION AND CONCLUSIONS

In this study two perspectives in deriving economic weights have been compared: maximization profitability per animal of unit of product. Smith et al. (1986) showed that in a one product situation identical relative economic weights are obtained for these two perspectives when appropriate rescaling of the size of the enterprise is applied with profitability per animal. Economic weights for product profitability where identical without any form of rescaling. They, however, they did not distinguish between fixed costs per animal and fixed enterprise costs. Results in this study (Tables 2, 3 and 4) show that the equivalence between the two perspectives holds in a situation with both types of fixed costs when in both cases the same restriction is applied. Smith et al. (1986) argued that rescaling should be used in calculating economic weights to correct for any extra profit that could also be obtained by altering the size of the operation. When rescaling is applied the economic value of genetic improvement comes from reducing costs per unit of product which is obviously equal to improving product profitability. Gibson(1989) and Groen(1989b) demonstrated that rescaling should be applied in situations where farmers have to operate within legislated quotas.

In this study it is shown that the equivalence between relative economic weights for the two perspectives also holds in situations with more than one product. In that case it has to be specified which trait or combination of traits is restricted and should be used as basis to calculate product profitability. The fact that this combination has to be specified seems to create a problem. However, this cannot be an argument to chose for maximization of cow profitability without any restriction on input or output. When fixed enterprise costs can be ignored the economic weights obtained for product profitability do not depend on the production situation in terms of restrictions on input or output.

The difference in perspective refers to the level at which economic weights are obtained and not to that on which they are expressed. Whether economic weights are
expressed on the level of the herd, cow or product affects the absolute size but not the relative economic weights.

Profit equations which reflect the realized profitability of cows have been used to determine the relative importance of traits, such as herd life and production, based on field data (see review Pearson and Miller, 1981). Van Arendonk (1989) showed that in case of differences in herd life between cows the profitability of each cow should be corrected for the profitability an average cow would have yielded during the same period. The economic weights with and without this correction correspond with those in Table 4 for a fixed number of heifers and cows, respectively. That this type of rescaling should occur is accepted in economic models to evaluate the effect of herd life.

A single profit equation has been used to determine economic weights in this study. The results obtained by partial differentiating the equation clearly show which elements contribute to economic weights of traits in a given situation. To calculate the different elements more complex bio-economic models can be used as demonstrated by Groen (1989). Presenting not only the resulting economic weight but also the elements that have contributed will improve its application and comparison.

In a multiple product situation the economic weights using product profitability depends on the linear combination of traits that is used as product unit. This is illustrated in Table 5 for a situation with fat and protein production. The economic weight of fat or protein in that case is a result of the reduction in costs per unit of product and the financial consequences of the change in ratio of fat and protein. The balance between these two elements depends on the weight of fat and protein in the product unit. These weights can be chosen to reflect the ratio of products that is aimed for in the breeding programme. This suggests that product profitability should be taken as perspective in deriving economic weights.

REFERENCES

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