BREEDING FOR IMPROVED WELFARE OF PIGS, A CONCEPTUAL FRAMEWORK

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INTRODUCTION

There is evidence that several animal welfare aspects have a genetic basis (e.g. Hemsworth *et al.*, 1990), indicating that purposive selection for a better animal welfare could be successful. However, pig breeding programmes seem to pay little attention to improving welfare. Indeed, selection for longevity, leg quality, exterior, heritable defects, disease resistance, etc. could improve pig welfare (Wilkie and Mallard, 1999; Yazdi *et al*., 2000), but their main aim is often economic benefit. Probably the best example in pigs of breeding for an economic trait (meat quality) that clearly resulted in a better welfare is, selection against stress susceptibility by means of the halothane test (e.g. Schaeffer *et al*., 1989 ; Geers *et al*., 1994).

Systematic selection for a better animal welfare first requires clear and unambiguous definitions of traits involved in welfare. Next, it should be decided what the breeding goal traits should be and which measurable traits could provide sufficient information about welfare. Direct selection for improved welfare is hindered by a lack of traits that represent animal welfare in a direct way and applicable to range of (practical) conditions. To find relevant traits, a conceptual framework is developed based on the capabilities of pigs to cope with their environment. Such a framework can act as a tool to facilitate breeding for better welfare, as is shown in an accompanying paper by Kanis *et al*. (2002).

WELFARE AND ADAPTATION

Animal welfare is a complex concept, which is difficult to define operationally, and hence to evaluate empirically (Rowan, 1997). In the present study we describe animal welfare as the quality of life, as perceived by the animal concerned (see Bracke *et al*., 1999). More formalised, we consider animal welfare as similar to "animal happiness" which can be seen as the balance between an animal's positive and negative emotions or feelings over a certain time period. Such emotions depend on the differences between the animals' needs and the extent to which those needs are satisfied. Usually animals will perform adaptive behaviour to bridge these differences, such that they feel better. The stronger the coping efforts and the lower their success rate, the more negative emotions likely arise with the animals and the worse their welfare is assumed to be. Adaptation is mainly based on behavioural and physiological mechanisms which are different per need but all are aiming at bridging the gap between the animal's ideal situation and the actual situation. Adaptation mechanisms can be an important starting point for genetic selection. To explain this we use the need for thermal comfort as an example.

THERMO REGULATION: A CONCEPT-DELIVERING EXAMPLE
In accordance with Mount (1979), we assume that pigs are able to maintain their deep body temperature within the ambient temperature range C0-C5 (figure 1), where the C-values represent critical temperatures marking different thermo-regulatory zones. The zone C1-C4, in which metabolic heat production (H) is independent of ambient temperature, is usually referred to as the thermoneutral zone (e.g. Verstegen and Close, 1994). In the zone C2-C3, pigs regulate their heat loss by just the unconscious mechanisms vasoconstriction and vasodilatation. An ambient temperature above C3 will motivate pigs to search for additional cooling possibilities, for example lying on a cold floor or wetting of the skin. A further increase of ambient temperature from C4 to C5 results in a reduced feed intake and additional physiological actions, like active panting, to get rid of the superfluous heat. A decrease in ambient temperature from C2 to C1 will generate motivation to perform adaptive behaviour like huddling, or to look for a well-insulated place to lie on in order to lose less body warmth. If the temperature decreases from C1 down to C0, other, more explicit regulatory mechanisms start to operate, pigs produce extra heat (e.g. by shivering). Ambient temperatures lower than C0 or higher than C5 cannot be coped with sufficiently, resulting in a loss of homeothermy, ultimately leading to death.

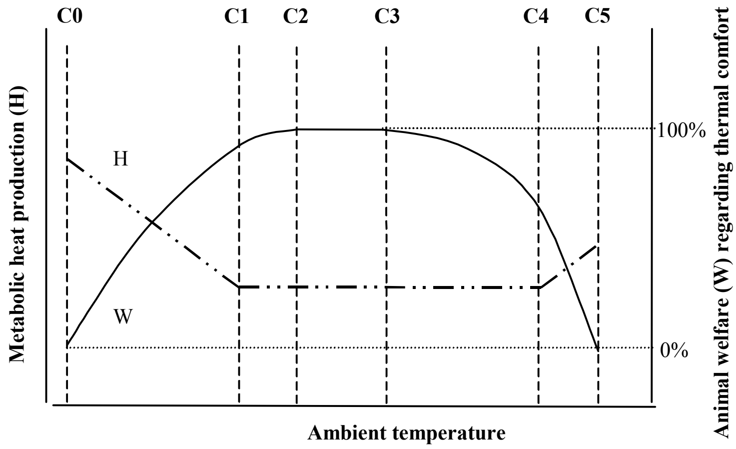

Figure 1. Relationship between ambient temperature and metabolic heat production (after Mount, 1979) and assumed effect on thermal comfort or welfare. CO to C5 represent ambient temperatures associated with different thermo-regulatory mechanisms (see text)

We assume that for ambient temperatures varying between C2 and C3, welfare (W) of pigs regarding their thermal comfort is at maximum, because very little and probably unconscious effort is necessary to cope with those temperatures. In the zones C3-C4 and C2-C1, pigs probably consciously adapt their behaviour, which is likely associated with somewhat negative emotions and thus with a lower welfare. Such behavioural changes are, however, to be considered as normal adaptations for which the animal is well equipped. Temperatures below C1 and above C4 require extra metabolic and behavioural efforts and are probably experienced as being uncomfortable, causing negative emotions and thus reduce animal welfare.

GENERALISATION OF THE THERMAL COMFORT CONCEPT

The need for thermal comfort is just one need that has to be satisfied. Bracke *et al*. (1999) listed the following needs of pigs: ingestion (including the need for food and water), rest, social contact, reproduction-related needs (sex, nest building and maternal care), kinesis, exploration (including exploration of novelty, foraging and play), body care, evacuation, thermal comfort, respiration, health (including no injuries or pain) and safety (including no danger and no aggression).

Each need is associated with particular husbandry conditions and the concept in figure 1 can be fitted to each need by putting the proper environmental factor on the horizontal axis (e.g. supply with energy or essential nutrients for ingestion, group size for social contact, concentration of infectious micro-organisms for health and incidence of unpredictable items for safety). For each need a zone C2-C3 is assumed with maximum welfare where just minor (non-conscious) adaptations are sufficient to maintain homeostasis. Outside that range, we assume a relationship between the values of each environmental factor on the horizontal axis and animal welfare, such that welfare increasingly declines from its maximum if environmental values are further outside the optimal welfare zone C2-C3. Outside this range C2-C3, the animal has motivation to change its situation. This motivation is limited between C1 and C2 and C3 and C4 and results in (behavioural) adaptation. The animal is able to bring the experienced situation close to the desired level, welfare is not seriously compromised. Below C1 and above C4, the subtle behavioural mechanisms are inadequate to bring the pig into its desired situation, and therefore, welfare is reduced. Because a unit to express feelings or comfort is not available we express it as a percentage of its maximum. In other words, the welfare level with respect to the respective need in C2-C3 is 100% and outside this zone it decreases curvilinearly to zero. Lengths of zones and declines of welfare on both sides of the maximum welfare zone depend on the animal (age, sex, pregnancy, etc.) and the type of need, and are arbitrary drawn in fig. 1.

USE OF THE CONCEPT

The C-values depict transition points at which animals change state with respect to the adaptive strategies they apply. In that way, C-values can be seen as animal traits (expressed as levels of a relevant environmental supply), that vary between animals. The concept can be used for optimising the conditions in which pigs are kept, as well as for breeding purposes. The most extreme C-zones (C1-C0 and C4-C5) represent those environmental conditions that force a pig to apply adaptive strategies that are considered as undesirable and that reflect a reduced welfare. To avoid that pigs have to perform such undesirable strategies, farming conditions should be at least within the zone C1-C4 and preferably in C2-C3. There is, however, always a risk that pigs end up in worse conditions because of economical or technical reasons or due to uncontrollable environmental variation (e.g. a disease outbreak). To minimise such risks an additional option is to shift C-values along the horizontal axis by means of purposive breeding. In words, this is similar to genetically improve pigs' ability to cope successfully with adverse farm conditions. Genetic selection can be performed by measuring animals' motivation to change their situation (C2 and C3) or by assessing traits that indicate lack of coping success (see Kanis *et al*., 2002).

DISCUSSION AND CONCLUSIONS

The aim of this study was to provide a conceptual framework that could act as a tool to facilitate breeding for better welfare. In the presented concept we have taken animal feelings (emotions as affected by the degree of satisfaction of needs) as the basis for welfare because we consider welfare as similar to happiness, which is an emotional status, partly depending on heritable factors. Emotions can, however, only be assessed indirectly. McGlone (2001) states that a multidisciplinary approach should be used to evaluate animal welfare, based on a combination of level of productivity, behaviour, physiology, anatomy and health and immunity. The present concept is primarily based on transition points in animal behaviour and physiology. Animal motivation and indicators of lack of coping success are key elements in this. Although the concept is derived from thermoregulation, other needs fit well in it. It is realised that the concept is simple. Generally, the degree of satisfaction of a need is affected by more factors than the chosen (most relevant) X-trait per need. In theory, C-values can be determined for each need and for each pig by varying the environmental conditions and recording animal behaviour and/or physiological parameters. Those C-values can then be used in two opposite but not exclusive ways: to either optimising the conditions in which pigs are kept, with respect to welfare, and/or the reverse: to select for pigs that have better coping abilities and thereby maintain a higher welfare level under non-optimal conditions.

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