Challenges of including welfare and environmental concerns in the breeding goal

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ABSTRACT

The increasing concern about animal welfare and environmental services related to animal production calls for a proper accounting for these values in the definition of animal breeding goals. The aim of this paper is to review current status in existing methodology and to discuss challenges associated with considering welfare and environmental concerns in the breeding goal. Challenges include; 1) the value of improved animal welfare may not be reflected by prices and costs in the market economy, 2) the views of many different stake holders (farmers, consumers, citizens, and governmental authorities) need to be considered, 3) traits related to environmental goods and animal welfare are often negatively correlated with production traits, which means that a) increased emphasis on these traits will reduce response in production traits, and b) traits related to animal welfare and environment may deteriorate even when they are included in the breeding goal. Animal welfare and environmental issues can be considered by adding so-called non-market values representing the value of improved environment and animal welfare to the economic values in the breeding goal. Breeding goals addressing animal welfare and environmental issues should be defined by deriving economic values (market economic values and non-market values) using methods based on studying consumer and citizen preferences and desired gains in addition to traditionally applied profit equations.

INTRODUCTION

Today European consumers view farm animals not only as an instrumental mean for nutrition but also in relation to other key social goals such as food safety, food quality, environmental protection, and animal welfare. Therefore, public authorities are obliged to take these demands of civil society into account when formulating and implementing relevant policy regarding farm animal production. There is a growing body of EU legislation on animal welfare which takes into account public concerns, stakeholder input and possible socioeconomic implications (Horgan and Gavinelli, 2006).

Potential economic benefits of improving animal welfare and protecting the environment depend on consumer beliefs and interest in "ethical" production. To properly assess the potential outcome of costs and benefits of welfare actions, it is important to also understand ethical values and their potential role in consumer behaviour and preferences. Animal welfare, resource use and the effect on the environment are some of the most pressing concerns about modern farm animal breeding (Gamborg and Sandøe, 2003). Good animal welfare is among other things characterized by freedom from pain and diseases and possibilities to express normal behaviour. Breeding influences environment, behaviour, and animal welfare through genetic changes in traits related to these issues such as disease resistance. The increasing concern about animal welfare and environmental issues related to animal production calls for a proper accounting for these values in the definition of animal breeding goals (Olesen et al., 2000, 2006).

In the breeding goal, each trait is weighted by its respective economic value, defined by the change in profit for a unit change in the trait (Hazel, 1943). The breeding goal expresses the targeted direction of genetic improvement for the different traits which are included in the

breeding goal and/or selection index. In the past livestock breeding programmes have primarily focused on improving production traits. Selection for production traits only will lead to deterioration of traits negatively correlated with the production traits (Rauw et al., 1998). An example of this is selection for milk yield which will reduce resistance to mastitis (see review by Heringstad et al., 2000) and other diseases in dairy cows (e.g. van Dorp 1998) if not proper measures are taken in the selection program to prevent it. These negative side-effects of selection for production traits are in conflict with animal welfare (Sandøe et al., 1999). Including traits related to welfare and environmental issues in the breeding goal is a step in the right direction but may not be enough to avoid deterioration of these traits.

Traditional methods to derive the economic values in the breeding goal using profit equations (e.g. Brascamp et al., 1985; Goddard, 1998) with the objective to maximize the profit of the farmer do not directly consider the values of public goods such as animal welfare and environment. Olesen et al. (2000) suggested including a "non-market" value in addition to the economic value in the breeding goal to consider values related to animal welfare and social aspects such as environmental issues. Tools for deriving values related to welfare and environmental issues have been proposed (Olesen et al., 1999) but literature on how to derive values to traits related to welfare and environment (e.g. Kanis et al., 2005; Nielsen et al., 2005, 2006) is scarce. In addition, assigning values to traits related to environment and animal welfare remains to be a challenge since the value of such issues may not be transferred via the market.

Therefore the objective of this paper was to outline challenges associated with including welfare and environmental issues in livestock breeding goal, and to review current status on available methodology and their advantages and limitations.

INCLUDING WELFARE AND ENVIRONMENTAL CONCERNS IN THE BREEDING GOAL

Definition of breeding goal values related to welfare and environment

The values used to weigh the traits in the breeding goal (breeding goal values) can be divided into values of private goods driven by current market forces and values of public goods independent of current market forces.

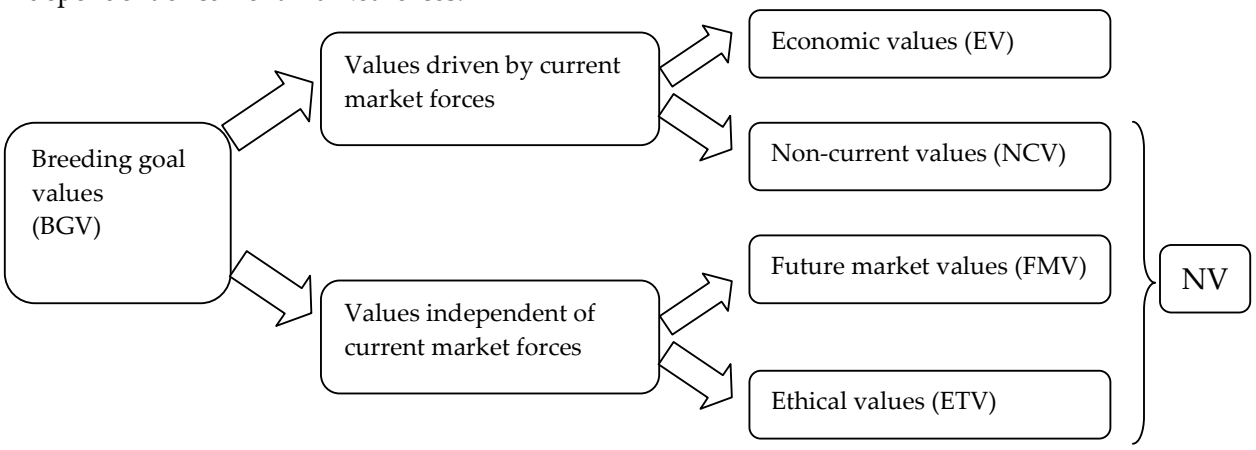

Figure 1. Breeding goal values determining the breeding goal grouped according to whether they are driven by current market forces or independent of current market forces.

Values which are directly linked to current market forces will be included in the calculated economic values (EV) because farmers and/or retailers get paid a higher price for the product from animal from a production system with a higher level of animal welfare or with lower influence on

the environment. Therefore these can usually be defined using traditional methods such as profit equations and bio-economic models.

In some cases however, the value of improved animal welfare and/or environment are linked to market forces in the sense that consumers are willing to pay extra for these improvements of the products. However, the product can not be differentiated from other products due to missing labelling in the current market (Non-current values, NCV). In order to quantify the value of improved welfare based on consumer's willingness to pay, products need to be labelled indicating that these differ in level of e.g. animal welfare. By this, parts of animal welfare or environmental improvements become private goods with values and prices reflecting market demand and supply. Another example could be legislation on levels of animal welfare and environment. The government might regulate the level of diseases which is acceptable, making an increase in the value of the trait possible to improve animal welfare without a change in the market price of products. However, the governmental legislation may mimic a market force through fines, which makes an effective market incentive.

With respect to values which are independent of market forces, improved animal welfare can have a value even though there are no market forces directly or indirectly linked to it. A change in traits may affect animal welfare and environment but farmers or breeding companies are not paid for the product improvement, as e.g. for breeding animals with better animal welfare or animals that contribute to improve or maintain the environment. Here we can differentiate between two types of values; future market values (FMV) and (ETV). With respect to FMV one can image a situation where consumers today are not willing to pay more for animals with a higher level of welfare such that the improvement in animal welfare will not be reflected in current prices of products. However, a breeding company may think that in the future their client will demand animals with a higher level of animal welfare due to the anticipation that consumers are expected to be willing to pay more for products from such animals in the future. In New Zealand and Australia for example, a substantial number of sheep breeders include selection for animal resistance to internal parasites (based on recorded faecal egg counts of animals under artificial or natural challenges) as part of their breeding programmes. In so doing, they sacrifice significant amounts of progress that could be made in alternative production traits, and also incur significant recording costs. With effective drenching systems, the economic value of internal parasite resistance is low. However, the calculated value (Amer et al. 1999) is based on a sustainable drenching regime, whereby the expected build-up of genetic resistance by the parasite to anthelmintic treatment is expected to be minimal. The breeders who are aware of the risks of drench resistant parasites and have ram buying clients demanding such rams, choose to adopt an index including a value of resistance to parasites calculated in this way.

Although consumers do not directly demand animal welfare products today, we know that consumers are concerned about animal welfare. Hence, a media scandal giving bad publicity about farm animal welfare may effectively introduce the market forces through drastically reduced consumer demand and prices of the animal product in question.

With respect to ethical values, improved animal welfare may have a value which will most likely never be linked to market forces (ETV). This can for example be feet and leg problems in pigs (Kanis et al., 2005) and dairy cattle where a reduction in problems have an ethical value due to the fact that farmers, and other people involved, e.g. in handling the animals (at slaughter) do not have to look at or know about pigs and cows suffering. Finally, parts of the improvement in animal welfare traits will never be reflected in the market because animal welfare is a public good and market prices do not fully reflect the economic value people place on animal welfare (McInerney, 2004; Olesen et al., 2006).

Challenges associated with including animal welfare and environment issues in the breeding goal

We will focus on three types of challenges associated with including animal welfare and environment issues in the breeding goal. First, the main challenge of including welfare and environmental issues in the breeding goals is, as specified earlier, that the value of improved animal welfare may not be reflected by prices and costs in the market economy. In addition, consumers do not see animal welfare in food production mainly as their responsibility (Kjørstad, 2005). People direct this responsibility to the government, producers, and retailers. Furthermore, consumers have limited knowledge about animal production and breeding (Ouédraogo, 2003). This may also explain the gap between attitudes and concerns of animal welfare and actual buying practices. This also indicates that market prices of labelled and animal friendly products do not reflect the total value people place on animal welfare.

Secondly, the views of many different stake holders (e.g. farmers, consumers, citizens, and governmental authorities) need to be considered when defining breeding goals including welfare traits in order to include their concern about animal production (Gamborg and Sandøe, 2005). When deriving economic values these are usually derived at the farm level aiming at maximising farmer profit. When including e.g. consumer and citizens views on animal and welfare concerns, the values need to be derived at a higher level of the production system (e.g. sector or national level). Deriving values at a higher level of the production system is complicated due to the increase in system size and often conflicting interests of the different actors (e.g. consumers and farmers).

The third which adds to the latter problem of conflicting interests is that increased emphasis on traits related to environmental goods and animal welfare may reduce the response in production traits. The reasons are that

- including more traits in the breeding goal normally reduces the response per trait in the breeding goal,

- relatively higher emphasis on functional traits affecting animal welfare will reduce the selection pressure on production traits

- functional traits are often negatively correlated with production traits.

Production traits usually have relatively high heritabilities and economic values, which means that too much reduction in response in production traits due to improvement in welfare traits is not desirable because this will cause large reductions in overall market economic response. Therefore, improvements in traits related to welfare needs to be balanced with improvements in production and quality traits. In addition, because traits related to animal welfare such as disease resistance usually have low heritabilities, these may deteriorate even when they are included in the breeding goal. Thus including a trait related to animal welfare in the breeding goal is no guarantee for genetic improvement in the trait. Hence, appropriate weighing of traits through real economic values is also needed to avoid unfavourable genetic changes

Including values related to welfare and the environment in the breeding goal

Olesen et al. (2000) suggested including ecological, social, and ethical priorities in the breeding goal by adding so-called non-market values. In that case the breeding goal by Hazel (1943) is expanded to a function of both economic values and non-market values:

$$H = [NV_1 * Y_1 + EV_1 * Y_1] + [NV_2 * Y_2 + EV_2 * Y_2]$$ (Olesen et al., 2000),

where

NV = non-market value for trait 1 and trait 2

EV = economic value for trait 1 and trait 2

Y_1 ,Y_2 = genetic value for trait 1 and 2

A trait may have both an economic value and a non-market value or only one of them. A trait with both an economic value and a non-market value could be mastitis resistance in dairy cows, where the economic value is derived based on lower costs to the veterinarian. In addition, mastitis resistance can have a non-market value due to improved welfare of the cow due to lower risk of getting mastitis. Response to selection can be divided into non-market response and market response (Olesen et al., 2000) where genetic gain in a given trait is weighted by their respective NV and EV:

Non-market response: $NV_1 * \Delta G_1 + NV_2 * \Delta G_2$
Market response: $EV_1 * \Delta G_1 + EV_2 * \Delta G_2$

where
ΔG = response for trait 1,2 and for non-market or market response

In this paper we used the term non-market values to refer to values unlinked to market forces (FMV, ETV) and those values which can not directly be measured in the current market (NCV).

Methods to derive the non-market value of improved welfare and environment

Different methods have been suggested in order to derive non-market values (Olesen et al., 1999). Among these are desired gain indices, and stated preference techniques such as contingent valuation methods (Mitchell and Carson, 1993) and choice experiments based on consumers willingness to pay for a given product. In the following, we will review existing methods which can be used to derive values of animal welfare and environmental issues and discuss advantages and limitations of the methods.

Methods to derive the value of improved welfare and environment driven by market forces

When the value of improved welfare and environment is directly linked to current market forces the value can be derived using traditional methods such as profit equations or bio-economic models. The different methods and approaches were reviewed by for example Goddard (1998) and will not be further considered here. When the consumers are willing to pay for a given product but the product can not be differentiated from other products due to missing labelling in the current market (NCV) situation the value of improved welfare and environment can be derived from consumer theory based on stated preference techniques such as contingent valuation methods (Mitchell and Carson, 1989; Bateman and Willis, 1999) or market experiments based on nonhypotetcical or real choices (RC) (Carlsson and Martinsson, 2001; Lusk and Schroeder, 2004). Contingent valuation (CV) and market experiments are useful to estimate peoples' willingness to pay for goods and products which are not traded in the market.

An example of application of contingent valuation theory is the study by von Rohr et al. (1999) who derived values for meat quality traits in pigs. Meat quality experts from slaughter and retail companies were interviewed about how much they were willing to pay for specific products because market prices were not available for the different meat quality classes. The values for the meat quality traits were then derived based on the answers from the interview.

A choice experiment may also be used to predict future trends and market values of e.g. labelled products. In a choice experiment, respondents (e.g. consumers or citizens) are asked to view various alternative descriptions of a good (e.g. meat or milk) differentiated by attributes (traits), levels of traits and prices. To give an example, consumers could be asked to choose

between milk produced from cows with either 1 case of mastitis or 2 cases of mastitis in different price scenarios. Within the context of consumer theory, the chosen alternative is assumed to be associated with the highest utility (satisfaction by consuming different bundles of goods and services) (Train, 2003).

An example of application of a real choice experiment is the study by Olesen et al. (2006a), where the aim was to estimate consumer's willingness to pay for improved fish welfare. People were asked to make 10 choices between various pairs of three types of salmon filets, which differed with respect to price and label of production system (i.e. conventional farm, organic production system or Freedom Food certified farm (certified by the animal welfare organisation, RSPCA). Based on consumers' choices of salmon filet, the willingness to pay for an organic produced salmon filet was 2 Euro more per kg filet compared to a conventional or Freedom Food salmon filet. This example illustrates that if animal products can be labelled and marketed as produced at a higher level of animal welfare or more environmental friendly, at least a part of the value of improved welfare can be estimated. This also means that if it is possible to label products in the future, the value of improved animal welfare is no longer a non-current value but a market economic value, because improved welfare of the fish then will be reflected by the market price.

A problem with labelling of animal products is that in order to be able to use labelling in an animal breeding context, the labelling need to be tied up to individual traits (Nielsen and Amer, 2007). For example in the study by Olesen et al. (2006) consumers were asked to choose between conventional or organic produced salmon filet, which was not specified on a trait basis (e.g. improved fish welfare due to higher disease resistance). This makes it difficult to include the value of improved fish welfare in the breeding goal, because the value needs to be defined per unit of the trait. Another problem with labelling on an individual trait basis is that it may be difficult for the consumers to conceive (Nielsen and Amer, 2007). When considering surveys with consumers as respondents, performance levels of traits must be explained properly to the consumers (e.g. what is mastitis and what are the consequences for the cow of getting infected with mastitis). Hence, appropriate and in depth CV studies (with interviews) are probably needed for this type of analyses.

A general problem with market studies such as choice experiments is that in practise with many traits in the breeding goal, it may be unrealistic to present the respondent with choices among all alternative combinations of traits and their levels. Therefore, it is important to generate and ask the survey questions in such a way that the maximum amount of information is collected from each respondent given other constraints such as limited complexity for the respondent and the cost of the survey. In addition, with many traits in the choice experiment, there is a risk that respondents may simplify the task by focusing only on the most important traits. Therefore, limits need to be placed on the number of traits that can be realistically examined (Carlsson and Martinsson, 2001). Nielsen and Amer (2007) showed how to simplify choices for respondents using a partial profile choice experiment. In a partial profile design the choices are simplified in the sense that only a subset of traits is presented to the respondent in each comparison. With a breeding goal with e.g. 6 traits, respondents can be presented with only 3 or 4 of the 6 traits at a time.

Methods to derive the value of improved welfare and environment independent of current market forces

Derivation of values in the breeding goals is complicated when these are not directly linked to market forces (FMV and ETV). Methods based on the selection index theory can be used to derive such values.

Kanis et al. (2005) used so called retrospective selection indices to define sustainable breeding goals for pig breeding programmes. Their method is based on exploring the selection response surface for traits in the breeding goal by increasing the breeding goal value for traits, which are

likely to have a non-market value. Based on the selection response surface, breeding company can then choose the breeding goal values corresponding to the response, which they find most sustainable or acceptable.

Nielsen et al. (2005, 2006) developed methods to derive non-market values for traits related to sustainability such as mastitis resistance in dairy cattle. Their methods are based on how much farmers or breeding organizations are willing to lose in selection response for production traits in order to improve functional traits related to sustainability. Accepting a reduction in response in a production trait, allows for increased value and thus increased response in one or more traits related to sustainability. The disadvantage is that the choice of level of loss in response in the production trait is subjective. However, it may be possible to obtain estimates for trade-offs between production traits and welfare related traits from surveys with respect to people's willingness to support governmental legislation or subsidies through taxes (Olesen et al., 2006). An advantage of the method is that it gives a value of the response in a functional trait relative to response in production traits, which may be appealing to farmers because production traits usually determine the farmers' main income. In addition, including the view of the farmer of the level of trade-off between responses in production versus in functional traits might reduce the risk of the breeding goal being ignored. Moreover, it is possible to directly show the public how much response in production traits farmers or breeding organizations are willing to loose to improve functional traits.

In general, methods based on selection index theory have the advantage that they integrate the concept of derivation of non-market values into classical breeding methodology, which may appeal to farmers and breeding companies. In addition, they are based on prediction of selection response for individual traits, which is an advantage because it may be easier to communicate with breeding companies based on selection response instead of breeding goal values (Kanis et al. 2005), since breeding goal value in it self does not say much about the actual selection emphasis on a given trait.

Without subsidies, the incentives for breeding companies to produce animals contributing positive to the environment or with improved animal welfare will be low. Due to slow genetic progress for low-heritable traits related to animal welfare, breeding companies, who has focused on these traits, may lose market shares to competitors who have focused on short term improvement of production traits. Therefore, it is likely that in many situations and for many reasons, livestock managers will place insufficient emphasis on e..g. animal welfare in their selection decisions. Under these circumstances, an outside party (e.g. governmental legislation) may construct a selection objective which they feel is more appropriate to achieving improved animal welfare. Such an approach is advocated by Olesen et al. (2000) based on a philosophical views of sustainability. However, this creates a serious risk of the selection objective being ignored. However, there seem to be a trend that breeding companies are increasingly focusing on consumer concern and the impact this could have on long term demand. Also super market chains may impose their buying power on their suppliers, to make sure production practices are acceptable and avoid food scandals in media. This is effectively compensating for market failure, and creating a new market driver which is not explicitly linked to consumers paying more for differentially labelled products (NCV). Breeding companies can use methods based on desired gain indices (Nielsen et al., 2006) to increase genetic progress for traits related to welfare and environment, and keep up with their competitors.

CONCLUSION

In this paper we have addressed challenges of included issues related to environment and animal welfare when defining breeding goals and discussed advantages and limitations of existing

methods. Even though these methods provides the tool sets for considering environmental and environmental issues in the breeding objective, it still remains to be shown how to apply these methods in practise. This includes decisions about whether farmers should take all the cost of improving trait related to sustainability or whether society should cover some of the losses e.g. through subsidised production. In order to define breeding goals including values related to animal welfare and environment, profit equations or bio-economic models should be combined with methods based on people's willingness to pay and/or methods based on selection index theory.

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