Breeding Focus 2016 – Improving Welfare

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Published by

Animal Genetics and Breeding Unit

University of New England

Armidale, NSW, Australia

Animal Genetics and Breeding Unit

University of New England

Armidale NSW 2351

Australia

http://agbu.une.edu.au

ISBN: 978-1-921-597-69-5

Cover design by Susan Joyal

Book design by Kathy Dobos

First published, 2016

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Preface

The inaugural 'Breeding Focus' workshop was held in 2014 to outline and discuss avenues for genetic improvement of resilience. The Breeding Focus workshop was developed to provide a forum for exchange between industry and research across livestock and aquaculture industries. The objective of Breeding Focus is to cross-foster ideas and to encourage discussion between representatives from different industries because the challenges faced by individual breeding organisations are similar across species. This book accompanies the Breeding Focus 2016 workshop. The topic of this workshop is 'Breeding Focus 2016 - Improving welfare'.

> *"Animal welfare means how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear, and distress. Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and humane slaughter/killing. Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment."* (World Organisation for Animal Health 2008).

Animal breeding offers opportunities to improve the state of animals. Existing methodologies and technologies used in animal breeding can be used to improve welfare of animals on farm while maintaining productivity. Welfare and productivity are not necessarily in opposition because several welfare measures are genetically independent from productivity traits. Further, it is often economically beneficial to improve welfare traits. These aspects provide ample opportunities to improve both welfare and productivity through selective breeding.

The chapters of this book describe existing frameworks to define welfare of animals and outline examples of genetic improvement of welfare of farm animals. A reflection on ethical issues of animal breeding and welfare is presented and further avenues for genetic improvement of welfare are discussed.

We thank all authors for their contributions to this book and their presentations at the Breeding Focus 2016 workshop in Armidale. Each manuscript was subject to peer review by two referees. We thank all reviewers who generously gave their time to referee each book chapter. A special thank you goes to Kathy Dobos for looking after all details of organising this workshop and for her meticulous work on putting this book together.

Susanne Hermesch and Sonja Dominik

Armidale, September 2016.

Breeding for improved welfare of growing pigs

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Abstract

Welfare should be considered in pig breeding programs. A number of welfare traits related to pork quality, health and survival of pigs have already been included in pig breeding programs and this list of welfare traits should be extended further. It is important to provide the best-possible environment to pigs on farms. Animal breeding can contribute to this aim indirectly by providing descriptors of environmental conditions from genetic analyses of performance traits which can be used for assessment and optimisation of husbandry practices. Further, selection for improved disease resistance reduces pathogen load in the environment. Maintaining good welfare for all pigs on farms all the time requires a detailed monitoring system which has been provided by the Welfare Quality® (2009) protocol. The 12 welfare criteria defined by the Welfare Quality® (2009) protocol provide guidance for the genetic improvement of welfare in pigs. Genetic variation exists for numerous traits related to these 12 welfare criteria. For example, genetic variation was found for the number of shoulder ulcers in sows which is an important welfare trait of sows. Selecting pigs with less skin ulcers may also offer opportunities to improve comfort of growing pigs. Growth is an important performance trait which is affected by the health status of animals. Therefore, growth has been used as a proxy for health which affects the welfare of pigs. For this purpose, it is important to record growth of all animals including sick pigs to better identify pigs with health and welfare problems. This will also enhance estimates of indirect genetic effects for growth which may be a selection strategy to improve behaviour of group-housed pigs and reduce the incidence of tail biting. Indirect genetic effects quantify the heritable component of the social effects a pig has on performance of its group mates. Multiple factors and traits affect and describe welfare of pigs and numerous avenues are open for pig breeding to further improve welfare of pigs on farms.

Good welfare for all pigs all the time

Maintaining good welfare for all pigs on farms all the time requires a detailed framework that covers all aspects of welfare of pigs. In Australia, the "Model Code of Practice for the Welfare of Animals – Pigs 3rd Edition (Primary Industries Standing Committee 2008) defines the Standards that form the basis for an assessment of compliance with good welfare of pigs. The Standard states that "*One measure of good welfare in farmed pigs is that they are coping with the environment they are placed in and a farm can demonstrate growth, reproductive performance, disease levels, injuries and death rates within industry standards.*" This statement relates to the definition of welfare provided by Broom (1986) who states that "*The welfare of an individual is its state [in regards to] its attempts to cope with its environment. Coping can sometimes be achieved with little effort and expenditure of resources, in which case the individual's welfare is satisfactory. Or it may fail to cope at all, in which case its welfare is obviously poor.*" Failure to cope with the effects of an environment may result in reduced growth, increased mortalities and/or reduced reproductive performance of sows which were proposed as welfare indicators by Broom (1986). This approach has been adopted by industry and a companion handbook was developed by Australian Pork Limited (APL, 2010) which provides detailed information about a) the competence of the stock person, b) food and water, c) accommodation, d) preparation for transport and slaughter, e) emergency euthanasia and f) quality assurance systems and record keeping to maintain high welfare of pigs on farms. Adoption of these strategies is important because they ensure that individual pigs face minimal environmental challenges arising from poor housing and husbandry practices.

While significantly reduced growth rate indicates an underlying physiological problem leading to reduced welfare of a pig, a high growth rate is not necessarily an indicator of good welfare because a high growth rate has been shown to be associated with increased incidence of osteochondrosis (e.g. Jørgensen and Andersen 2001). Further, a high growth rate does not provide information about the time and energy an animal requires for coping with an environmental challenge. The effort required and the number of attempts that are necessary for an animal to maintain welfare were described by Broom (1986) as an additional type of welfare indicators. These welfare measures are independent of productivity and include physiological and behavioural parameters to quantify health status, stress, injuries and social comfort of animals. For example, 'Appropriate behaviour' is included as a major welfare principle in the welfare protocol for pigs provided by Welfare Quality® (2009). This welfare protocol was developed as part of an extensive European research project involving approximately 200 scientists over a ten-year period (Blokhuis *et al.* 2013). Other welfare principles, in addition to 'Appropriate behaviour' are 'Good feeding', 'Good housing' and 'Good health'. Each of these four welfare principles is further described through two to four welfare criteria (Table 1) which is a minimal, but comprehensive list of independent criteria to describe the welfare of pigs. Specific measures were then developed to quantify each criterion. Each measure had to be valid, i.e. it reflects some aspect of welfare of animals; it had to be reliable, i.e. it is repeatable and robust to external factors like time of day or weather conditions; and it had to be feasible, i.e. the measure can be recorded on farm. These conditions for welfare measures are also relevant for traits used for genetic improvement of pigs and as such welfare measures are potential selection criteria for genetic improvement.

These welfare principles and welfare criteria correspond closely to the ten "General Principles for the Welfare of Animals in Livestock Production Systems" that were adopted by the World Organisation for Animal Health in 2012 (Fraser *et al*. 2013). The first principle states that "Genetic selection should always take into account the health and welfare of animals." The review lists a number of positive examples where animal breeding contributed to improved welfare of livestock. Examples in pigs included pork quality and piglet survival, and these have also been adopted by pig breeders in Australia following research conducted in the 1990s (e.g. Hermesch 1997; Hermesch 2001). However, numerous avenues exist to further improve welfare of pigs. It is the aim of this document to outline opportunities for pig breeding to further improve the welfare of pigs on farms.

Table 1. The four major welfare principles and 12 welfare criteria of Welfare Quality® (2009) along with some examples of welfare measures for growing pigs and corresponding traits that may be used for selection

Principles	Criteria	Measures	Potential selection traits
Good Feeding	Absence of prolonged hunger	Body condition score	Body weight, growth, feed intake.
	Absence of prolonged thirst	Number, functioning, cleanliness of drinking places	Water intake
Good Housing	Comfort around resting	Bursitis, manure on the body, skin ulcers.	
	Thermal comfort	Shivering, panting, huddling, temperature. Feed and water intake, growth.	
	Ease of movement	Space allowance	
Good Health	Absence of injuries	Lameness, wounds on the body, tail biting	Lameness, lesion scores
	Absence of disease	Mortality, coughing, sneezing, pumping, twisted snouts (atropic rhinitis), rectal prolapse, scouring, skin conditions, ruptures and hernias	Survival rates, Incidence of specific diseases; Incidence of bursitis and skin ulcers
	Absence of pain induced by management procedures	Castration, tail docking,	Incidence of tail biting
Appropriate Behaviour	Expression of social behaviours	Social behaviour	Lesion scores, indirect genetic effects
	Expression of other behaviours	Exploratory behaviour	Flight time, back test
	Good human-animal relationships	Fear of humans	
	Positive emotional state	Qualitative behaviour assessment	

Welfare measures for different welfare principles

Good feeding and good housing

Measures of the environment

It is important to provide the best-possible environment to animals consistently. This aspect is addressed by the welfare principles of Good Feeding and Good Housing outlined by Welfare Quality® (2009). Feeding strategies have to provide a sufficient and appropriate amount of nutrients and water to pigs. Access to feed and water should be easy for pigs with sufficient feeder and drinker spaces and provision of clean feed and cool water. A number of air quality measures such as temperatures, CO_2 levels and ammonium can be monitored on farm using commercially available measuring devices (e.g. Hermesch *et al*. 2015b). These air quality measurements showed high overall variability when measured in individual pens within a shed (Table 2). Monitoring air quality, including measurements of pathogen load (e.g. Meranda *et al*. 2014), is essential for the provision of superior environments for pigs that will lead to improved welfare because pigs require fewer resources when environments are superior to cope with environmental conditions.

Table 2. Data statistics for air quality measures recorded in weaner, porker and finisher pens (Hermesch et al. 2015b)

	N	Mean	SD	CV%
			Weaner shed	
Temp (°C)	472	23.5	3.5	14.8
Humidity (%)	472	58.7	11.4	19.5
Carbondioxide (ppm)	417	1057.9	477.4	45.1
Ammonia (ppm)	471	6.5	3.3	50.7
			Porker shed	
Temp (°C)	221	23.8	2.3	9.6
Humidity (%)	221	57.1	8.3	14.6
Carbondioxide (ppm)	186	1044.9	238.2	22.8
Ammonia (ppm)	222	5.9	3.1	52.5
			Finisher shed	
Temp (°C)	364	26.8	9.3	34.6
Humidity (%)	364	52.1	8.5	16.4
Carbondioxide (ppm)	280	957.0	210.0	21.9
Ammonia (ppm)	364	5.8	3.1	53.2

Environmental conditions may also be described indirectly through animal-based measurements. Techniques are now available to further quantify the state of an animal as it tries to cope with environmental conditions. For example, porcine oral fluid samples collected from robes accessible by pigs housed in the same pen is a current research focus in pigs worldwide. In Australia, Finlaison and Collins (2014) developed procedures for the use of saliva samples for herd-health monitoring and point out that oral fluid could also be used to monitor stress and welfare in pigs. Cortisol, acute phase proteins and salivary alpha amylase can all be detected in oral fluid. These physiological measures have been used as markers of stress in pigs. This non-invasive method of detecting stress may have an application in evaluating group housing of gestating gilts and sows, separation of piglets from sows during lactation and at weaning and for management practices such as tail docking." Overall, these examples demonstrate that more and more procedures and technologies are and will become available to monitor environmental conditions more effectively leading to improved housing conditions which will improve welfare of pigs on farms.

Measuring animals

A scoring system was proposed by Welfare Quality® (2009) to measure body condition of growing pigs. These scores require training of staff and may be subjective. Technologies are now available to record body weight of pigs using handheld devices (e.g. www.hl-agrar.de) that do not require moving pigs to weighing crates and handling pigs for weighing which would be too labour intensive. Repeated body weight measures should be implemented on farms to monitor body condition of growing pigs. These measures are also useful to monitor the health status of pigs as disease or unspecified environmental challenges are known to reduce growth of pigs (Hyun *et al.* 1998; Black *et al*. 2001). However, the use of growth as a health and therefore welfare measure differs from the use of growth as a performance trait. Standard recording procedures for growth as a performance trait may not include sick pigs because their growth rate is not included in genetic evaluations as an indicator of their growth potential. In contrast, the incidence of low growth rate is of high interest when growth is used as a health and welfare indicator. Procedures need to be developed to define when growth can be used as a performance or a health and welfare indicator.

Good housing includes a number of animal-based measures that describe the comfort of pigs. Among them, number of shoulder ulcers recorded in sows at weaning was heritable (0.25 ± 0.03) in a Swedish study (Lundgren *et al*. 2012). Recording of these ulcers was performed by the farmer and was based on a score from 0 to 4. Estimates of genetic correlations indicated that selection for increased lean meat growth leads to higher incidence of shoulder ulcers in sows. Sows with more shoulder ulcers were genetically leaner as described by lower body condition scores (genetic correlation of -0.59 ± 0.09) and nursed heavier piglets at three weeks (genetic correlation of 0.23 ± 0.10). The unfavourable genetic association between lean meat growth and shoulder ulcers was confirmed in a separate study (Lundeheim *et al*. 2014), which provides a strong argument to include shoulder ulcers of sows in selection decisions. Farmers provide care and possibly medication to sick animals on farms. The costs associated with treating sick animals should be used to derive economic values for health and welfare traits such as shoulder ulcers in order to include health and welfare traits in breeding objectives.

Good health

Most welfare measures relate to the welfare principle of good health which is a current research focus in Australia. The main findings were reviewed by Hermesch *et al*. (2015a) who outlined avenues to select for both productivity and robustness and health. The main conclusions of this review are also relevant for genetic improvement of welfare traits in pigs. For example, the first conclusion of 'Improving environmental conditions on farm is the first priority" will impact directly on the welfare of pigs.

A flexible approach to derive economic weights for breeding objective traits of growing pigs was developed (Hermesch *et al.* 2014) which may also be used to include welfare traits in breeding objectives. Selection for improved disease resistance was recommended because it reduces pathogen loads with beneficial effects for overall environmental conditions experienced by group-housed pigs on farms. Repeated records of growth and feed intake will aid genetic improvement of health status of pigs complementing other information about disease incidence, survival of pigs and immune parameters. By using this information in pig breeding programs it is possible to improve both productivity and robustness or health with positive outcomes for the welfare of growing pigs.

Tail biting

The incidence of tail biting poses an important welfare concern because tail biting directly affects two welfare criteria. Tail biting of pigs housed in groups leads to substantial injury of animals. Cutting the tip of the tail in young piglets, called tail docking, is a management procedure that is currently practiced in pig industries to reduce the incidence of tail biting. This partial solution to tail biting is now also regarded as a growing welfare concern and research is now underway in Europe to reduce the need for tail docking (http://farewelldock.eu/about/). Pig industries may be forced to phase out tail docking in the future and alternative strategies to eliminate tail biting in pigs are required.

The incidence of tail biting is poorly recorded and often unknown. Monitoring of tail damage on carcasses at abattoirs is the most common method to estimate the incidence of tail biting in Europe according to a review by the European Food and Safety Authority (EFSA 2007). Although this method is simple and allows rapid monitoring of animals from many farms, this approach underestimates the real prevalence of tail biting on farms because pigs most severely affected will have died on farm or were euthanized prior to slaughter. Further, the review highlighted considerably lower incidence of tail biting in routine monitoring schemes in comparison to specific scientific investigations. Overall, the incidence of pigs with tail lesions at abattoirs was about 3% in tail-docked pigs and 6-10% in pigs whose tail had not been docked although extremely high incidence of 30% damaged tails has been reported in individual scientific studies (EFSA 2007).

The causes of tail biting are multifactorial and the prevalence of tail biting may depend on interactions between factors of the environment and the animal. Risk factors include the gender of pigs, herd size, stocking density, age and weight of pigs, floor material, feeding regime, health status, environmental enrichment, air quality and genetics (Sonoda *et al*. 2013). This long and comprehensive list of factors demonstrates that a holistic approach is required to reduce the incidence of tail biting in pigs.

Sonoda *et al.* (2013) summarized breed differences in aggressive, foraging and exploratory behavior which are thought to be related to tail biting. Within breeds, Breuer *et al.* (2005) identified genetic variation in tail biting in Landrace pigs, but found no genetic differences in the incidence of tail biting among Large White pigs. Further results by Breuer *et al.* (2005) indicate that selection for increased leanness and growth rate, which is common practice in pig industries, may increase the incidence of tail biting. This selection focuses on individual pigs and it ignores the effects a pig may have on the performance and welfare of its pen mates. Indirect genetic effects (IGE) quantify the heritable components of the effects of a pig on the performance of its pen mates (Griffing 1967; Muir and Schinckel 2002) which have been demonstrated for growth rate in pigs (Bergsma *et al.* 2008). Following these findings, a selection experiment over one generation was setup to select pigs for high and low IGE effects for growth (IGE-growth). The group of pigs divergently selected for high and low IGE were compared for a number of behaviour traits and welfare indicators, including tail biting (Camerlink 2014). During the later growth period, from 12 to 23 weeks of age, high IGE-growth pigs had lower tail damage scores than low IGE-growth pigs indicating that selection for high IGE-growth pigs may lead to lower incidence of tail biting in growing pigs. Further, the high IGE-growth pigs showed more comfort behaviour, less chewing, less biting and less ear biting thus indicating a true effect. However, it was not possible to identify differences in tail biting behaviour between selection groups, possibly because it was difficult to capture this short-lasting behaviour on camera with the scan sampling method that was applied. This aspect highlights a challenge in reducing tail biting on farms because current technology makes it difficult to identify the perpetrator within a group that injures its pen mates. However, it is possible to record performance traits for all and selection for indirect genetic effects of performance traits and growth in particular may provide avenues to select more sociable pigs that exhibit less tail biting.

The studies conducted by Camerlink (2014) include some promising results as outlined above. However, the divergent IGE-growth groups of pigs did not differ in growth rate and a number of other behaviour traits including skin lesions which quantify aggression among pigs. Therefore, the results of this first experiment should be repeated because, as Sonoda *et al*. (2013) pointed out, information about genetic influences on tail biting remains sparse and inconsistent.

Appropriate behaviour

Detailed instructions are provided in Welfare Quality® (2009) for various measures of behaviour of pigs. Often these behaviour measures are quite time consuming because a group of pigs needs to be observed for a certain time period until certain behaviours can be noted. The length of the time period required for a reliable observation may differ between behaviours. Further, some behaviours like biting (a negative social behaviour) or sniffing, nosing and licking (positive social behaviours) can easily be noted, some behavioural measures rely more on subjective evaluations. For example the qualitative behaviour assessment uses 20 terms such as active, tense, positively occupied, relaxed, enjoying, listless or fearful to describe the behaviour of pigs. These types of behaviour measures are time-consuming and may be more prone to personal interpretation and may be less repeatable between, or even within operators which limits their use for pig breeding.

Based on an extensive review of behaviour traits in cattle, pigs, poultry and fish, Canario *et al.* (2013) concluded 'that behaviour traits can be as heritable as some production traits that are considered for genetic improvement.' The review focused on traits describing the behavioural responses to both acute and chronic stressors in the physical environment (feed, temperature) and social environment (other group members, progeny, humans). These responses to acute and chronic stressors define different mechanisms of adaptation that describe the capacity of an animal to adapt behaviourally to an environmental challenge.

In pig breeding, flight time and nervous behaviour, as indicated through variation in body weight of pigs as they wait in the weighing crate, were developed as behaviour traits to describe temperament of pigs in Australia (Crump 2004). These two temperament traits were heritable and were genetically different traits. Further, flight time was not affected by environmental and genetic social effects among pigs estimated by the random group effect (Jones *et al.* 2009) supporting Crump (2004) who hypothesised that these behaviour traits may provide information on different aspects of temperament and may have different relationships with meat quality. This hypothesis is also relevant for welfare traits and more information is required about genetic relationships between behaviour and welfare traits recorded on farms in order to incorporate these traits in pig breeding programs.

Flight time was evaluated in pigs because this trait is used in the beef industry as a selection criterion for tenderness (e.g. Reverter *et al*. 2003; Kadel *et al.* 2006). Flight time had lowly positive genetic correlations with backfat, while no genetic associations were found between flight time and growth (Hansson *et al.* 2005; Jones *et al*. 2009) indicating that selection for improved productivity and leanness has a minimal impact on flight time. However, Bunter (2005) reported a significant genetic correlation between flight time and pH recorded 24 hour post mortem of -0.53±0.21. High final pH indicates dark, firm and dry pork and this genetic correlation suggests that selection for higher flight time would lead to a reduced incidence of dark, firm and dry (DFD) pork. This is relevant for pig breeding programs because flight time is recorded on the live animal prior to selection. This aspect increases the value of flight time as a selection criterion for DFD pork which is an important aspect of pork quality. Furthermore, DFD pork is an indication that glycogen levels in the muscle were depleted prior to slaughter and the incidence of DFD pork may also be used as a welfare indicator for pigs.

Conclusions

Pig breeding programs have considered pork quality, health and survival of pigs which are important welfare traits. Further welfare traits should be included in pig breeding programs. The Welfare Quality® (2009) protocol provides an excellent framework to define welfare systematically which is useful for pig breeding. Genetic variation exists for numerous traits related to the 12 welfare criteria defined by Welfare Quality® (2009) protocol demonstrating that selective breeding has a role to play in the improvement of welfare of pigs on farms. This requires systematic recording of welfare traits on farms for better consideration of welfare traits in selection decisions.

Acknowledgements

This study was supported by the Australian Pork CRC under Project 2B-105.

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