PROCEEDINGS

LowInputBreeds

The project acknowledges the financial support of the Commission of the European Community under the Seventh Framework Programme of the European Community for Research, Technological Development and Demonstration Activities.

Ethical Consideration in Livestock Breeding

Proceedings of the First LowInputBreeds Symposium held in Wageningen, The Netherlands, 15-16 March 2011




Ferry Leenstra, Karsten Klint Jensen, Gillian Butler, Brian Baker, Helga Willer and Veronika Maurer

Organised by Wageningen University on behalf of the European project LowInputBreeds in collaboration with the European Consortium for Organic Animal Breeding (ECO-AB)

Ethical Consideration in Livestock Breeding

Proceedings of the
First LowInputBreeds Symposium held in
Wageningen, The Netherlands,
15-16 March 2011

LowInputBreeds

First Symposium on
Ethical Consideration
in Livestock Breeding
March 15 and 16, 2011
Wageningen, The Netherlands

The publishers gratefully acknowledge co-funding from the European Commission, under the Seventh Framework Programme for Research and Technological Development, for the Collaborative Project Development of integrated livestock breeding and management strategies to improve animal health, product quality and performance in European organic and 'low input' milk, meat and egg production - LowInputBreeds (Grant agreement No 222623)"

Leenstra, Ferry, Karsten Klint Jensen, Gillian Butler, Brian Baker, Helga Willer and Veronika Maurer (2012): Ethical Consideration in Livestock Breeding. Proceedings of the first LowInputBreeds Symposium held in in Wageningen, The Netherlands, 15-16 March 2011. Research Institute of Organic Agriculture (FiBL), Frick, Switzerland

The abstracts and slides presented at the first LowInputBreeds symposium are available at the LowInputBreeds project website at http://www.lowinputbreeds.org/lib-symposium-2011-programme.html?&L=0

Research Institute of Organic Agriculture (FiBL), Ackerstrasse, 5070 Frick, Switzerland, Tel. +41 62 865 72 72; Fax +41 62 865 72 73, e-mail info.suisse@fibl.org, Internet www.fibl.org

Layout: Helga Willer, FiBL, Frick, Switzerland

Cover: Claudia Kirchgraber, FiBL, Frick, Switzerland

ISBN 978-3-03736-230-3

Table of Contents

Foreword

The first LowInputBreeds Symposium was organised by the LowInputBreeds project partners Wageningen UR Livestock Research and the Danish Centre for Bioethics and Risk Assessment of the University (CeBRA) of Copenhagen in cooperation with ECO AB, the European Consortium for Organic Animal Breeding.

The aim of the symposium was to discuss the plans and progress in LowInputBreeds in an early stage of the EU-project with stakeholders. For the symposium farmers and policy workers from governmental and non-governmental organisations were invited. Special attention was paid to possible ethical issues in organic and free range systems of livestock production as considered by the LowInputBreeds project. CeBRA had arranged for facilitators and a structure to discuss in species specific workshops these ethical issues.

The proceedings of the symposium contain abstracts of the plenary and species specific presentations, links to the presentations and reports on the workshops per species.

The organisers would like to thank all participants for their active contribution.

Ferry Leenstra

Wageningen, July 2012

Summary

Report on the First LowInputBreeds Symposium

FERRY LEENSTRA[1]

On March 15 and 16, 2011 the first LowInputBreeds symposium was organized in cooperation with ECO AB, the European Consortium for Organic Animal Breeding, in the Hof van Wageningen, The Netherlands.

Over 50 participants (researchers, policy makers and farmers) participated in plenary lectures, discussions and species specific workshops. Central theme in the symposium was: "low input, niche or model for future livestock production?" with attention paid to ethical issues.

On March 15, the participants were welcomed by Veronika Maurer (FiBL), the scientific coordinator of the LowInputBreeds project. In the first plenary session Karsten Klint Jensen (Danish Centre for Bioethics and Risk Assessment) introduced the theme and set the scene for the discussions in the species specific workshops. Jozsef Ratky (Research Institute on Animal Breeding, Hungary) discussed the effects and risks of different reproduction methods and Jack Windig (Wageningen UR Livestock Research) discussed the risks, benefits and alternatives of genomic selection. In a joint paper Wytze Nauta and Anet Spengler Neff (ECO AB) discussed the organic perspective on breeding and reproduction in livestock production.

For the first workshop, participants split up according to their species of interest: cattle, sheep, pigs and poultry. Each workshop considered the aims and outputs of the LowInputBreeds project within the context of ethics including comment by invited scientists from outside the project. Identified ethical issues were explored further in the second set of workshops on March 16.

In a second plenary session Anne-Marie Neeteson of the European Forum of Farm Animal Breeders (EFFAB) and FABRE TP gave a view on breeding goals in relation to current and future livestock production and Irene Hoffmann (FAO) discussed agro-biodiversity in animal production and food security. Marijke de Jong (Dutch Society for Animal Protection) discussed welfare in livestock production and how specific labelling might increase consumers'

[1] Dr. Ferry Leenstra, Wageningen UR Livestock Research, 8200 AB Lelystad, The Netherlands, Tel. +31 320 238517, ferry.leenstra@wur.nl, www.livestockresearch.wur.nl

awareness of animal friendly, low input systems. The last speaker in this session was Tom Dedeurwaerdere (University of Louvain) presenting first results on utilization of resources in low input livestock systems.

March 16 started with a plenary session on climate change and food security. Jorgen Elvind Olesen (Aarhus University) discussed the role of livestock production in climate change and Carlo Leifert (Newcastle University) presented views on food production in relation to utilization of resources. Discussion was lively—occasionally furious—on identifying region and farm specific aspects and especially the need for a fundamental change of mind set in mainstream agriculture.

These ideas and other ethical issues listed the day before formed the basis of the second set of species workshops, identifying how they will be accommodated in future plans in the LowInputBreeds project.

Feedback from workshops opened the last plenary session and was reflected on by Anet Spengler Neff and Wytze Nauta offering an organic perspective. Anne Sophie Lequarré (EU project officer for LowInputBreeds) finished with an overview of the structure and role of the EU in relation to livestock research. The output of the workshops was elaborated on by Karsten Klint Jensen and co-workers for the across species activities of LowInputBreeds.

LowInputBreeds had its second general assembly during the meeting and ECO AB its annual general meeting.

Ethical Concerns in Low Input Breeds: Observations from the First LowInputBreeds Symposium

KARSTEN KLINT JENSEN[1]

The first LowInputBreeds symposium featured species-specific workshops with the purpose of identifying ethical issues for further reflection within the project. The overall objective of the LowInputBreeds project is to develop novel breeding strategies and integrate them with management innovations in order to improve productivity, and animal health and welfare. Except for possible concerns about the consequences of certain breeding technologies, this objective does not in itself appear to raise ethical concerns. However, since there are often conflicts between improving productivity and animal health, the main ethical issues are concerned with how these objectives are balanced in the breeding goals.

Low input animal production differs from conventional production by being based on specific values, ideas or conceptions that underlie the production. A clear example is organic production, which is based on a range of ethical principles summarized some years ago by the International Federation of Organic Agriculture Movements (IFOAM).[1] Other forms of low input animal production are not organic, but are based on local traditions which again involve specific principles of production. The values underlying low input animal production systems thus make up their identity, which often find a clear expression in a brand. These basic characteristics of low input animal production both create specific problems—often related to keeping the animals outdoors—and constrain the set of feasible strategies for addressing problems.

Hence, in the workshops, researchers from the LowInputBreeds project met invited stakeholders from the communities supposed to benefit from the research. The researchers presented their perception of relevant ethical issues, and how these issues are dealt with by the research aims. The idea was then to have a dialogue with the stakeholders about whether the perception of problems is adequate, and whether the strategies deals with the problems in the best way. The details of this process still remain to be analysed.

[1] Professor Dr. Karsten Klint Jensen, Danish Centre for Bioethics and Risk Assessment (CeBRA), Rolighedsvej 25, 1958 Frederiksberg C, Denmark, Tel. +45 353 33010, e-mail kkje@life.ku.dk, internet www.bioethics.dk/

An interesting observation from the symposium was the great interest and engagement in more global issues such as climate and food security on a long term global scale. These issues tended to pop up in and interfere with the more local perspectives of the workshops. Animal production in general faces enormous challenges. Also low input animal production is affected by these challenges; however, no clear consensus of its future role in this global perspective was reached.

Plenary Session: Introduction to the Symposium

Ethical Concerns in LowInputBreeds: Background Paper for the LowInputBreeds Symposium in Wageningen, The Netherlands, 15-16 March 2011[1]

KARSTEN KLINT JENSEN[2]

Introduction

This paper is the first part of a review of ethical concerns in LowInputBreeds. In this part, the overall context for raising ethical concerns for breeding for low input animal production and assessing these concerns is characterized. Low input animal production differs from conventional production in several important ways. The implication is that it faces a partly different array of ethical challenges, but also that the background for ethical assessment in many ways is different.

After the symposium, the major ethical challenges for low input breeding identified during the workshops will be described in some detail, and the available courses of action will be sketched in a scientific paper which will also include a review on the ethical literature on these issues.

What is Ethical Impact Assessment?

An ethical assessment of a practice, such as an instance of low input animal production, is firstly concerned with an evaluation on the impact of the practice on all affected parties, compared with the impact of available alternatives; and secondly, whether the practice involves actions that could be considered wrong in themselves. In the present context, I shall not attempt a clear definition of low input but rather leave it to intuition how to demarcate it from other production systems.

As for the evaluation of impact, it makes a clear difference with which alternative the practice is compared. Comparing the impact of low input animal production with conventional production is one thing; comparing it with no animal production is another. However, ethi-

[1] The slide presentation of this paper is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Jensen-Background-purpose-presentation.pdf.

[2] Professor Dr. Karsten Klint Jensen, Danish Centre for Bioethics and Risk Assessment (CeBRA), Rolighedsvej 25, 1958 Frederiksberg C, Denmark, Tel. +45 353 33010, e-mail kkje@life.ku.dk, internet www.bioethics.dk/

cal impact assessment is normally conceived as a maximizing exercise, i.e. we should search for the practice with the best overall consequences. This implies also an answer to the question of what the volume of the practice should be; i.e. how animal production should be composed, and how large scale each component should have.

In order to perform an impact assessment, more precise evaluation criteria have to be defined: what exactly makes up good or bad impacts. However, there is disagreement about such criteria. For instance, does animal welfare consist in the greatest balance of pleasurable states over painful states? Or does it consist in living a natural life? If such disagreements exist, they should be identified. But even given a set of criteria, there will often be uncertainty about the detailed consequences of a practice, and this will of course affect the evaluation.

Actions that might be considered wrong in themselves can be violations of rights or—more controversially—violations of the integrity of organisms or nature. For example, is genetic modification wrong because it violates the integrity of organisms or goes against 'nature'? Promise breaking might clearly be a relevant wrong in our context in the case where producers do not live up to their own stated standards. However, again there is not necessarily agreement about what should be considered wrong in itself; and again, if there are disagreements, they should be identified.

Clearly an ethical impact assessment has to consider how the flow of energy and matter through a farm affects the environment and the further consequences this may have. Such further consequences may affect future generations, but they may also affect wildlife and its biodiversity, which may be a concern in its own right. Belonging to these issues are questions about the scale of production: how much meat and dairy products should be produced worldwide, and how should the production be distributed? What should be the role of low input production on a global scale?

However, for the purposes of this paper, I shall largely leave these questions aside, because in the LowInputBreeds project they have been located in work package (WP) 5.1. There will be a presentation from WP5.1 on the use of resources alongside some invited talks on related issues. I shall therefore concentrate on the more direct impact on humans and animals.

A Hierarchy of Ethical Decisions Concerning Animals

Animal production is a practice characterized by using animals for the benefits of humans. Hence, it is based on a positive answer to the most fundamental question of animal ethics: Is it justifiable to use animals for human purposes, i.e. raise them solely for this purpose and, in an early age, either kill them for their meat or dispose of them, when they have served their purpose? There is a long practice for using animals, and it is widely accepted in most societies. However, there is also a minority of ethically motivated vegetarians in most societies, and use of animals is increasingly under pressure for justification.

Given that the practice of using animals is considered acceptable, the main ethical problems concerning animals are: to which purposes, and under which conditions can they be used? The purpose of producing food is probably among the most widely accepted purposes. However, as other uses, this involves a conflict of interests between humans and animals. Up to a certain point, good conditions for the animals also serve the human interest in production; but then increased productivity often involves higher pressure on the animals with impaired welfare as a consequence. Although low input animal production in many ways is less intensive than conventional production, it faces the challenge of striking the right balance between human interests and animal welfare.

Value-Based Choice of Production Form

Low input animal production is typically based on specific values, ideas or conceptions that inform the production. A clear example is organic production, which is based on a range of ethical principles summarized some years ago by IFOAM. These principles imply that organic production should be locally rooted and preferably be based on local cycles of nutrients and energy. Other forms of low input animal production are not organic, but still based on local traditions which again involve specific principles of production. By contrast, conventional production is not rooted or committed to special values; in principle, conventional farming systems can produce anywhere and buy their input and sell their output on the world market.

The values underlying low input animal production systems thus make up their identity, which often finds a clear expression in a brand. These production systems are easy recognizable by the consumers as an alternative to conventional production, and in many cases the products can be sold with a price premium.

These basic characteristics of low input animal production have many consequences for the impact of production and also for actions that are available to address ethical problems. On the general level, it means that the basic ethical issue of striking a balance between animal and human interests presents itself rather differently for low input animal production than for conventional production. In the following, some of the important differences will be outlined.

Outdoor Animals

It is almost a defining characteristic of low input animal production that the animals are allowed freedom of movement, and much of the time they are kept outdoors or at least given access to outdoor areas. Most people would agree that, compared with indoor high-input animal production, this outdoor access presents a huge advantage for the animals in terms of welfare. However, the weight of this advantage of course depends on the exact point of comparison, and it is also to some extent debated.

However, to allow the animals this freedom also involves a cost in terms of problems that can be avoided or at least far better controlled by keeping the animals indoors and restricting their movements. The animals may be aggressive against each other. Outdoors, the animals are far more exposed to pathogens and parasites and perhaps even predators; and they may be exposed to more extreme weather conditions. And clearly, it is more difficult and takes more time to inspect and control the animals. In some cases, the overall consequence is higher mortality rates than those found in indoor systems.

Apart from the negative impact on animal welfare, these problems often also involve losses for the producers. It is therefore a major challenge for low input animal production to address these problems, and addressing them is in many ways the principal task of the LowInputBreeds project. The challenge of striking the right balance between the interests of humans and animals remains, but because of the different conditions for the animals, the balance consists of different components.

Values Restrict the Set of Feasible Solutions

Another consequence of the value based choices underlying low input production systems is a restriction on the set of feasible actions. Conventional production in principle does not exclude any available technology, strategy or practice. Through its fundamental choices, low input production commits itself to certain practices which define its identity—like keeping animals outside or abstaining from pesticides and fertilisers; from this identity also follows further restrictions in dealing with the problems, as outlined above, following from the fundamental choices.

For instance, IFOAM's organic standards put severe restrictions on the use of medicine, and also prohibit dehorning, beak trimming, tail docking and most other mutilations. Such restrictions pose an extra challenge in addressing the problems from allowing free movement and outdoor access, like exposure to parasites or aggressions among the animals. Another example is low input production which commits its identity to specific breeds; clearly, cross breeding is not a feasible option for these production systems. Also the organic principles put restrictions on breeding methods and breeding goals. Overall, low input animal productions systems are concerned with the diversity of breeds, whereas this concern presumably has far less weight in high input production.

A major task for the LowInputBreeds project is to carry out breeding research for the sake of the special needs of low input animal production. Apart from the general ethical issue of how breeding solutions will affect the balance between the interests of humans and animals, another important issue for the LowInputBreeds project is to clarify the precise nature of the value based restrictions on feasible practices.

Higher Expectations

Because low input animal production systems identify themselves by their own value based choice of standards, they also raise higher expectations among consumers, not least among the more dedicated and loyal segments who buy the largest share of the products. Such expectations again make low input production more vulnerable in case of problems than high input conventional production systems to which expectations generally are quite low.

One consequence is that addressing the problems of animal welfare that are specific for low input production is a matter of some urgency, because there will be an expectation among consumers that problems should be addressed. There is a clear perception of this expectation in the LowInputBreeds project description. However, there is room for debate – and probably disagreement – about which solutions are compatible with the basic values of the different production systems.

Another consequence is that practices which to a large extent are shared with high input production, e.g. the handling of male animals, may pose a greater challenge for low input production because of the higher expectations. For instance, the destruction of day old male chicks in layer breeds is a common practice for both organic and conventional egg production. While conventional production generally is expected to choose the most cost efficient practices, such practice may not be compatible with the organic principles.

Conclusion

The ethical impact assessment must first identify 'concerns', or the issues that enter into the balancing of human and animal interests; and, second, assess how this balance is influenced by different alternative actions. Because of the value based choices that define low input animal production systems, the balance between human and animal interests involve other components and take a different form compared with high input conventional production.

The actions under assessment are the research strategies of the LowInputBreeds project. Thus one question is how these strategies change the balance of interests between humans and animals. Another question is how they relate to the basic values of the relevant production system, and how other stakeholders perceive this issue.

One cannot expect clear cut answers to these questions, derived from a few widely shared value premises. However, one can identify concerns as they are perceived by researchers of the LowInputBreeds project and other stakeholders. Through dialogue, one can identify the most important lines of argument concerning the assessment of actions. These results will comprise the take-home message for the LowInputBreeds project.

Plenary Session: Reproductive and breeding methods

Reproductive Methods in Low Input Animal Breeding[1]

J. Ratky[2], I. Egerszegi[3], P. Sarlós[4], K.-P. Brüssow[5], K. Kikuchi[6], and B. Berger[7]

Ethics result from principles and long-lasting social rules directing human behaviour. In animal breeding, practices are based on historical traditions and the emotional relationship of the people of the countryside with their animals. Reproductive researchers usually are modest and realistic in their work aiming to improve the farmers' results in their daily lives.

Ethical aspects of reproductive methods in low input breeding (LIB) need a complex approach determined by:

1. Human factors – healthy food supply; rural development; reduced unemployment; agricultural traditions; rural tourism; and environment protection.
2. Animal factors – gene conservation; animal welfare; farming traditions; and improvements to meet the challenges of a rapidly changing world.

Applied reproductive management cannot meet all the criteria mentioned above. Therefore we should set the priorities based on a particular farm. Even LIB requires needs the input of well-trained experts who have the relevant knowledge and experience in reproductive methods. Animal health conditions, individual registration of animals, exact documentation of mating or artificial insemination (AI) are required in the LIB as in intensive farming. Professionals involved in LIB should be familiar with both traditional methods and the newest results of innovation.

The authors offer their experiences regarding LIB reproductive techniques, which have a special importance also in Hungary. They conducted international research projects on low input breed techniques. In Hungary, animal breeds in low input systems are mostly indigenous and sometimes endangered adapted to the Carpathian Basin climate. These animals

[1] The slide presentation is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Ratky-Reproduction-methods-presentation.pdf

[2] J. Ratky, Research Institute for Animal Breeding and Nutrition, Herceghalom, Hungary

[3] I. Egerszegi , Leibniz Institute for Farm Animal Biology, Dummerstorf, Germany

[4] P. Sarlós , Research Institute for Animal Breeding and Nutrition, Herceghalom, Hungary

[5] K.-P. Brüssow Leibniz Institute for Farm Animal Biology, Dummerstorf, Germany

[6] K. Kikuchi National Institute for Agrobiological Sciences, Tsukuba, Japan

[7] B. Berger , Institute of Organic Farming and Biodiversity of Farm Animals, Thalheim bei Wels, Austria

incorporate our traditions, represent our agricultural national value and can play a key role in rural development and rural tourism. These breeds can be used to produce unique processed products, such as Hungarian winter salami, sausage, bacon, and other meats. In Europe there are several successful projects that use commercial breeds in organic farming for producing meat and processed products with an organic label. Apart from the widely known breeds - the Hungarian Grey cattle, Mangalica pig and Racka sheep – Hungary has native horse, donkey and poultry breeds as well.

The projects and results listed below deal with reproductive physiology and techniques related to the Mangalica pig and the Racka sheep. These two Hungarian breeds have different levels of utilization. The population of the Racka sheep is decreasing (6 450 breeding ewes) and animals are kept only by enthusiasts. Mangalica pigs began increasing since the early 1990s to about 30 -40 000 fattening animals per year as domestic and export markets have developed. So Mangalica found its new role in the modern world, whereas Racka still needs to do so.

Mangalica pig

Mangalica pigs—more precisely Blond, Red and Swallow Belly Mangalica—were in the past always bred in small and large-scale farms, and the situation is the same today. Apart from their own production, large companies integrated the activities of small farmers, and organized the breeding and trading. The Mangalica Breeding Association gives guidance to its members and supplies boars or semen for them.

Reproductive work is done by natural mating and AI both in small and large farms. In some strains the low number of animals requires natural mating for in vivo gene preservation. In some production units AI is a daily practice. AI costs less than keeping at least 5 times as many boars, but requires more skilled labour. AI is significantly different and probably more complicated in native breeds than in their modern counterparts for both male and female reproductive physiology.

Semen freezing connects farmers and companies that cooperate with research units and develop tools for in-vitro gene conservation. Although boar semen cryopreservation is not solved, our group has some promising results, averaging 50% post-thaw motility.

National parks have a duty to demonstrate our agricultural traditions, and should keep indigenous domestic animal breeds such as pure bred Mangalica pigs raised in traditional LIB circumstances.

Low input breeding has found its proper position in the Hungarian Mangalica sector, and small farmers can contribute to local and regional food supply by supplying high value processed pork products. However, Mangalica breeders have been hurt by increasingly high feed prices.

Racka sheep

The Racka sheep has hundreds of years of history. Hungarian and other nomadic tribes raised similar types of sheep on the Middle Asian steppes. Nearly identical breeds are found there even today. Hungary has a diminished population with two colour types: the White and Black Racka. National parks, enthusiastic sheep breeders, and some village hotels keep them in small units. Although some attempts have been made to establish new markets for it, lower meat yield % under EU classification has undermined the efforts until now. A different evaluation system is desirable for the ancient breeds. Racka is well-suited for LIB in the continental climate of the Carpathian Basin, offering the potential to contribute to rural development programs in remote areas.

The Hungarian Sheep Breeders' Association declared that its pre-eminent purpose of reproductive management is the preservation of this breed. Racka ewes are mated naturally by selected rams throughout Hungarian sheep farms. The Racka sheep population is increasing, and in vitro preservation should be the focus of research. Our group found that reproductive characteristics in male and female Racka sometimes differ markedly from those of modern ones. To train Racka rams for semen collection is much harder than in intensive breeds, thus semen handling and freezing also needs innovation. Our experimental Black Racka population consists of 75 ewes and 20 rams. Recently, 16 rams have been trained for semen collection, and we were able to attain more than 50 % post-thaw motility in frozen semen.

Conclusion

LIB has a special significance in modern animal breeding, rural development and tourism. Farmers involved should clearly know their role in the sector. If they choose small scale farming, they must use relevant reproductive methods, and if they decide to increase production, they should adapt to a more modern and effective system. Innovation is always necessary either by taking part in it or by adopting the available achievements. In our opinion reproductive methods in LIB does not mean closed eyes and ears means to be open for the new results enabling the farmers to improve their dedicated work.

Genomic Selection: Alternatives, Risks and Benefits

JACK J. WINDIG[1]

Animal Breeding can be very effective in changing properties of populations. Examples include increases in production in high input breeds, but also increasing disease resistance. An example of the latter is the successful breeding programme against scrapie in the Netherlands. Scrapie has been around for hundreds of years, but only after the discovery of genetic variants being resistant to scrapie and the following breeding programme the incidence could be decreased. However, less beneficial changes because of animal breeding have occurred as well. Especially when the breeding goal was too narrowly focused on production increased problems with health and welfare have occurred as a side effect. In Holstein cattle, for example, a tremendous increase in milk production has been achieved, but mastitis incidence has increased and getting cows pregnant often proves problematic.

With the rapid developments in molecular biology genomic selection has become possible. In genomic selection breeding values are determined with the help of dense marker maps. First a reference population is formed of animals with reliable breeding values, based on own performance data and performance data of relatives. Then these animals are types for genetic markers. The standard now is a 50K SNP marker chip, but numbers will soon increase. With a statistical model then a breeding value for each separate marker allele is estimated. Next, with the help of this statistical model, breeding values can be computed for typed animals without performance records, or a reliable pedigree. The main advantage is that breeding values become available much earlier, and consequently breeding programmes can be accelerated. Especially, for difficult to measure traits, e.g. traits late in life, post slaughter traits or traits only expressed in one sex, advantages can be great. One promising development is a technique called velo- or whizzo-genetics. Here cell cultures derived from oocytes are set up in the laboratory. With genomic selection the best cultures are selected and after inducing meiosis and fertilization the next generation is again cultured in the laboratory.

[1] Dr. Jack J. Windig, Quantitative genetics and biodiversity, Livestock Research, Wageningen UR, Animal Breeding and Genomics Centre, P.O. Box 65, 8200 AB Lelystad, The Netherlands

The current situation is that the large breeding companies with global high input/high output breeds are implementing genomic selection. Benefits are possible for low input breeds as well. Performance based breeding values for special traits such as methane emissions or performance on special diets may be recorded on a part of the population, while selection may take place using all typed animals. However, the reference population should be of considerable size, greater than 2 000 animals, and closely related to the rest of the population.

The ethical questions can be illustrated with the example of breeding for polledness in dairy cattle. Nearly all dairy cattle in NW Europe are being dehorned, which is a painful process. Breeding polled animals may be an alternative. Polledness is based on a single gene with polled being dominant over horned. Currently, polled animals are rare and generally have low breeding values. A classical breeding programme may result in polled cattle with high genetic merit in about 20 years, and can be successful as illustrated by Fleckvieh in Germany. With genomic selection such a breeding programme can be reduced to less than 10 years. Social research in the Netherlands indicated that citizens judge the livestock on the effect on animal welfare, whereby the idea is that the more natural processes are the better for livestock. Genetic modification is seen as unnatural and bad for animals and society. No distinction is made between animal breeding and genetic modification. Horns are seen as natural and no distinction is made between polled animals and dehorned animals. Farmers also indicate that animal welfare is very important, whereby animal welfare is mainly achieved by good care for the animals. Genetic modification is also judged negatively but animal breeding positively. Informing citizens about livestock and animal breeding changes the opinion of part of them. Whether or not breeding for polledness is judged positively depends on whether natural polledness is judged as a genetic defect or as a trait that occurs naturally since prehistoric times, and whether polled animals are judged to function normally. Furthermore, the discussion is whether animals should be adapted to the production environment or the other way around.

The discussion around breeding polled cattle shows that the ethical aspects not so much concern genomic selection but more whether the breeding goal is acceptable. The main effect of genomic selection is that it accelerates breeding programmes. Whizzo-genetics will be totally unacceptable to the general public, at least in the Netherlands. On the other hand, genomic selection can be beneficial for low input breeds as well, but it may be problematic to form a reliable reference population.

An Organic Perspective on Reproduction and Breeding Methods[1]

WYTZE NAUTA[2] AND ANET SPENGLER-NEFF[3]

Organic production is often low input in the sense of using local and renewable resources. Production methods have to be based on natural processes, have to be animal friendly and durable including species-specific feeding and husbandry. What does this mean with respect to animal breeding and reproduction? Many researchers and farmers have discussed this already (Baars and Nauta, 2001; Haas and Bapst, 2004; Nauta, 2009; Pryce et al., 2001; Spengler Neff, 2011). In a world where breeding and reproduction methods have become very high tech and unnatural, the organic sector has to find its way. This paper gives an impression of what is needed for organic/low input breeding.

Main differences between conventional and organic breeding

Conventional production and conventional breeders focus on uniform and stable systems with similar housing, feeding and treatments independent of location. Animals can be developed in this way for those systems on a large scale and genetic progress towards high production levels can be maximized. Sufficient feed for such animals is purchased from all over the world and the animals receive all the needed inputs such as antibiotics and feed supplements, and are often de-horned, de-beaked, de-tailed, or subjected to other mutilations to prevent them from harming each other and keep more animals per square meter. Housing systems are fitted to maximize production levels per animal and per person working at the farm.

Organic farming, however, is depending on local resources and those are divers in their nature. To produce from local resources means that every area needs own adapted husbandry-systems and adapted animals. Even at small distances environments may differ. Therefore, the European outlines for organic animal production recommend the use of local breeds. Local, native breeds were selected and bred and adapted to their specific environments as

---

[1] The slide presentation is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Nauta-Neff-Organic-perspective-presentation.pdf

[2] Dr. Anet Spengler Neff, Research Institute of Organic Agriculture, Animal Breeding/ECO-AB, Ackerstrasse, 5070 Frick, Switzerland, Tel. +41 62 865 7272, Fax +41 62 865 7273

[3] Dr. Wytze Nauta, Louis Bolk Instituut/ECO-AB, Hoofdstraat 24, 3972 LA Driebergen, The Netherlands, info@louisbolk.nl, Tel. +31 343 523860, Fax +31343 515611

well as to social, cultural and economic situations (Spengler Neff, 2011; see also Wagner, 2006).

A main goal of organic farming is to respect animals' species-specific features by giving them the opportunity to perform their natural behaviours, be fed in a way to which they are physiologically adapted, and live in a suitable environment (Lund, 2006). Organic standards limit the use of antibiotics (AB). European organic standards prohibit a preventive use of AB and limit their use to infections where animals have to be prevented from suffering and no complementary therapy is known to be successful. Withdrawal periods are twice as long compared to conventional agriculture. AB use is an issue for all agriculture. Policy makers in the Netherlands have set the task to reduce the use of AB in livestock production by 50% in the next 3 years to limit the risk of spreading resistant bacteria.

Selection traits for organic and low input systems – for example: dairy cattle

All these facts ask for animals that can adapt to specific local environments. Many examples show that animals from conventional breeding programmes do not fit well into low input systems (Hardarsen, 2001; Rauw et al., 1998; Essl, 1982). The rapid genetic progress of production traits during the last two - three decades makes it even more difficult to feed those animals adequately on organic farms. Today, functional traits and health traits are getting more emphasis in all breeding programmes, however, environments between organic and conventional production systems also differ and GxE effects make it difficult to select the best animals for organic farming (Nauta 2009; Simianer, 2007; Ahlman, 2010). In general low input systems ask for cattle that can convert high amounts of roughage into milk and meat. Such cattle are not built too openly, and have a good body condition score (BCS) (Thomet, 2007). Dairy cows that don't show great changes in body condition during lactation and never get very low in body condition are healthier, especially in roughage-based feeding systems (Spengler Neff, 2011). Those are flexible, self-sustaining animals that can adapt their production to available feed. They are often dual purpose and don't use much body fat to produce milk, which would be a risk for their health, but instead use also energy from their muscles. Other interesting traits for low input systems such as roughage intake or roughage converting ability are not measured at all, up to now.

The problem of breeding technologies

Conventional breeding programmes are dealing with a strong competition on the market. Therefore reproduction technologies like AI, super-ovulation, ovum pick up, IVF, ET, oestrus synchronisation and recently sperm separation are used heavily to increase selection intensity and shorten generation intervals. However, these technologies are unnatural and carry numerous ethical concerns with them (Rutgers et al., 1996; Schroten, 1992). Most of them are not in agreement with the intensions and rules of organic production (IFOAM, 2002; EU, 1999). Even AI shouldn't be used, but because of the wide spread use and the belief that the sector cannot breed animals without AI, it is allowed in an additional specification of the organic rules (EU, 1999). Recently genomic selection has been developed. If used with a main focus on production traits, it can increase genetic progress of production even more. Next to direct impacts on animal welfare and integrity, because of one-sided, yield-focused breeding goals all these developments create the risk of increasing inbreeding levels on a population scale (Weigel et al., 2001).

Does the organic sector have alternatives?

Organic products should be produced in a closed production chain, certified from 'seed to meat'. Concerning reproduction methods, the organic sector needs to become independent of the supply of conventional breeding stock. Achieving this goal mainly depends on the farmers. More and more organic cattle farmers have at least partly started to use natural service for breeding (Nauta, 2009). Pig producers also often use boars for natural breeding along with AI. Goat and sheep breeding is still based on natural mating since synchronizing is not allowed and insemination of a few animals at a time is too expensive. Very few small scale poultry producers breed their own new stock. Those farm based breeders breed for traits like good health, feeding competence in a varying environment, roughage intake, stress resistance, etc. (Baars et al., 2005). Specific breeding programmes are described for such small populations (Baars et al., 2005; Nauta, 2010). A supply and market of breeding stock is still lacking for these farmers.

Most organic animal producers are, however, still using breeding stock from conventional programmes. They are used to the supply of breeding stock and over the years became estranged from breeding with their own stock at the farm. But they can be supported with some new tools. A first option is a special selection and publication of ET-free breeding bulls with very good breeding values in functional traits from the conventional supply (Nauta and

Langhout, 2004; Spengler Neff, 2011). Secondly, bulls can be selected to be suitable for organic production (Postler, 1998; Rozzi et al., 2007); finally, the best young bulls from organic farms can be used in a young bull system for natural mating and AI (Nauta, 2009; Bichard, 2002).

In Dutch organic pig production the first steps are made to select suitable sows on organic farms for the production of new gilts in a three-way cross system (Ten Napel et al., 2009). For poultry research is still on-going to find the perfect breeds and hybrids for organic farms (LIB, 2011. The first steps are taken to breed new and unconventional breeds and hybrids at organic farms (Baumann, 2010; Nauta, 2011; Zeltner, 2008). Some aspects of natural living conditions for breeding animals should be considered, such as outdoor runs for AI-bulls, boars, and poultry pure lines. Such aspects are not discussed and there are no rules for it either.

Conclusions

Today's conventional breeding goals and methods often don't fit to the guidelines and intentions of organic farming, because of animal welfare and integrity reasons and because of genetic aspects concerning production, which doesn't fit to farm-own feed supply. Organic food remains in short supply and, especially in dairy farming, a growing number of farms are converting to natural breeding. To develop a closed organic production chain, including breeding and selection methods, the organic sector has to work out new methods for breeding, selection and specific selection traits, preferably within the sector itself. Opportunities exist for different species. However, new intensions, knowledge, incentives, and even rules should help to promote developments towards a truly organic animal breeding.

References

Ahlman, T., 2010: Organic dairy production, Herd characteristics and genotype by environment interactions; PhD thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden

Baars, T. Nauta, W.J., 2001. Breeding for race diversity, herd adaptation and harmony of animal build: a breeding concept in organic farming. In: M. Hovi & T. Baars (Eds), Breeding and Feeding for Health and Welfare in Organic Farming. In: Proceedings 4th Network for Animal Health and Welfare in Organic Agriculture (NAHWOA). Workshop, 24-27 March 2001, Wageningen, University of Reading, Reading, p.107–113.

Baars, T., Schmidt, G., Olbrich-Majer, M., 2005. Linien-Zucht mit Kuhfamilien, Basis für eine biologische Rinderzucht. Verlag Lebendige Erde, Darmstadt, 160 pp.

Baumann, W., 2010. Kritische Beleuchtung der verschiedenen Ansätze Workshop„Zweinutzungshuhn – wie kann es gehen?“ 2. Juni 2010, Frankfurt am Main

Bichard, M., 2002. Genetic improvement in dairy cattle – an outsider's perspective. Livest. Prod. Sci.

Essl, A., 1982. Untersuchung zur Problematik einer auf hohe Lebensleistung ausgerichteten Zucht bei Milchkühen, Züchtungskunde 54: 361-377.

EU, 1999. EC Council Regulation No 1804/1999 of July 1999, Supplementing Regulation (EEC) No 2092/91 on Organic Production of Agricultural Products and Indications Referring thereto on Agricultural Products and Foodstuffs to Include Livestock Production. www.europe.eu.int/eur–lex/en.

Haas, E., Bapst, B., 2004. Swiss organic dairy farmer survey: Which path for the organic cow in the future? In: Hovi, M., Sundrum, A., Padel, S. (eds.) Organic livestock farming: Potentials and limitations of husbandry practice to secure animal health and welfare and food quality. Proc. Of the 2nd SAFO Workshop, 25-27 March 2004, Witzenhausen, University of Reading, Reading, 35-41.

Hardarson, G.H., 2001. Is the modern high potential dairy cow suitable for organic farming conditions? Acta Vet. Scand. Suppl. 95: 63-67.

IFOAM, 2002. International Federation of Organic Agriculture Movements (IFOAM) Basic Standards for Organic Production and Processing. IFOAM General Assembly. <www.ifoam.org/standard/publications> Accessed (18-01-2005). Leenstra, F. et a. (2011): Ethical Consideration in Livestock Breeding. Proceedings of the First LowInputBreeds Symposium held in in Wageningen, The Netherlands, 15-16 March 2011. Research Institute of Organic Agriculture (FiBL), Frick

Lund, V. 2006. Natural living – a precondition for animal welfare in organic farming. Livestock Sci., 100 (2-3): 71-83.

Nauta, W.J., 2009, Selective breeding in organic dairy production, PhD thesis, University of Wageningen, The Netherlands.

Nauta, W.J., 2011, Organic breeding of dual purpose poultry. Project Louis Bolk Institute, 2009/2012.

Nauta, W.J. and Langhout, J., 2004. ET-free Bulls 2004. Louis Bolk Instituut, Driebergen. www.louisbolk.nl/ downloads/ J. Langhout/ stierenlijst04.pdf.

Postler, G., 1998. Der Ökologische Gesamtzuchtwert. Kultur und Politik 2:16-22

Pryce, J.E., Wall, E.E., Lawrence, A.B. and Simm, G. 2001. Breeding strategies for organic dairy cows. The 4th NAHWOA Workshop, Wageningen.

Rauw, W.M., E. Kanis, E.N. Noordhuizen-Stassen, F.J. Grommers. 1998. Undesirable side effects of selection of high production efficiency in farm animals: a review. Livest. Prod. Sci. 56: 15-33.

Rozzi, P., Miglior, F., Hand, K.J., 2007. A total merit selection index for Ontario organic dairy farmers. J. Dairy Sci. 90: 1584-1593.

Rutgers, L.J., F.J. Grommers & B. Colenbrander, 1996. Ethical aspects of invasive reproduction techniques in farm animals. Reproduction in Domestic Animals 31(4/5): 651–655.

Schroten, E. 1992. Embryo production and manipulation; ethical aspects. Animal Reproduction Science, 28, 1-4, 163-169

Simianer, H., Augsten, F., Bapst, B., Franke, E., Maschka, R., Reinhardt, F., Schmidtko, J. and Stricker, C. 2007. Ökologische Milchviehzucht, Entwicklung und Bewertung züchterischer Anzätze unter Berücksichtigung der Genotyp x Umwelt- Interaktion und Schaffung eines Informationssystems für nachhaltige Zuchtstrategien, ÖKUH, www.orgprints.org/11222.

Spengler Neff, A. 2011. Neue Ansätze für die ökologische Milchrinderzucht. Untersuchung von neuen Merkmalen für die ökologische Milchrinderzucht, unter Berücksichtigung von wesentlichen Aspekten des Tierverhaltens, PhD Thesis University of Kassel, Germany. Available at https://kobra.bibliothek.uni-kassel.de/handle/urn:nbn:de:hebis:34-2011051637469 (not published, yet)

Spengler Neff, A. and Metz, C., 2007. Stierhaltung für die Zucht im Biobetrieb. Leitfaden zur Optimierung von Haltung, Zucht und Management. Merkblatt, FiBL und Demeter, Demeter Bayern e.V., Kranzberg, ISBN: 978-3-03736-007-1.

Ten Napel, J., Leenhouwers, J., and J. Merks. 2009. The supply of organic gilts. Wageningen University, publ. 252. Biokennis.

Thomet, P., Steiger Burgos, M., 2007. Kuhtyp für die graslandbasierte Milchproduktion. AGRARForschung 14 (9): 412-417.

Wagner, S. 2006. Eignung von Original Braunvieh-Genetik im Vergleich zu Brown Swiss-Genetik für Bio-Milchviehbetriebe, bachelor thesis, SHL, Zollikofen, Switzerland

Weigel, K.A., R. Rekaya, N.R. Zwald, and W.F. Fikse. 2001. International genetic evaluations of dairy sires using a multiple-trait model with individual animal performance records. J. Dairy Sci. 84: 2789-2795.

Zeltner, E., 2008. Evaluation of laying hen strains for biodynamic farms. 16th IFOAM Organic World Congress, Modena, Italy, June 16-20, 2008; archived at http://orgprints.org/view/projects/conference.html

Plenary Session: Input from outside: speciali-sation and high input vs low input

Breeding Goals[1]

ANNE-MARIE NEETESON[2]

The presentation provides information on the European umbrella organisation for breeding companies, their general ethical code and discusses how breeding programmes in all livestock species have to balance between different issues. Sustainable breeding programmes have to pay attention to food quality and safety, animal health and welfare, biodiversity, resource efficiency and the environment. Moreover, animal breeding has to be transparent on the breeding programme.

Because of increased computing power and the introduction of genomic selection more traits can be combined in the breeding goal, and antagonistic effects can be overcome. Production environments might differ between systems and the breeding programme has to provide the optimal animal for the defined environment.

[1] The slide presentation of Anne-Marie Neeteson is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Neetseson-Breeding-Goals-presentation.pdf

[2] Anne-Marie Neeteson, Coordinator of Sustainable Farm Animal Breeding and Reproduction Technology Platform, FABRE-TP Secretariat, P.O. Box 76, 6700 AB Wageningen, The Netherlands, Tel. +31 317 412006, www.fabretp.info

Contribution of Low input Livestock Farming to Biodiversity Conservation[1],[2]

IRENE HOFFMANN[3]

Challenges

Consumption and production increase

World population is projected to surpass 9 billion people by 2050. Most of the additional people will be based in developing countries, where population is projected to rise from 5.6 billion in 2009 to 7.9 billion in 2050, while the population of developed regions is expected to remain stable (United Nations, 2009). FAO projects that by 2050, global average per-capita calorie availability could rise to 3130 kcal per day, accompanied by changes in diet from staples to higher value foods such as fruit and vegetables, and to livestock products, requiring world agricultural production to increase by 70 percent from 2005/07 to 2050. Over the past decades, growing demand for livestock products has been driven by economic growth, urbanization and rising per-capita incomes. Annual meat consumption per-capita is expected to increase globally from 41 kg in 2005 present to 52 kg in 2050. In developing countries, the effect of the "livestock revolution" that led to fast growth of meat consumption in developing countries and that was mainly driven by China, Brazil and some other emerging economies, is expected to decelerate. However, annual per-capita meat consumption increases from 31 kg in 2005 to 33 kg in 2015 and 44 kg in 2050 are projected for developing countries. Annual per-capita meat consumption in developed countries is projected to increase from 82 kg in 2005 to 84 kg in 2015 and 95 kg in 2050 (OECD-FAO 2009; Bruinsma, 2009, FAO, 2010a). Given that net trade in livestock products is a very small fraction of production, the production projections mirror those of consumption. This implies that

---

[1] The views expressed in this publication are those of the author and do not necessarily reflect the views of the Food and Agriculture Organization of the United Nations. Also the designations employed and the presentation of material in this information product do not imply the expression of opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Content and errors are exclusively the responsibility of the author.

[2] The slide presentation is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Nauta-Neff-Organic-perspective-presentation.pdf

[3] Irene Hoffmann, Animal Genetic Resources Branch, Food and Agriculture Organisation of the United Nations (FAO), Viale delle Terme di Caracalla, 00153 Rome, Italy, e-mail Irene.Hoffmann@fao.org

much of the projected additional cereal and soybean production will be used for feeding enlarging livestock populations.

Biodiversity impact of livestock production

While the world is projected to need a major increase in production to feed the growing population, it must do so against a challenging backdrop including the decreasing availability of and competition for land and water, including from other land uses such as production of biofuels, urbanization and industrial development; poor soil fertility and reduced access to fertiliser; as well as climate change and biodiversity loss. The most important direct drivers of biodiversity loss are habitat change (e.g. land use changes), climate change, invasive alien species, overexploitation, and pollution (MEA, 2005). Natural wilderness areas are mostly absent in areas of high population density (Groombridge & Jenkins, 2002). Agriculture and livestock production, being the largest land users, thereby contribute to biodiversity loss and ecosystem service changes. FAO (2006, 2010a) provides an exhaustive overview on the land use changes, biodiversity degradation, water pollution and greenhouse gas emissions from the livestock sector. The impacts range from local (e.g. soil and water pollution) over regional (e.g. deforestation, invasive species) to global (e.g. greenhouse gas (GHG) emissions). Reid et al. (2010) provide an overview of livestock- related threats to biodiversity.

Pasture and feed crop expansion into natural ecosystems have the highest impact on wild biodiversity at all three levels of biodiversity (FAO, 2006) and are global in extent. Livestock grazing occupies 26 percent of the ice-free terrestrial surface and the production of livestock feed uses 33 percent of agricultural cropland (FAO, 2006; 2010a). Direct effects of livestock grazing and trampling on species diversity differ, depending on the long-term grazing history of the ecosystem. In historically old grazing systems, rangeland vegetation and animal grazing have co-evolved, with a certain amount of grazing needed to maintain structural and species diversity. They are usually resilient to livestock grazing (e.g. African savannah). In contrast, systems with recent introduction of grazing are vulnerable to its impact (e.g. Australia) (Reid et al., 2010), especially when introduction of livestock has been accompanied with introduction of fodder species (Hoffmann, 2010a). Management is critical to the biodiversity impact of grazing. While mobile pastoral systems in arid areas make strategic use of landscape heterogeneity and key resources (Behnke et al., 1993), sedentary heavy grazing tends to shift vegetation composition. Water point distribution is important as it influences livestock spatial distribution and density. On the other hand, well-managed livestock grazing can have positive biodiversity impacts (CAST, 2002; Amend et al., 2008; FAO, 2009a, b).

Greenhouse gases contribute to climate change which in turn increases the risk of biodiversity losses. The livestock sector is a large producer of greenhouse gases (GHGs). Eighteen per cent of global GHG emissions are attributed to livestock – via land use and land-use change (directly for grazing or indirectly through production of feed crops), manure management, and enteric fermentation (FAO, 2006a, 2010). Many of the environmental changes that are already occurring as a result of human activities and those that are likely to occur in the future as a result of climate change are incremental, but they are cumulative and may eventually materialize in environmental crises. The intergovernmental panel on climate change (IPCC) has warned of 'tipping points' where damage due to climate change occurs irreversibly (Lenton et al., 2008). Thomas et al (2004) estimate that 15 to 37% of species will be threatened by extinction by 2050 through changes in species range and distribution, population size, disease pattern and species invasion. Especially sensitive are marginal ecosystems (rainforest, high altitude, low fertility, marine etc).

Intensification of agricultural systems, coupled with specialisation in breeding and the harmonizing effects of globalization and zoosanitary standards, has led to a substantial reduction in the genetic diversity within domesticated animal species (MEA, 2005). FAO (2007a) indicates that the risk for breed survival in the past century was highest in regions that have the most highly-specialised livestock industries with fast structural change and in the species kept in such systems. Globally, about one-third of cattle, pig and chicken breeds are already extinct and currently at-risk (FAO, 2010b).

Pollution and contamination in intensive production areas, and nutrient concentration in extensive grazing systems also have impacts on biodiversity (FAO, 2006), mostly at regional scales. Nitrogen and phosphorous from fertiliser and manure run-off lead to eutrophication and algae bloom, damage aquatic species (e.g. coral bleaching) and, in the worst case, cause biologically dead zones in water systems. Pollution related increases in soil fertility result in the out-competition of nitrogen-sensitive plants.

Invasive alien species are another pathway how livestock affects biodiversity (Hoffmann, 2010a). Feral pigs, goats and rabbits are classified among the top 100 world's worst invasive alien species (Lowe et al., 2000). Linked to the introduction of livestock species was the concomitant introduction of alien plants, often to improve fodder quality of native range-lands. The IUCN/SSC Global Invasive Species database lists 95 invasive plant species, many of which were introduced as livestock improvement crops and later invaded natural grasslands, out-competing native grasses and decreasing biodiversity. Grazing livestock in turn contributes to seed dispersal and triggers habitat changes that facilitate invasions. On the other hand, livestock can become a victim of alien plant invasions in pastures, driving pasture expansion and land-use change (Reid et al., 2010).

The impacts of high and low external input production systems on different levels of biodiversity, from the gene to the ecosystem, are not consistent, due to the complex biological interactions between livestock and their production environments and the high trophic level of livestock in the food web. Usually, the effects of land-use change and GHG emission that affect natural biodiversity at global level go in the same direction. From a global point of view, high-external input systems may have advantages as regards their lower GHG emissions per unit product, with positive indirect impacts on land-use and global natural biodiversity. However, at regional and local level, habitat and species diversity tend to be higher in low external input systems. Besides natural resources endowment and socio-economic data, societal choices also depend on cost-benefit ratio as well as farmer personal preferences (Hoffmann, 2011).

Solutions to reduce the biodiversity impacts of livestock production

The Millennium Development Goals' targets and the targets of reducing the rate of biodiversity loss are expected to require trade-offs (Hoffmann, 2011). However, potential synergies between the various internationally agreed targets relating to biodiversity, environmental sustainability, and development exist (Herrero et al., 2009). Strategic Priorities 5 "Promote agro-ecosystems approaches to the management of animal genetic resources" and 6 "Support indigenous and local production systems and associated knowledge systems of importance to the maintenance and sustainable use of animal genetic resources" of the Global Plan of Action for Animal Genetic Resources, the internationally agreed framework for the management of livestock biodiversity (FAO, 2007b), also aim at co-benefits.

By lowering the livestock sector's biodiversity impacts at the demand side, a modification or reduction of meat consumption with a shift from ruminant to monogastric meat may reduce the climate change and land-use related impacts due to the latter's better feed-conversion ratio (FAO, 2010a). In future, the separation of meat production from live animals, through in-vitro meat, or meat substitution by other protein-rich foods can be envisaged.

On the supply side, intensification, productivity increases and waste reduction in all production systems will improve the resource efficiency of livestock production and thereby pressure on natural biodiversity. To reduce the impact on natural biodiversity from high external input production systems, the focus should be on reducing land use changes and emissions associated with feed production. This also goes along with a shift from ruminant to monogastric livestock species (FAO, 2010a). Due to the already high productivity in these systems, the options for further improvement are limited; however, frontier research in breeding and feeding could make a difference.

In low external input production systems, various opportunities for productivity gains, including options for climate change mitigation, exist. However, it may easily happen that local breeds, which are usually fed on roughage and/or crop residues and have low output in single food products, are considered inefficient if efficiency is just considering output of marketable food products. The pressure to increase efficiency may thus disadvantage local breeds, especially of ruminants, thereby exacerbating the current trends of economically driven breed loss (FAO, 2009c, 2010b; Hoffmann, 2011). On the other hand, there are huge potentials to increase productivity of local breeds that could easily be achieved with improved feeding and within-breed genetic improvement (FAO, 2010c).

Another issue in the assessment of "efficiency" that links the global to the local level impacts of livestock on biodiversity is that of human-edible food needed to produce one unit of livestock source food, taking account of species' different ability to use forages that cannot otherwise be used by humans. Generally, countries with very intensive grain-based livestock production systems have a human-edible protein output/input ratio of below or near one, while countries with a predominance of low external input grazing ruminants have considerably higher ratios, meaning that they add to the overall supply of protein (CAST, 1999). This food-feed competition can be reduced either by producing a larger share of the world's livestock products within forage grazing and low external input mixed systems, leaving more plant protein to be eaten by humans, or by recycling more crop residues and waste products, including agro-industrial by-products, through animals. Such systems would favour the return of herbivore livestock species to forage-based diets and land-based production systems and might offer new opportunities for local breeds (FAO, 2009a). Besides more research in breed-vegetation-soil interactions, especially in semi-arid pastoral areas, a supportive political and economic environment will be needed.

At regional and local level, where habitat and species diversity is directly influenced by livestock production, the multiple products and services of livestock, especially in low external input systems, play an important role, and co-benefits between different objectives can be expected. The use of local breeds and the introduction and maintenance of extensive grazing systems contribute to agricultural biodiversity and conservation of agricultural landscapes as well as food security (FAO, 2009b).

In agricultural systems, livestock often 'mimicked' the role of wild large herbivores in controlling vegetation. Traditional farming and associated land management practices have produced a range of semi-natural environments that favoured a variety of wild fauna and flora, with high heterogeneity and a mixture of spatial and temporal land uses, including the presence of 'neglected' areas. Local animal breeds are getting recognized as part of culture and landscape, and as attractive for tourism. As many traditional farming landscapes are now protected, Amend et al. (2008) asked what types or proportion of agro-biodiversity might be included within a protected area.

The European Council Habitat Directive, in its Annex 1 (European Union, 1992) lists habitats that are considered as being of importance for their biodiversity value. To implement the Habitat Directive, the EU Biodiversity Action Plan established more than 26 000 Natura 2000 sites, corresponding to 18% of the EU (27) territory. In addition to protected areas, EU agri-environment measures aim to support public goods such as high nature value grasslands with high structural heterogeneity. Although there is some evidence that local adapted breeds exert pressure on vegetation different than exotic breeds due to their feeding behaviour and grazing ranges, there is generally little research in special adaptation of local breeds or ecosystem functions linkages. An indication on the situation of rare or endangered breeds inside and outside the Natura 2000 sites is still missing (Diana, 2011).

Agri-environment payments from the European Union Rural Development Programme (RDP) support the rearing of local breeds indigenous to the area and in danger of being lost (Council Regulation EC 1698/2005 and 1974/2006). Both Regulations allow for specific measures for the conservation of genetic resources in agriculture at national or regional levels. However, Signorello and Pappalardo (2003) showed that previous EU RDP measures were not as effective and efficient as expected in conserving breeds at risk.

Well-managed livestock grazing can have several benefits (Amend et al., 2008; FAO, 2009a,b). For example, improved grazing management leads to reduced rangeland degradation, improved vegetation biodiversity and, depending on aridity, improved soil-carbon sequestration which may partially offset GHG emissions from other components of the production process; it also has a favourable impact on livestock productivity (CAST 2002; Smith et al., 2007; FAO, 2009a; 2010a). However, usually only the value of rangeland as a source of forage supply for grazing livestock has an economic market value. The absence of market values for the other ecosystem services results in low incentives for the conservation of their provisions to the public. It is thus important that policies are implemented to provide appropriate incentives and benefits in support of the provision and conservation of ecosystem services. Also institutional problems such as land-use rights and secure access to resources need to be solved to enable the diverse and often marginalized livestock keepers in dry and sub-humid lands to partake in decision making and develop and adopt improved rangeland management practices.

With regard to the development of niche markets for local breed's products, it is often the production system associated with the breeds, rather than the breed itself, that results in higher prices. Not only the genetic characteristics of traditional breeds contribute to taste and structure of the meat but also the vegetation consumed the slow extensive production system, or special processing of meat or cheese.

Conclusion

There is no question that demand for animal products will continue to increase in the next decades and a further push to enhance livestock productivity across also production systems is needed to reduce the global level environmental footprint of livestock production. However, many of the required new technologies will accelerate the structural change of the sector towards more intensive systems and thereby the loss of animal genetic diversity.

Arguments in favour of low input breeds are based on the multiple products and services they provide, mostly at regional and local level. First, their ability to make use of low-quality forage results in a net positive human edible protein ratio. Second, under appropriate management, livestock kept in low external input mixed and grazing systems provide ecosystem services. Thirdly, as a result, and linked to local breeds' recognition as cultural heritage, linkages to nature conservation need to be further explored and strengthened. Improved capacity to predict the consequences of changes in drivers for biodiversity, ecosystem functioning, and ecosystem services, together with improved measures of biodiversity, would aid decision-making at all levels (MEA, 2005).

One can assumed that contracting public budgets will require clear monitoring of outputs and outcomes for future payment for environmental schemes. Therefore, more research in both the livestock and ecosystem functioning and their interaction would be needed, including public databases for breed genetic and phenotypic data, their performances in different production environments, and in breed-vegetation-soil interactions. FAO's efforts to implement production-environment descriptors in its global breed database in DAD-IS (FAO, 2008) is a critical step in this direction, but country-level research to provide data is needed. Baselines and indicators would need to be developed to allow for monitoring and underpin incentive mechanisms. The Economics of Ecosystems and Biodiversity (TEEB) initiative recognized the need to develop tools to properly value ecosystem goods and services and to determine the cost of biodiversity loss. It aims at making better use of economic incentives for the sustainable use of ecosystem services (TEEB, 2010).

Science can help ensure that decisions are made with the best available information, but ultimately the future of biodiversity will be determined by societal choices. Policy instruments are required to stimulate implementation of a portfolio of options that include changes in consumer behaviour, the development of niche markets and labelled products as well as the fostering of sustainable livestock agriculture and food production.

References

Amend T., Brown J., Kothari A., Phillips A. and Stolton S. (eds.) 2008. Protected Landscapes and Agrobiodiversity Values. Volume 1 in the series, Protected Landscapes and Seascapes, IUCN & GTZ. Kasparek Verlag, Heidelberg.

Behnke, R.H., I. Scoones and C. Kerven. (eds.) 1993. Range ecology at disequilibrium. New models of natural variability and pastoral adaptation in African savannahs. London

Bruisma, J., 2009. The resource outlook to 2050: By how much do land, water and crop yields need to increase by 2050? FAO Expert Meeting on How to Feed the World in 2050, June 2009.

CAST 1999. Animal agriculture and global food supply. Interpretative Summary. Council for Agricultural Science and Technology, USA.

CAST 2002. Environmental impacts of livestock on US grazing lands. CAST Issue Paper 22, Council for Agricultural Science and Technology, USA.

Diana, O. 2011. EU policy context and conservation and use of animal genetic resources. GLOBALDIV Final International Workshop February 8 and 9, 2011Lausanne, Switzerland

European Union, 1992. Council Directive 92/43/EEC (1) of 21 May 1992 on the conservation of natural habitats and of wild fauna and .ora. Annex I: Natural habitat types of Community interest whose conservation requires the designation of special areas of conservation. Available from http://europa.eu.int/comm/environment/nature/hab-an1en.htm.

Food and Agriculture Organisation of the United Nations (FAO), 2006. Livestock's Long Shadow – Environmental Issues and Options, Rome.

_____, 2007a. The State of the World's Animal Genetic Resources for Food and Agriculture, Rome.

_____, 2007b. Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration, Rome.

______. 2008. Report of the FAO/WAAP Workshop on Production Environment Descriptors for Animal Genetic Resources, held Caprarola, Italy, 6–8 May 2008, edited by D. Pilling, B. Rischkowsky & B.D. Scherf. Rome. http://dad.fao.org/cgi-bin/getblob.cgi?sid=-1,593

______, 2009a. Review of evidence on drylands pastoral systems and climate change. Implications and opportunities for mitigation and adaptation. Neely, C., Bunning, S., Wilkes, A. (eds.), Land and Water Discussion Paper 8. Rome. (available at http://www.fao.org/climatechange/15537-0-0.pdf).

______, 2009b. Livestock keepers – guardians of biodiversity. Animal Production and Health Paper 167. Rome. (available at http://www.fao.org/docrep/012/i1034e/i1034e00.HTM).

______, 2009c. Threats to animal genetic resources – their relevance, importance and opportunities to decrease their impact. CGRFA Background Study Paper No. 50, Rome.

______, 2010a. The State of Food and Agriculture 2009. Livestock in the Balance. Rome.

______, 2010b. Status and trends report on animal genetic resources – 2010, CGRFA/WG-AnGR-6/10/Inf. 3, Rome.

______, 2010c. Greenhouse gas emissions from the dairy sector. A life cycle assessment. Rome. (available at http://www.fao.org/docrep/012/k7930e/k7930e00.pdf).

Groombridge B., M.D. Jenkins 2002. World Atlas of Biodiversity: Earth's Living Resources in the 21st Century. University of California Press, UNEP, WCMC

Herrero M, Thornton PK, Gerber P, Reid RS 2009: Livestock, livelihoods and the environment: understanding the trade-offs. *Curr Opin Environ Sustain*, 1:111-120.

Hoffmann, I. 2010a. Livestock biodiversity. *OIE Scientific and Technical Review*, Special Issue Invasive Species Part 1: General aspects and biodiversity. 29: (1).

Hoffmann, I., 2011. Livestock biodiversity and sustainability. *Livestock Science*, Special Issue "Assessment for sustainable development of animal production systems". (in press)

Lenton, T.M., Held, H., Kriegler, E., Hall, J.W., Lucht, W., Rahmstorf, S. & Schellnhuber, H.J. 2008. Tipping elements in the Earth's climate system. *Proc. Natl. Acad. Sci. USA*, 105: 1786–1793.

Lowe S., Browne M., Boudjelas S. & de Poorter M. 2000. 100 of the World's worst invasive alien species. A selection from the Global Invasive Species Database, ISSG, 12pp, http://www.issg.org/pdf/publications/worst_100/english_100_worst.pdf

Millennium Ecosystem Assessment (MEA), 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

OECD-FAO. Agricultural Outlook 2009-2018. Paris, Rome.

Reid R.S., Bedelian C., Said M.Y., Kruska R.L., Mauricio R.M., Castel V., Olson J., Thornton P.K. 2010. Global livestock impacts on biodiversity. In: Steinfeld H., Mooney H.A., Schneider F., Neville L.E. (eds) Livestock in a Changing Landscape Volume 1: Drivers Consequences, and Responses, 111-138, Island Press.

Signorello, G., G. Pappalardo 2003. Domestic animal biodiversity conservation: a case study of rural development plans in the European Union. Ecological Economics 45, 487-499

Smith, P., D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko, M. Howden, T. McAllister, G. Pan, V. Romanenkov, U. Schneider, and S. Towprayoon. 2007. Policy and technological constraints to implementation of greenhouse gas mitigation options in agriculture. *Agric. Ecosyst. Environ.*, 118: 6-28.

TEEB 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.

Thomas, C.D., Cameron, A., Green, R.E., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., Ferreira de Siqueira, M., Grainger, A., Hannah, L., Hughes, L., Huntley, B., van Jaarsveld, A.S., Midgley, G.F., Miles, L., .Ortega-Huerta, M.A., Peterson, A.T., Phillips, O.L. & Williams, S.E. 2004. Extinction risk from climate change. *Nature* 427: 145–148.

United Nations Population Division 2009: World Population Prospects. The 2008 Revision. http://esa.un.org/wpp/index.htm

Breeding and Animal Welfare[1]

MARIJKE DE JONG[2]

The presentation discusses the role of an animal welfare organisation in society and the vision of the organisation on breeding programmes. Welfare issues related to breeding and genetics are indicated, several are related to high productivity. On the other hand breeding can contribute to prevent mutilations, currently common practice in a number of livestock species. Breeding programmes should pay more attention to robustness and animal welfare should be an integral part of the breeding programme.

To improve animal welfare the Dutch society for animal protection has initiated a labelling programme: the Better Live hallmark. The programme requires higher welfare standards than what legally is required. For meat type poultry also specifications for the genotype are given.

[1] The slides of Marijke de Jong's comment are available at: http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Jong-Animal-Welfare-presentations.pdf

[2] Marijke de Jong, Dutch Society for the Protection of Animals, http://www.dierenbescherming.nl/

Plenary Session: Low Input Breeds, Utilization of Resources and Climate Change

Utilisation of Resources[1]

TOM DEDEURWAERDERE[2]

Work package 5.1 of the LowInputBreeds project aims to evaluate existing accreditation mechanisms and economic approaches related to low-input livestock farming systems and thus of sustainable development processes through a multi-criteria evaluation of the public goods delivered by different production systems, management techniques and breeding innovations. To this end, we are conducting a comparative analysis of approaches to low-input livestock production, based on the multi-criteria assessment of the performances of production schemes in the delivery of public goods.

This analysis operates on the 'best representative' production schemes for which breeding innovations are developed within the scope of the LowInputBreeds project; production schemes that have been initially drawn from a working paper of the project, modified and consolidated in accordance with literature and e-mail consultation of LowInputBreeds experts. Identified relevant and most-different systems have been presented, showing the transition from defined production schemes to reference quality assurance schemes. Indeed, at least four reference quality schemes have been identified for each animal species, both for organic and low-input production (Table 1).

The next step of our analysis entailed the determination of relevant criteria that needed to be taken into account within the multi-criteria assessment of the defined reference quality schemes. To that end, the initial template established through literature review has been consolidated and amended through a multi-stakeholder expert workshop with participants of all the other LowInputBreeds work packages, convened on the 26th May 2010 in Brussels. The environmental assessment thereby pertained to the analysis of energy or input efficiency, but also to the potential for biodiversity and landscape conservation; while welfare, animal health, food safety and quality criteria were also taken into account. Bearing in mind the rationale of such assessment, the table was filled for each species un-

[1] The presentation of Tom Dedeurwaerdere is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Dedeurwaerdere-resources.pdf

[2] Prof. Dr. Tom Dedeurwaerdere, Université catholique de Louvain, 2 Place Montesquieu, Ottignies-LLN 1348 Belgium, Tel. +32 10 862447, www.uclouvain.be

der study, highlighting different criteria to be evaluated in the further course of this research project.

Table 1: Summary of Identified reference quality assurance schemes)

	Feed / Geography		Animal Welfare / Housing (Outdoor)	
	Dairy cows	**Sheep**	**Pigs**	**Laying hens**
Organic	Pasture-based (grass-lands)	Pasture-based (grass-lands in mountains)	Pasture-based with maximum outside husbandry (fields)	Maximal outside husbandry (Large flocks, ±15 000)
	Mixed systems (silage and pasture)	Feed self-sufficient (mountains)	Concrete-based, with maximum outside husbandry (sows in fields/pigs concrete)	Minimal outside Husbandry (small flocks, ± 3 000)
		Feed self-sufficient (Plains)	Concrete-based with minimal outside husbandry (all concrete outdoor run)	With extended laying period (up to 100 d. against throw outs)
Low Input	Traditional grazing systems (mountains)	Pasture-based (grass-lands in mountains)	Traditional extensive grazing (Me-diterranen)	Free range with maximum outside husbandry
	Low-cost mixed produc-tion (Grasslands: NZ)	Grazing systems with forage and lower concen-trates (plains)	Conventional outdoor with mini-mum outside husbandry (fatten-ing inside / breeding outside)	Free-range with minimum outside husbandry
		Mixed systems (sheep+crop); semi-extensive (plains)	Conventional outdoor with maxi-mum outside husbandry (fatten-ing outside or deep straw / breed-ing outside)	Free range with extended laying period

Table 2: Example of completed intermediate term multi-criteria assessment for dairy cows

			Conventional	Organic	Low input
ENVIRONMENTAL	Energy / Input efficiency	Methane emissions	High	Low	Lower
		For emissions, measurement problem: per cow/herd or production liter? Results differ: Is conventional more efficient per litre of production due to higher yields?			
		Carbon dioxide emissions	High	Low	Lower
		Fuel use	High	Lower	Low
		Carbon sequestration potential	Low	Higher	High
		Fertiliser Use	No reduction (nitrogen) 380 kg/N/ha	Highly reduced	Reduced 240 kg/N/ha
	Biodiversity / Landscape	Landscape preservation	Low	Very high	High
		Water use and quality	Good	Good	Good
		Soil nutrient richness	Low	Very high	High
		Nitrogen capturing	Low	High	Average
WELFARE, HEALTH AND QUALITY	Animal Welfare	Open air pastures	Average (10 per cent with open air pastures DE)	Very high	Very high (regional conditions)
		Mutilation prohibition	No (horn burning)	Yes	No (local practices, awareness)
		Adaptive breeding	Not required but induced by private sector: functional	Average	Yes (bull semen purchases local markets)
		Nutrition (balanced and organic)	Average	High requirements	Average (too expensive to follow)
		Disease prevention	Same performance levels		
		Veterinary treatment limitations	Strong	Very strong	Strong
	Public Health	Pesticide residue (importance of withdrawal time)	None (very strict controls)	High levels	Average levels
		Zoonotic Pathogens: tuberculosis, dysentery…	High risk (antibiotics use)	Lesser risks (homeopathy)	Lesser risks
		Antibiotic-Resistant Infections (MRSA)	High risk (antibiotics use)	Low (homeopathy)	Lesser / average
	Food quality	Sensorial (taste, cooking)	Good	Good	Good
		Nutritional (vitamins, aminated acids)	Good	Higher	Good

Low Input Breeds and Climate Change

JØRGEN E. OLESEN[1]

The greatest challenge of agriculture during the 21st century is probably to feed the increasing number of people on earth while maintaining soil and water resources (Cassmann et al., 2003). Climate change significantly adds to this challenge by reducing the quality of soil and availability of water in many regions and by increasing variability of temperature and rainfall (Tubiello et al., 2007). The already now large contribution of agriculture to global greenhouse gas emissions will increase in importance, unless more effective and climate friendly farming systems are adopted (van Beek et al., 2010). The challenge of agriculture within the climate change context is therefore two-fold, both to reduce emissions and to adapt to a changing and more variable climate.

Global demand for food is expected to increase by 70% by 2050 (FAO, 2009). The increase in demand for animal products driven by growing populations, incomes and diet preferences is stronger than for most other food items. Global production of meat is projected to more than double from 229 million tonnes in 1999/2001 to 470 million tonnes in 2050, and that of milk to increase from 580 to 1,043 million tonnes (FAO, 2006, 2009). The bulk of the growth in meat and milk production will occur in developing countries, with China, India and Brazil already representing two thirds of current meat production. Poultry will be the commodity of choice for reasons of acceptance across cultures and technical efficiency in relation to the use of feed concentrates. Food supply must increase sustainably to meet this demand and this will be complicated by climate change (Foresight, 2011).

The global animal food chain generates 18 % of global greenhouse gas emissions as measured in CO_2 equivalents (FAO, 2006). Livestock production systems emit 37% of anthropogenic methane most of that from enteric fermentation by ruminants. Moreover, they induce 65% of anthropogenic nitrous oxide emissions, the great majority from manure. Furthermore, livestock production would also induce 9 % of global anthropogenic CO_2 emissions. The largest share (i.e. 7%) of this derives from land-use changes – especially deforestation – caused by expansion of pastures and arable land for feed crops (FAO, 2006).

[1] Joergen E. Olesen, Department of Agroecology - Climate and Bioenergy, Blichers Allé 20, 8830, Tjele, Denmark, Tel. +41 87157778, jorgene.olesen@agrsci.dk

European studies have shown that the consumption of food products, beverages, tobacco and other stimulants contributes 21-31 % of the total EU greenhouse gas emissions. Meat and dairy products are the foods that have the greatest impact on climate. Vegetables generally have the smallest contribution to global warming. Agricultural production is the link in the production chain, which for all food products is associated with the largest emissions, but only a smaller part of the emissions come from manufacturing, packaging and transport. Initiatives to support climate-friendly food should therefore primarily be directed to improving agricultural practices.

Life-cycle analyses of food production systems in Denmark show the annual emissions of a milk cow is about 14 ton CO_2, from a sow with associated production of fatteners about 7.5 ton CO_2, and arable crop production about 3.5 ton CO_2 per ha. An analysis of available measures for reducing emissions show that the realistic potential for emissions reductions in Danish agriculture is about 15, 20 and 30 % for dairy, pig and arable production systems, respectively. At the global level the largest reduction potentials are found for accumulation of carbon in restoring degraded lands and avoiding CO_2 emissions from intensive cultivation of peat soils (Smith et al., 2008).

Organic farming contributes to emissions of the same greenhouse gases as conventional farming. However, management is in many respects different in organic systems, and this affects both soil carbon storage and emissions of methane and nitrous oxide. There are few experimental and modelling studies that compare greenhouse gas emissions from organic and conventional farming. However, they mostly point to lower emissions from organic systems on a per area basis, whereas there is often little difference in emissions, when organic and conventional systems are compared on a unit product (kg or litre) basis (e.g., Olesen et al., 2006). In cool temperate climates this is particularly the case, where conventional systems normally out-yield organic systems. The higher rate of soil organic matter turnover in warmer climates improves crop nitrogen supply under organic farming in these climates, and organic farming therefore typically does not result in large yield reductions in warm temperate, subtropical and tropical climates. The greenhouse gas effect of organic farming will be relatively more positive for warmer climates.

As countries put policies in place to curb GHG emissions, the livestock sector will be concerned. While the growth in livestock production will likely take place in countries with relatively low production levels, intensification of production comes at a cost of higher emissions of greenhouse gases (van Beek et al., 2010); these strategies may be ineffective in reducing emissions while at the same time causing negative economic, social and environmental effects. Understanding how policy frameworks addressing climate, energy or agriculture will affect the livestock-climate nexus is thus urgent; their social acceptance and cost-effectiveness across animal production systems being central issues. Moreover, some lobbying groups advocate for reduced animal product consumption in OECD countries, pointing at the sector's effects on the environment and animal welfare, and at the public health issues associated with high consumption levels.

References

Cassman, K.G., Dobermann, A., Walters, D.T., Yang, H., 2003. Meeting cereal demand while maintaining natural resources and improving environmental quality. Ann. Rev. Env. Res. 28, 315-358.

FAO, 2006. Livestock's Long Shadow. Environmental Issues and Options. Food and Agriculture Organisation, Rome, Italy.

FAO, 2009. How to feed the world in 2050. Food and Agriculture Organisation, Rome, Italy.

Foresight, 2011. The future of food and farming: Challenges and choices for global sustainability. The Government Office for Science, London, UK.

Olesen, J.E., Schelde, K., Weiske, A., Weisbjerg, M.R., Asman, W.A.H., Djurhuus, J., 2006. Modelling greenhouse gas emissions from European conventional and organic dairy farms. Agric. Ecosyst. Environ. 112, 207-220.

Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H.H., Kumar, P., McCarl, B., Ogle, S., O'Mara, F., Rice, C., Scholes, R.J., Sirotenko, O., Howden, M., McAllister, T., Pan, G., Romanenkov, V., Schneider, U., Towprayoon, S., Wattenbach, M., Smith, J.U., 2008. Greenhouse gas mitigation in agriculture. Phil. Trans. Roy. Soc., B. 363, 789-813.

Tubiello, F.N., Soussana, J.F., Howden, S.M., 2007. Crop and pasture response to climate change. Proc. Nat. Acad. Sci. 104, 19686-19690.

van Beek, C.L., Meerburg, B.G., Schils, R.L.M., Verhagen, J., Kuikman, P.J., 2010. Feeding the world's increasing population while limiting climate change impacts: linking N_2O emissions from agriculture to population growth. Env. Sci. Pol. 13, 89-96.

Livestock Production Systems and Future Food Security?[1]

GILLIAN BUTLER[2], JULIA COOPER[3], STEVE WILCOCKSON[4], AND CARLO LEIFERT[5]

The presentation focusses on how food security can be achieved in different systems and how different production systems can be compared for their performance. Globally agricultural production increases, but at the expense of more and more resources. The returns on fertiliser application are diminishing. Nitrogen can be recycled, but at the expense of energy. Phosphorus is essential, but will eventually run out. Different types of animal production differ in the efficiency by which cereals are converted into animal product and it is questionable which and how much animal production can be justified against food security.

[1] The presentation from Butler et al. is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Leifert-Niche-or-model-presentations.pdf

[2] Gillian Butler, Nafferton Ecological Farming Group, Newcastle University, Nafferton Farm, Stocksfield, Northumberland, NE43 7XD, UK, Tel. +44 1661 830222, www.ncl.ac.uk/afrd

[3] Dr. Julia Cooper, New Nafferton Ecological Farming Group, Newcastle University, Nafferton Farm, Stocksfield, Northumberland, NE43 7XD, UK, Tel. +44 1661 830222, www.ncl.ac.uk/afrd

[4] Dr. Steve Wilcockson, School of Agriculture, Food & Rural Development, Room 405, Agriculture Building, Newcastle University, Newcastle upon Tyne, NE1 7RU, UK, http://www.ncl.ac.uk/afrd

[5] Prof. Dr. Carlo Leifert, Nafferton Ecological Farming Group, Newcastle University, Nafferton Farm, Stocksfield, Northumberland, NE43 7XD, UK, Tel. +44 1661 830222, www.ncl.ac.uk/afrd

Species specific sessions: Dairy Cattle

Improving "Low Input" Dairy Cattle Production Systems[1]

F. BISCARINI[2]

Thanks to developments in DNA sequencing technology, in recent years a growing amount of information on the genetic make-up of livestock animals has become available. This information, typically in the form of panels of single nucleotide polymorphisms (SNPs), has been used in farm animal populations—usually specific breeds—to map Quantitative Trait Loci (QTLs) and, more recently, to estimate genome-wide breeding values (GEBVs) to be used in the so-called genomic selection schemes. During this process, not much attention has been paid to differences between animals farmed in different environments, such as intensive or rural production systems. Research and applications have so far focused on high input farming, due mainly to the larger available populations and the greater commercial interest. Within sub-project 1 of the LowInputBreeds (LIB) project, we investigate the methodology, scope and applications of genomic selection of dairy cattle reared in low input and organic farms, particularly in mountainous areas of Europe. The objectives are to investigate the aspects of genomic selection that are specific to low input production systems, and to estimate genomic breeding values for traditional production performance traits and for novel phenotypic characteristics related to the product quality, to the reproductive performance of cows, and to the health and welfare of animals. Knowledge about the genetics of traditional traits in cattle from low input farms and of novel traits of special interest in low input environments, together with the availability of GEBVs based on key genetic parameters estimated directly on low input populations will be highly beneficial for the low input and organic farming sector. Such an approach would provide low input dairy farming with tailor made tools for genomic selection, thus avoiding the need of resorting to genomic information and genetic material from the high input dairy cattle breeding industry. With this information and tools, ad hoc breeding programmes to improve production performance, reproduction ability, product quality and health and welfare of low input dairy cattle could be designed.

[1] The slides are available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Biscarini-Cattle-aims-presentation.pdf

[2] F. Biscarini, Department of Animal Sciences, Animal Breeding and Genetics Group, Georg-August-Universität Göttingen, Albrecht-Thaer-Weg 3, 37075 Göttingen, Germany, tierzucht@agr.uni-goettingen.de, www.uni-goettingen.de/en/92842.html

So far, along with the collection of phenotypic data and the high-density (HD) genotyping of cows, methods for genomic selection are being tested in a population of Swiss Brown bulls. At the same time, quantitative genetic parameters for milk production and cow fertility in Swiss Brown cattle from alpine pastures have been estimated in a random regression framework that allows for the analysis of longitudinal data, such as those related to lactation and fertility cycles that span over time. No appreciable effect on the accuracy of GEBVs of markers placed on the sex chromosomes was detected. As expected, GEBVs were more accurate for traits with high heritability than for traits with low heritability; nevertheless, the relative increase in accuracy compared to standard BLUP breeding values is likely to be higher for low heritability traits, for which therefore greater benefits from genomic selection are to be expected. Estimates of heritability for traits related to milk production and reproductive performance from random regression models were in line with those found in literature. A negative genetic correlation (~ -0.7) between cow fertility (conception rate) and milk yield was estimated throughout the entire lactation.

The thus tested methodology for genomic selection will be later applied to HD genotypes and novel traits, and the information will be combined with the estimated genetic parameters in order to design ad hoc breeding programmes for the improvement of production, product quality, reproduction, welfare and health of low input dairy cattle.

Ethical Problems and Breeding Goals in Dairy Cows and Beef Cattle[1]

HENNER SIMIANER[2]

The presentation discusses the expected and required increase in dairy production and the contribution of breeding and selection to this increase. Genomic selection can and will play an important role in achieving the increase in production through genetics. Over 50% of the required progress will come from genetics and increased resource efficiency is the major goal.

Items for discussion are the acceptability of reproduction technology, required for genetic progress and the fact that through genomic selection inbreeding might be reduced and breeding for fitness and welfare facilitated.

[1] The slides of the paper “Ethical Problems and Breeding Goals in Dairy Cows and Beef Cattle” presented by Henner Simianer is available at: http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Simianer-Cattle-ethical-considerations-presentation.pdf

[2] Prof. Dr. Henner Simianer, Georg-August-Universität Göttingen, Albrecht-Thaer-Weg 3, D-37075 Göttingen, Germany, Tel. +49 551 39-5604, www.uni-goettingen.de/tierzucht

Species Specific Sessions: Sheep

Improving Low Input Sheep Production Systems in Europe

HERVÉ HOSTE[1]

Sheep production in EU represents more than 100 million head, which are mainly found in less favoured areas throughout Europe. Small ruminants are usually kept in geographical areas where other livestock or crop industries are difficult to implement.

By comparison to the main conventional systems of production in other livestock species included in the Low Input Breeds project—dairy cattle, pig and laying hen—the current situation of sheep production is first characterised by its diversity in production. Primary products are meat or milk, with wool usually considered to be a by-product in Europe. Production corresponds to a diversity of breeds, including the maintenance of several local or traditional breeds. Compared to monogastric species, the use of extensive systems of sheep production is common throughout Europe. The links between outdoors practices in a specific territory and sometimes the use of a local breed are often valued by the occurrence of premium products identified by labels of quality or of geographical origin for both dairy or meat products.

Within this frame, the general aim of the sheep subproject within the LowInputBreeds project is to explore the interactions between breeding and environment in low input systems to improve the animal health, production and quality of products. The studies concern in priority systems of production which occur in Mediterranean or mountainous/alpine areas within Europe and which are dedicated either to milk or meat production. The scientific teams involved in the subproject are the research institutions: FiBL (Switzerland), NAGREF (Greece), INRA (France), the University of Catania (Italy) and the University of Lincoln (New Zealand), each of these teams having strong interactions and supports from national groups of stakeholders.

The overall issue addressed within the sheep subproject is how to determine the optimal balance between genetic improvement and/or management methods depending on the different environments and objectives of production related to performance and the quality of products.

[1] Dr. Hervé Hoste, Institut National de la Recherche Agronomique, Department of Animal Health, 31076 Toulouse Cedex, France, Tel. +33 5 61193800, h.hoste@envt.fr, www.envt.fr

This concerns three main issues which will be addressed in three different work packages. However, it is important to underline the strong interactions between the different work packages.

1. The genetic ability of sheep to adapt to abiotic (heat stress) or biotic stress factors (nematodes of the gastrointestinal tract and agents of mastitis) will be examined within a dairy sheep breed in Greece, firstly, by a wide phenotyping of their response to these stress factors; secondly, by exploring whether or not this can be improved /accelerated by the use of available molecular markers (work package 2.1)
2. The control of gastro-intestinal nematodes (GINs) by a combination of methods based on i) the possible use of tannin rich resources with natural anthelmintic properties, ii) the hygiene of pastures (grazing management) and iii) the possible improved host response (evaluation of genetic resistance between local vs more intensive breed) will be examined in the second work package (work package 2.2)
3. The consequences of the choice of breed/genotypes, management systems and the feeding regime and their possible interactions on the nutritional and sensory quality of lamb meat (and milk) will be examined in the different previous studies (work package 2.3).

The main ethical issues which will be addressed within the LowInputBreeds project in the sheep subproject concern

› the animal health and welfare
› the sheep behaviour
› the interactions with local environments in a wide, diverse range of situations including the
› preservation of diversity

These issues will also be examined in relation with some economic issues to illustrate how low input breeding in sheep might be efficient and economically viable in a highly competitive sector.

Ethical Problems and Breeding Goals in Sheep[1]

SMARO SOTIRAKI[2]

The presentation focusses on sheep and goat production in Mediterranean countries. Food safety, food quality and animal welfare are important aspects. Animal welfare is defined through the five freedoms as mentioned by the Brambell Committee. In sheep and goats welfare management is crucial. Availability of sufficient feed and water of sufficient quality is one aspect, whereas the lay out of the housing, hygiene and another is the prevention of infections, parasites, foot rot, mastitis. A system for scoring of welfare of sheep is introduced.

[1] The slides of the paper "Ethical Problems and Breeding Goals in Sheep" presented by Smaro Sotiraki is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Sotiraki-Sheep-Ethical-concerns-presentation.pdf

[2] Dr. Smaragda Sotiraki, National Agricultural Research Foundation NAGREF, Veterinary Research Institute VRI, 57001 Thermi Thessaloniki, Greece, Tel. +30 2310356373, www.nagref.gr

Main Areas for Discussion Regarding the Ethics of Organic and Low input Sheep Breeding

JOANNE CONINGTON[1]

Mismatch between genotype & environment is of concern.

As we can't 'control' the environment outdoors, then making sure the right breed does the right job is critical for animal and human welfare. Introduction of inappropriate breeds or crosses without corresponding modifications to the environment can have negative consequences. For example, more prolific breeds in extensive environments will have smaller birth weight offspring and hence potentially higher levels of mortality. Key management steps need to be in place to mitigate the consequences of such practises and it is certainly questionable whether or not the use of some prolific breeds—some with associated congenital defects—is morally right[2].

On the same note – having larger number of sheep looked after by one shepherd inevitably means less individual attention per sheep.

Using breeds that require little human intervention to lamb unaided is critical to both animal welfare and flock efficiency. Using 'easy care' breeds that have been created specifically for this purpose has been the solution to the low human inputs that has been brought about by the relatively low product value of sheep. Simply using the same genotypes but reducing labour inputs is not acceptable. Ways to breed such sheep are possible without compromising sheep welfare if undertaken in a controlled way – not the way they developed the Marshall Romney breed in NZ –survival of the fittest where lots of sheep died in the process, which is unacceptable.

Breeding for disease resistance is a sustainable way forward particularly for organic systems and low input sheep systems where they are only gathered from extensive

[1] Dr Joanne Conington, SAC, Roslin Institute Building, Easter Bush, Midlothian, EH25 9RG, UK, http://www.sac.ac.uk/research/groups/animalhealth/teams/animalbreedingandgenomics/

[2] An example of this is the Inverdale gene where homozygous ewes have streak ovaries and are infertile but heterozygous ewes are more prolific with ovulation rates about 1.0 units higher than non-carriers. Davis et al., 1992. Infertility due to bilateral ovarian hypoplasia in sheep homozygous (FecXI FecXI) for the Inverdale prolificacy gene located on the X chromosome. Biol. Reprod. 46:4 636-640.

hills once or twice during the lambs' lifetime and so implementing treatments is difficult.

More resistant sheep are healthier, require less human intervention and are cheaper to keep, and are better for the environment. However, in order for conventional methods of animal breeding practices to take place, it's more efficient if this is undertaken in diseased environments, that is when the prevalence of a disease is high. All evidence to date suggests that there is greater genetic & phenotypic variance for resistance to disease when the prevalence is high, leading to higher heritabilities and more efficient selection strategies. This means that usually, animals are not routinely treated with anthelmintics or at least they may suffer a period when treatments may be withheld, in order for such expression of resistance and/or susceptibility to take place before phenotypes are collected and selection takes place. Often coupled with large between year variations in the prevalence of certain diseases, conventional selection for disease resistance is a relatively difficult, long-term commitment. Hence the development and use of molecular tools and information to aid selection for disease resistance should be encouraged for conventional, low input and organic sheep breeding systems.

Using molecular genetic information in sheep breeding for disease resistance potentially overcomes the limitations that exist using the conventional selection method.

New robust tools and more efficient ways to implement these are needed for the sheep industry. Potentially the use of the ovine SNP chip could be the solution but for this to work effectively for multitude of breeds, a far denser SNP chip (800K+) than that which is currently available (50K) is required for the diversity of breeds that exist in Europe. Needless to say, there still needs to be large training populations for all breeds with detailed phenotypes for the diseases of interest, in order for the use of SNP technology to be realised. As it is far easier to measure milk yields and growth, the danger exists that SNP technology will accelerate selection response for these traits. Unless disease traits are included alongside them, they will get left behind and potentially undesirable correlated responses to selection for production only will be manifested in increases in susceptibility to some diseases.

Some other concerns for sheep breeding

- Laparoscopic AI – a surgical method – is used to maintain genetic connectedness in geographically diverse sub-populations such as ram cycles in Norway and Sire Reference Schemes in the UK.

- Breeding for aesthetic qualities such as horn size and broad shoulders often contributes to greater frequency of difficult births or dystocia. This is not conducive to low input sheep production and should be discouraged.
- Introducing fertility genes into populations of sheep where the management of the outcomes of so doing is not adequate. Higher levels of mortality are the consequence of increasing litter size, without corresponding emphasis on ability of sheep to rear larger litters.

Species Specific Sessions: Pigs

Aim of the Breeding Research in the LowInputBreeds Subproject on Pigs and the Methods to be Used[1]

JAN MERKS[2]

Low input pig production systems are usually characterised by smaller herd size, more space per animal, lower capital investment, often outdoor management, provision of bedding, greater labour requirement and focus on animal welfare. Examples of low input pig production systems are "Iberico" in Spain, "Neuland" pigs in Germany, "Scharrelvarkens" in The Netherlands, "Natura Farm" in Switzerland, "Label Rouge" in France and "Freedom Food" in United Kingdom.

Organic pig production systems have similar characteristics to those described for low input systems above. However, organic farming standards prescribe low stocking densities, access to outdoor runs, and restrict the level of bought in, non-organic feeds, which usually results in higher management and feed costs and more limited dietary composition choices than in other low -input systems.

The main issues that are addressed in the LowInputBreeds subproject for pigs are:

› Lack of appropriate breeding infrastructure for the low input sector In conventional pig production, cross-breeding has been widely used since the 1970s. Such cross-breeding systems are not available for organic or low input production.

› Piglet survival and associated traits, with piglet losses up to weaning 20% on organic and 12% on conventional farms.

› Abiotic stress factors in particular heat stress, where pigs raised in outdoor production systems are often exposed to greater challenges by both abiotic and biotic stress factors that adversely affect production.

› Nutritional and sensory quality of pig meat affected by (a) breed/genotype and (b) dietary regimes.

These issues are addressed within 3 work packages (WP):

[1] The slide presentation is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Merks-Pigs-aims-presentation.pdf

[2] Jan Merks, Institute for Pig Genetics IPG, 6641SZ Beuningen, The Netherlands, Tel. +31 24 6779999, jascha.leenhouwers@ipg.nl, www.ipg.nl

- WP3.1 Development of an on-farm system to improve pig survival and robustness related traits in small populations without the need to establish central testing stations called the "Flower Breeding System" in this project.
- WP3.2 Development of management innovations in gilt rearing and lactation systems on mothering ability of sows and losses of piglets.
- WP3.3 Effect of traditional, improved and standard hybrid pig genotypes and feeding regimes on carcass, meat and fat quality.

Along these WP's, the partners in SP3 want to achieve:

1. Indication of European breeds/genotypes that show the "best" performance with respect to desired robustness, animal health and welfare and product quality traits while economically competitive under low input conditions.
2. To quantify to what extent and what kind of specific breeding programmes such as the proposed Flower Breeding Programme are needed for (a) different types of organic and low input production systems (b) different macro-climatic/geographic regions in Europe and (c) to reduce piglet and finisher mortality.
3. Gilt rearing system(s) and piglet environment during lactation that suit best for the health and welfare and productivity of pigs in low input systems.
4. Determine the effects of breed/genotype. Traditional and modern breeds/genotypes and crosses between modern and traditional breeds/genotypes and different feeding regimes on performance, carcass quality as well as nutritional and sensory quality aspects of fresh and processed pork and sausage characteristics.
5. Determine the effect of pig genotypes and feeding regimes on nutritional and/or sensory quality characteristics of pork meat in three different macro-climatic zones organic and low input systems in D, ES and UK

These results are achieved along a combination of experiments and desk research, which consists of literature and model analysis. Traditional selection and breeding methods are used for the achievements 1 and 2, while for the other achievements use is made of available genetics. SNP technology is used only for parental identification of dead pigs.

For the optimisation of 1 and 2, the actual breeding goals, based on mainly economic values, are used. The economic values are determined by the actual prices for labour, feed, housing etc. in the region where the breeds are selected and maintained.

Ethical Problems and Breeding Goals: Pigs[1]

SANDRA EDWARDS[2]

Ethical problems in pig production systems arise when the rights of different stakeholders conflict. These rights can be summarised in the ethical principles of well-being, autonomy and justice. The stakeholders who should be considered are the animal itself, the farmer, the consumer, wider society and, more generally, the natural environment.

The most prominent ethical problems arise from the conflict between animal welfare and farmer income, associated with affordable food for consumers. These frequently arise from the breeding goals which have been adopted in order to increase system output relative to resource inputs. Selection for prolificacy has resulted in dramatic increases in litter size and annual sow production of weaned piglets, but at the cost of increased piglet mortality arising because of lower birth weight, reduced vitality and greater suckling competition. A further cost in sow longevity is also becoming apparent as sows are unable to meet the greater metabolic demands of sustaining high production levels. Both issues are exacerbated in low input systems, where environmental challenges to low vitality piglets and nutritional challenges to high production sows are greater. Since both piglet survival and sow longevity have significant heritability, these are important breeding goals for low input systems.

Similar challenges for animal welfare, especially in low input systems, result from selection for high lean tissue growth rate in order to improve rate and efficiency of meat production. Extreme selection for this trait results in reduction in robustness and ability to adapt to low input conditions. Metabolic demands cannot be met with low quality diets, natural ability to resist disease is compromised by reduced immunological function, and mobility can be impaired by greater susceptibility to leg weakness. Breeding goals for low input systems demand a better balance in selection programmes between these genetically correlated functions. Furthermore, selection for this trait has also impacted on thermoregulatory function through loss of fat insulation, which is important in cold conditions, and high metabolic heat production, which is detrimental in hot conditions. Low input systems require animals with

[1] The slide presentation is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Edwards-Pigs-ethical-concerns-presentation.pdf

[2] Prof. Dr. Sandra Edwards, School of Agriculture, Food and Rural Development, Agriculture Building University of Newcastle, Newcastle upon Tyne, NE1 7RU, UK, www.ncl.ac.uk/afrd/

greater tolerance to climatic variation, which has a genetic component and is therefore another important breeding goal.

Whilst breeding for efficiency can have many disadvantages for the animal, it is important to consider consequences of inefficiency for environmental impact. Traditional breeds, with slower growth, greater fatness, and more extensive environments, reduce food production efficiency. Lower efficiency can increase the carbon footprint of meat produced in this way, and give greater excretion of nutrients with the potential to increase environmental acidification and eutrophication. This represents another potential ethical conflict in low input systems.

In addition to animal genotype, ethical conflicts also arise between management decisions which improve production efficiency and animal welfare. Decisions relating to economically optimal group size, composition and stability can give rise to increased aggression and injurious behaviours. Since these traits have also been shown to have a genetic component, breeding for reduced social problems is a feasible option. However, this does raise other ethical considerations regarding the integrity of the animal. Other contentious management decisions such as weaning age and housing choices that restrict natural behaviour are equally important ethical issues, but are unlikely to be solved by breeding approaches.

Ethical conflicts also exist between the rights of consumers and animals. The most prominent of these relates to the issue of castration, where the demand of consumers for meat without boar taint conflicts with the integrity and welfare of the animal. Once again this conflict is greater in low input systems where use of early-maturing, slow-growing traditional breeds and provision of diets with lower quality, imbalanced proteins will exacerbate taint problems. Since the concentration of boar taint compounds in carcass fat have a genetic component, breeding strategies will be an important part, but not total solution, in future resolution of this problem. Consumers also demand safe and healthy food, which sometimes is facilitated in low input systems, but sometimes conflicts with other goals. For example, fatter animals deposit more saturated fats harmful to human health, giving a conflict between promotion of traditional breeds and well-being of consumers. Since fatty acid composition of lipid deposits also has a genetic component, in addition to the much stronger dietary influence, breeding approaches to this issue might be considered.

Finally, the way in which breeding goals are achieved can, in itself, raise ethical issues. Technology has delivered powerful new tools to implement rapid genetic change in populations.

For example, the use of genomic selection using genetic markers and SNP information can give faster progress than the use of only phenotypic information. The extent to which such approaches compromise the integrity of the species, and hold dangers for the welfare of the individual animal, can be debated. At the extreme, the use of genetic modification techniques to achieve specific targeted traits is now possible and, whilst being increasingly adopted in plants, still holds many issues for implementation in animals.

Ethical Aspects of Breeding in Organic Pig Production

ANNA WALLENBECK[1]

Animal breeding for organic production

Organic animal production is becoming more common in many European countries. While much effort has been put on the development and promotion of organic products, little attention has been paid to one of the most important foundations of organic animal production, i.e. the animal material used. The breeding strategy currently applied by most farmers is to use the same breeds and lines as used in conventional production. These animals are selected for high production in conventional production environments. In order to assess if this is a sustainable and suitable breeding strategy and to assess other potential breeding strategies, several issues need to be investigated. The process of developing sustainable breeding strategies for organic animal production should involve identification of environmental demands on the pigs, including environmental variation within and between farms and regions, identification of traits especially important and the relative importance of different traits in these production environments and assessment of interactions between genotype and environment. Moreover, factors such as population size, use of reproduction techniques and the structure and cost of breeding programmes are important for the outcome of the breeding activities and should be considered.

Principals and aims of organic production

Organic production is based on an ethical framework set up by the organic movements joined under the International Federation of Organic Agricultural Movements (IFOAM) and the four basic principles are health, ecology, fairness and care. Moreover, organic food production strives to have a holistic and systemic approach, aiming towards environmental, social and economic sustainability. IFOAM's general principles stated in IFOAM's basic standards—the criteria that some organic certification organisations follow—emphasize that animal husbandry should be an integrated part of the agro-ecosystem and embrace good animal welfare and health. Thus, the development of organic pig production systems and

[1] Swedish University of Agricultural Sciences, 7023. Gerda Nilssons väg 2, 75007 Uppsala, Sweden, anna.wallenbeck@slu.se

breeding activities for these production systems need to balance the interests of humans—including both consumers, farmers and the broader society—animals such as pigs and the environment, both locally and globally. Ethical dilemmas, conflicts and trade-offs between different interests are natural consequences of the ambitious aims and principals of organic production, and these conflicts lead to a constant revision of organic standards and development of organic production systems.

Ethical key issues relevant for organic pig production

The fact that producers in many cases only can access pig breeds and lines bred for high production in conventional production environments can be a dilemma. This is especially problematic if the breeding goals for those breeds and lines differ from what would be desired in animals on their own farm. Interesting examples are traits affected by difference in the nutrient content of diets and housing conditions.

The nutrient content in pig diets composed of organic and locally produced feedstuff is usually less optimal in relation to pig requirements, compared to diets composed of feedstuff used in conventional production. Pigs bred for improved production on diets with high nutrient quality will have a poor feed conversion when fed diets with lower nutrient quality. Poor feed conversion leads to increased nutrient leakage that conflicts with the aim of environmental sustainability. Thus, pigs for organic production systems should be bred for improved feed conversion when fed diets composed of organic and locally produced feedstuff.

Breeding goals for pig dam lines have been focused on increased litter size for a long time. Additionally, most breeding companies produce hybrid sows for commercial producers in order to make use of hybrid vigour, i.e. increase litter size even further than in the pure bred animals. Consequently, the litter size in commercial pig production has increased considerably the last decades. The goal trait is number of pigs weaned or slaughtered per sow per year, and these numbers have increased with increased litter size at birth. However, other and less favourable consequences are that piglet birth weight and piglet survival has decreased. Piglet mortality is often higher in organic than in conventional production systems. Likewise, more pigs die during the growing and finishing periods. The main reason for the high mortality is the more extensive housing conditions—outdoor access, loose and group housed—leading to larger environmental variations, higher pressure for some diseases and reduced possibilities for humans to care for individual pigs. Furthermore, due to large space allowance and rough ground surface, the stress on pigs' legs is often high in organic production systems, and lameness is frequently occurring. Sows, piglets and growing pigs for organic production should be bred for improved survival, better disease resistance and stronger legs.

Other, and in this context less central, examples of ethical issues in organic pig production that could be related to breeding activities—at least to some extent—are the issue of boar taint without castration and the reduction in productivity caused by sows' timing of oestrous when they are group housed.

In summary, pigs for organic production should preferably be bred for improved ability to adapt to environmental variations, such as climate changes between seasons and variation in diet composition between years; the ability to utilise local feed resources, including diets with less optimal nutrient quality; survival at all stages of development; disease resistance; and leg strength.

Species Specific Sessions: Laying Hens

Laying Hens

Selection and characterization of low input farm groups in 3 macro-climatic regions in Europe for inclusion in a "farmer participatory" performance recording network (FP-PRN) and performance recording of currently used layer genotypes[1]

FERRY LEENSTRA[2], VERONIKA MAURER[3], MONIQUE BESTMAN[4], ESTHER ZELTNER[5], THEA VAN NIEKERK[6], FABIEN GALEA[7] AND BERRY REUVEKAMP[8]

Introduction

In poultry, breeding is carried out by a very limited number of international operating breeding companies. For laying hens two companies dominate the market. Most laying hens are 4-way crosses. Since 1960 the majority of commercial layers are bred and housed in cages. Non-cage housing started to appear again from 1980 onwards and increases slowly in importance, at first in Europe, but recently also in North America. It is questionable whether birds bred to perform in cages are also suited for free range housing. In this project we examine the performance of current genotypes in free range systems—organic and conventional—and if and how an improved genotype for free range housing can be developed.

Methods

In subproject 4 we work with networks of farmers. As first step we carried out an inventory among laying hen farmers in Switzerland, The Netherlands and France that keep free range

[1] The slide presentation is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Leenstra-Poultry-aims-presentation.pdf.

[2] Dr. Ferry Leenstra, Wageningen UR Livestock Research, 8200 AB Lelystad, The Netherlands, Tel. +31 320 238517, ferry.leenstra@wur.nl, www.livestockresearch.wur.nl

[3] Dr. Veronika Maurer, Animal Husbandry, Research Institute of Organic Agriculture (FiBL), Ackerstrasse, 5070 Frick, Switzerland, www.fibl.org

[4] Dr. Monique Bestman, Louis Bolk Institute, Hoofdstraat 24, 3972 LA Driebergen, The Netherlands, info@louisbolk.nl, www.louisbolk.org

[5] Dr. Esther Zeltner, Animal Husbandry, Research Institute of Organic Agriculture (FiBL), Ackerstrasse, 5070 Frick, Switzerland, www.fibl.org

[6] Thea von Niekerk, Wageningen UR Livestock Research, 8200 AB Lelystad, The Netherlands. www.livestockresearch.wur.nl

[7] Fabien Galea, Institut de Sélection Animale BV (ISA) a Hendrix Genetics company, Villa 'de Körver, 69 Spoorstraat, P.O. Box 114, 5830 AC Boxmeer, The Netherlands, www.isapoultry.com

[8] Berry Reuvekamp, Wageningen UR Livestock Research, 8200 AB Lelystad, The Netherlands, www.livestockresearch.wur.nl

or organic hens. We have data of 325 flocks on 275 farms. Questions asked were on general information about the farm, on housing system and management procedures, among which recording of data, genotypes and performance.

As a second step we organised workshops with farmers to discuss their ideas on breeding goals and 'the ideal hen' for free range systems. Secondary purpose of these workshops was to form a network of farmers, that might be interested in experimenting with different genotypes and give feed back to the breeding company on performance of the flock in a standardized way.

Results

Table 1 gives the average farm size, egg production and mortality for the two systems and three countries.

Farm size considerably differs between the two systems and the three countries. Egg production in organic systems is lower and mortality higher in organic systems compared to free range. The difference is most pronounced in The Netherlands and almost non-existent in France. Farmers in France indicated that both organic and free range hens had treated beaks; in Switzerland none of the birds had treated beaks. In The Netherlands free range birds have treated beaks, organic birds not.

Table 1: Egg farm characteristics in Switzerland, France and the Netherlands

	Switzerland		**France**		**Netherlands**	
	Free range	Organic	Free range	Organic	Free range	Organic
Number[1]	35	91	32	11	48	57
Farm size[2]	3 093	1 635	7 577	4 682	17 625	8.077
Eggs produced[3]	244.1	241.9	247.0	245.4	244.9	231.0
Mortality[4]	5.9	6.6	4.9	4.7	6.6	12.0

[1]Number of farms included in the study.
[2]Average number of laying hens per farm.
[3]Average number of eggs produced per hen housed per year.
[4]Percent mortality at 60 weeks of age.

In Switzerland and The Netherlands brown, white and silver hens were kept; in France only brown hens. In total there were 30 different genotypes: 10 'brands' of brown hens (1– 51 flocks/brand), 3 brands of white hens (4-28 flocks/brand), and 4 brands of silver hens (3-15 flocks/brand). There is a clear difference between countries with regard to genotypes. In Switzerland one brown genotype is favoured, in The Netherlands another one and in France a third one. In Switzerland there were quite a number of white flocks (CH 35, NL 7), while the silvers were much more kept in The Netherlands (CH 5, NL 32). In Switzerland there were 3 flocks with original genotypes. In Switzerland there were 73 mixed flocks (brown and white, brown and silver, white and silver).

Table 2 gives an overview of egg production and mortality by housing system and group of genotypes. The white and mixed flocks are mainly from Switzerland, the silvers from The Netherlands, while in the group of brown birds all three countries are present.

In free range the brown and white mixed flocks produced significantly worse than all other groups. In organic systems the silver hens were not significantly different from the brown ones, but produced less than all other groups. In general differences in production can be attributed to the differences in mortality. The white hens perform quite well in free range and organic systems. These results are confounded by country: the white hens were predominantly present in Switzerland and the silvers in The Netherlands. Yet, the general picture is lower production per hen housed and higher mortality in organic systems compared to free range systems and lower production per hen housed and higher mortality among the silvers. The differences in production per hen housed can be explained by the differences in mortality.

The farmers were also asked to give a score for feather condition. The results corresponded with data on production and mortality: White hens had, compared to the other types, a rather good feather cover, while among silver hens a rather high percentage of birds had a bad feather cover and the brown ones were in between.

The differences between performance of organic and free range hens might be influenced by beak treatment: in organic flocks no beak treatment is allowed, in free range flocks beaks can be touched or even trimmed. Another reason might be the differences in diet. Diets for organic hens have to contain at least 95% of organic raw materials, for free range flocks all available sources can be used.

Table 2: Egg production and mortality by genetic group and system

	White	Brown	Silver	Brown + Silver	Brown + White	White + Silver
Flocks[1]	32	120	31	5	28	4
Production Free range[2]	248.7	246.2	237.8	248.0	200.0	NP
Production Organic[2]	243.5	239.1	227.2	254.3	240.8	243
Mortality Free range (%)[3]	5.2	5.8	9.8	5.6	1.0	NP
Mortality Organic (%)[3]	3.5	8	13.4	9.6	7.1	10.4

[1]Number of flocks of the genetic group included in the study.
[2]Average number of eggs produced per hen housed per year by breed.
[4]Percent mortality at 60 weeks of age.

Table 3 indicates if farmers consider for the next flock the same or another genotype. We asked the farmers for reasons to change. It appears that free range farmers stick more to the same genotype than organic farmers. These decisions on genotype are in Switzerland and France often dependent on the egg trader and/or the hatchery, while in The Netherlands this is less the case. This explains the rather high rate of change in Switzerland.

Table 3: Next flock same or different genotype?

	Same	Different	Don't know
Free range	103	25	12
Organic	66	97	8
Switzerland	69	77	0
France	32	6	0
The Netherlands	68	29	20

Workshops

Farmers in workshops conducted in Switzerland and the Netherlands discussed the results of the inventory and the most important characteristics for free ranging hens. In both countries longevity and adaptability scored high. Other important characteristics deal with behaviour: curious, but calm, good nesting behaviour, and not prone to trooping or smothering.

Productivity and a good feed conversion also ranked high, but farmers indicated that the ideal hen has a good eating capacity and probably should be a bit heavier than current genotypes. The farmers indicated that in free range systems often stress factors of different origins are present. Hens then tend to eat less and do not have sufficient reserves to draw on.

Adaptability and fast recovery after a dip in production were considered more important than a high peak production.

How to continue

Besides a more thorough analysis of the data set—especially for interactions—farm visits are planned to get more insight in possible causes of differences between genotypes and systems, specifically for feather cover, and health and mortality related issues. During the farm visits data on and samples for egg quality will also be collected.

The researchers will identify the criteria farmers use to decide on when to finish a flock or plan to moult them. They will also examine which farmers are interested in experimenting with a new genotype, most likely a heavier type of bird.

We plan to set up an experiment to test two different genotypes—the new one and one prone to feather damage—on a pure vegetarian diet and on a diet containing meat and bone meal. Quantity and quality of protein is a critical factor in poultry diets, especially with current high prices of raw materials. High costs and low availability of protein components are more pronounced in organic than in conventional diets.

Ethical Problems and Breeding Goals: Poultry[1]

VERONIKA MAURER[2]

Killing male chicks and discarding layers after one year of production

Poultry lines are highly specialised and used either for egg or meat production. Layers reach a body weight of about 2 kg after a rearing period of about 20 weeks, while broiler lines reach more than this weight after a fattening period of 6 weeks.

This divergence of layer and broiler lines leads to several problems:

Layers: High egg production and low body weight

- Negative reaction to slight variation from optimal environment;
- Health problems associated with high egg production:
    - reduced bone strength;
    - keel bone deformation;
    - feather pecking;
- Female birds only one year in production;
- Male chicks and spent layers not used for human consumption or animal feed;
- Fattening males is not economic (long fattening period, low feed conversion rate).

Broilers: Fast muscle growth and high body weight

- Health problems associated with fast growth of muscles compared to growth of supporting structures:
    - leg deformation and lameness;
    - breast blisters;
    - heart problems.

[1] The slide presentation is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Maurer-Poultry-Ethical-concerns-presentation.pdf

[2] Dr. Veronika Maurer, Animal Husbandry, Research Institute of Organic Agriculture (FiBL), Ackerstrasse, 5070 Frick, Switzerland, veronika.maurer@fibl.org. www.fibl.org

These problems are mainly caused by creating specialised lines, and they can therefore be decreased by breeding. There have been several attempts to overcome disadvantages of specialised lines with *dual purpose* chicken. These are expected to solve:

- the problem of killing male chicks;
- growth related health problems of broilers;
- some health problems of layers.

As a third purpose, heavier hens of these lines would be better suited for human consumption after their life as a layer. However, all the results obtained with possible dual purpose lines so far have not been economically acceptable for large scale organic and low input egg or table bird production, while they may be for small scale speciality production.

An alternative to be considered is the prolonged use of layers. Egg and feathering quality as well as egg production naturally decrease in older layers. After moulting, an unproductive period during which the feathering is renewed, these problems are often substantially reduced.

Induced moulting was banned for animal welfare reasons by the Swiss organic regulations in the past. However, "animal friendly" moulting systems without complete feed and light deprivation and with access to the veranda were recently developed that are now approved by the organic regulations and increasingly applied in Switzerland. The situation is similar in other countries. This development was reflected in the workshops for farmers participating in the "farmer participatory breeding network" of LowInputBreeds: the wish to have a layer suited for longer use with or without moulting, and with a flat production curve—with no peaks in egg production and good persistence—was expressed in all the Swiss workshops. Production planning by the egg traders was mentioned as the main obstacle.

Model calculations show that using hens longer without moulting (70 weeks laying period instead of 47) reduces the number of male chicks to be killed and old layers to be discarded per year by about one third. If layers are moulted and used during two laying cycles instead of one, there are about 50% less animals to be killed and discarded per year.

Management and health of the individual flock are crucial for the success of prolonged use or moulting. In addition, not all layer lines seem to be equally suited for prolonged use and moulting. Breeding is therefore an important element of success.

Uneven use of run by large flocks and feather pecking

Hens kept in large flocks use the outdoor run less frequently and less evenly than hens in smaller flocks. This leads to damage to the grass cover and, more importantly, over-fertilisation and nutrient leaching in the area close to the house.

Feather pecking is considered the major animal welfare problem on organic and free range farms. In a survey performed in LowInputBreeds on 320 flocks in the Netherlands, France and Switzerland the proportion of flocks not affected by feather pecking was 34%. About one-third of the flocks were heavily affected by feather pecking. Other studies revealed that the risk was reduced in flocks with a better use of the outdoor run. Beak trimming is often used to prevent feather pecking. However, this mutilation is not acceptable in organic farming and also prohibited by many free-range labels.

Both, feather pecking and the readiness to use the run depend on management—for example light, feeding and the structure of the house and outdoor run—but they also have a genetic component and selection is therefore possible.

Critical Comment: Laying Hens[1]

GERARD ALBERS[2]

The presentation focusses on the perceived contradiction between increased utilisation of resources and animal welfare in poultry. More freedom to move around for chickens increases perceived animal welfare accompanied by higher mortality in those systems on average.

Important ethical issues are the killing of day old males, which might be solved by choosing a dual purpose breed and feather pecking which might be reduced by selection for birds with less of a tendency for feather pecking. However, dual purpose chickens have lower resource efficiency than specialised breeds, while systems with more freedom to move around have a higher risk for feather damage. In fact there is a conflict between welfare requirements as perceived by the general public and food security for all.

[1] The slide presentation of Gerard Albers is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/albers-poultry-reflections-presentions.pdf

[2] Institut de Sélection Animale BV (ISA) a Hendrix Genetics company, Villa de Körver, 69 Spoorstraat, P.O. Box 114, 5830 AC Boxmeer, The Netherlands, www.isapoultry.com

Reflection

Food, Agriculture and Fisheries, and Biotechnology – Knowledge-Based Bio-Economy[1]

ANNE-SOPHIE LEQUARRÉ[2]

The presentation focusses on how in the European Union decisions on research items and research budgets are made. In breeding and genetics research sustainability of production, animal welfare and product quality are important factors. Impact on the environment, biodiversity and breeding goals are essential for sustainability. Animal health, natural behaviour, quantity and quality of feed and the quality of lodging are essential for animal welfare. Product quality should consider product safety and sensory properties. The position of several EU research projects in relation to ethical issues is discussed.

[1] The presentation of Anne-Sophie Lequarré is available at http://www.lowinputbreeds.org/fileadmin/documents_organicresearch/lowinputbreeds/events/2011-03-15-16/Lequarre-EU-programs-presentation.pdf

[2] Anne-Sophie Lequarré, Unit E4 "Agriculture, Forestry, Fisheries, Aquaculture", European Commission - DG RTD, SDME 08/9, 1049 Brussels, Belgium

Dairy Cows and Beef Cattle: Ethical Concerns

KARSTEN KLINT JENSEN[1]

The presentation on ethical problems and breeding goals in subproject 1 by H. Simianer took its point of departure in some global trends. The area of usable arable land has probably reached its maximum level. The population is expected to grow until 2050. For this period, the arable land per capita will then be declining. This means that food production has to increase its volume with about 1% per year until 2050. If the increasing demand for animal product is to be met, animal production will have to increase with 2-3% per year. Given constant input resources, this increase can only come from increased efficiency in using input resources.

Simianer estimated that up to 2007, more than 50% of the increase in productivity stemmed from breeding. He also estimated that with traditional breeding tools, it would only be possible to obtain a progress of 1% per year at the maximum. But genomic selection has the potential to boost the level up to the necessary 2-3%. In recent years, there has been increasing interest in functional traits. But they have been difficult to realize, because they have low heritability and are unfavourably correlated with production traits. Genomic selection, however, offers the option of different trade-offs in the genetic progress between production traits and functional traits. It should therefore also be of interest for low input production. Having made his case for the necessity of using genomic selection, also in low input production, in order to meet the ethically urgent future demand on animal products, he ended by claiming that the technologies associated with genomic selection are in fact socially accepted and in routine use.

F. Biscarini presented two of the aims of Subproject1 of the LowInputBreeds project. One is to test the potential of genomic selection for low input and organic dairy farms. Another is to collect available data and use a multi-criteria model to design breeding and management strategies for dairy farms in various regions. The discussion was centred around two overall themes: genomic selection and resource efficiency.

[1] Professor Dr. Karsten Klint Jensen, Danish Centre for Bioethics and Risk Assessment (CeBRA), Rolighedsvej 25, 1958 Frederiksberg C, Denmark, Tel. +45 353 33010, e-mail kkje@life.ku.dk, internet www.bioethics.dk/

The invited commentators from ECO AB stressed that organic production is governed by a set of values, which basically stresses the importance of the local rooting of farming; but they also recognized that compromises are necessary in order to make organic production work under most conditions. They suggested that evaluation could be made from the point of view of what organic farming needs in order to develop positively. From this perspective, they rejected technologies such as ET and sperm sexing as incompatible with organic values—although this is debated among farmers and advisers—but they did not outright reject genomic selection in itself. Genomic selection offers the potential to speed up the breeding process and direct it at the specific needs of organic production; there was also interest in learning more about the genetics of important traits. However, the commentators saw a number of risks associated with genomic selection, which made them sceptical overall.

There is a threat to the local infrastructure of organic farming and its transparency and there is the threat of losing sight of the importance of the different environments, and thus indirectly a threat to biodiversity. Particularly for health traits, the environment was estimated to be very important, because the heritability is so low. Ideally, breeding should be on-farm.

However, most of these claims were met with opposition in the discussion. Thus it was remarked that genetics *is* important and that data for genomic selection are available from many different environments. It is possible to genomically select bulls for natural service on farm and genomic selection tends to reduce the inbreeding rate, and even increase biodiversity. In the end the participants did not reach consensus.

Concerning resource efficiency, the discussion was basically about how wide or narrow this notion should be defined. One side considered efficiency a matter of feed conversion and a matter of the genetics of metabolism at least as an important aspect. On the other hand, from an organic perspective, it was emphasised that low input animal production could be efficient in grasslands where no other use is possible; but also that organic milk production *is* efficient, not that different from conventional. Also, it was pointed out that in comparing efficiency, all costs of using concentrates should be included and that concentrate prices tend to increase.

Finally, it was stressed that there is an upper limit to how much an animal can produce, and we have a duty to respect this fact.

Sheep: Notes from the Sheep Group

Mickey Gjerris[1]

1 Introducing remarks

The two group discussions concerning sheep held during the LowInputBreeds workshop in Wageningen, March 2011 had few participants, and those that were there are all involved in the LowInputBreeds project as scientists. The researchers discussed what challenges they find in sheep production and what strategies would be the best to counter them. During these discussions some ethical considerations were identified and the facilitator tried to challenge the scientists to include these considerations into their discussion of perceived challenges and possible solutions. An important limitation of the discussions was that the participants only focused on Mediterranean sheep production, especially Greek sheep production. The participants stressed that challenges and solutions were context-specific, so that different regions in Europe face different challenges and evaluate the solutions differently

2 Challenges to sheep production and possible solutions

The overarching consideration was how to organize sheep production in an economically sustainable way. Several other goals were also seen as important, including animal welfare, maintaining local breeds, low environmental impact and others, but all participants stressed that these could only be solved to the extent that the economic concerns were addressed.

The participants identified areas within the production systems where improvements could be made that would either increase production efficiency or add extra value to the end product that would also enable a higher degree of animal welfare and lower environmental impact. Below they have been listed as they pertain to the animals, to the products or to the environment

[1] Prof. Dr. Mickey Gjerris, University of Copenhagen, Faculty of Life Science, Institute of Food and Resource Economics/Consumption, Health and Ethics Unit, Rolighedsvej 25 , 1958 Frederiksberg C, Denmark, Tel +45 353-32165, E-Mail mgj@foi.ku.dk, http://www.bioethics.kvl.dk/mgj/index.htm

Animal Health, Animal Welfare and Animal Ethics

- Heat: Either breed animals that are more heat-tolerant or change production systems to allow for cooling of the animals.
- Parasites: Breed parasite resistant animals— specifically to gastrointestinal nematodes—combined with different strategies for feed and grazing areas to avoid disease. A combination of breeding, controlling feed and environmental factors were seen as the most efficient.
- Mastitis: Breed mastitis resistant animals combined with different strategies for feed and grazing areas to avoid disease. The combination of breeding, controlling feed and environmental factors was again seen as the most efficient.
- Environment: The advantages and disadvantages of both indoor and outdoor production were discussed in relation to animal welfare. Indoor housing was seen as facilitating the goals of reducing heat stress and parasites, but at the same time created other problems for the animals, especially a reduction of the possibility of the animal to perform its species-specific behaviour. These discussions reflected the often found discrepancies between different paradigms of animal welfare. These will be discussed in section 3.
- Species specific behaviour: The time for weaning the lambs was one of the parameters that were heavily discussed. To some participants early weaning—seven days as in France—both constituted the most efficient production method and ensured the welfare of the animals, where others found that later weaning—40 days as in Greece—both gave better animal health, allowed the animals to experience the maternal bond between sheep and lamb and made economic sense due to the better health of the animals.
- Animal integrity: The notion of animal integrity was connected with the idea that it could be important to allow species-specific behaviour even though the animals deprived of the opportunity would not have negative experiences. One could imagine that lambs weaned early in France would not have a negative effect on their mental states, but from an animal integrity view this would still be ethically problematic. From an ethical point of view this distinction marks the border between animal welfare considerations and animal ethics considerations.

Product

- Production efficiency: Economic sustainability of production was the overarching challenge. The goal of breeding initiatives was seem as to ensure increased production efficiency—perhaps in combination with other measures such as changes in diet or environment—without damaging the value of the product through lower consumer evaluation of the product.

- Product quality: One way to increase the value of the product was seen as increasing the physical quality of the product. Parameters such as taste and tenderness were mentioned. Again this was seen as something that could both be reached through breeding to change the animals or changing the environment through diet. A general problem with using breeding strategies or changing environmental or dietary factors that was often mentioned was that this approach carries the risk of diminishing the differences between local breeds and local products. Such an approach could cause problems both with regard to the genetic diversity of the sheep population but also with regard to the expectance of the consumers to be able to get a local product that distinguishes itself from other products. The local nature of the product was thus also seen as a quality inherent to the product – albeit less tangible than the physical quality. In the same way more intensified production systems were seen as entailing advantages for the production efficiency and sometimes even animal welfare, they were also seen as going against the whole idea of low input production that to some consumers is seen as a quality as well.

Environmental impact

In general there was agreement among the participants in the group that sheep production is an environmentally friendly way to produce meat. The main reasons for this is the extensive nature of the production systems that often adapt to the local environment and the utilization of marginal agricultural land that otherwise would go unused. Advantages could perhaps be gained through breeding for animals with lower CO_2-emissions through more effective digestion. These advantages could also be sought through changes in feed and would probably call for a more intensive production. Intensification could be counterproductive to the environmental profile of the production. From the perspective of the researchers present at the workshop it seemed as if changes in the present production could move either way in this area and would be dependent both on consumer acceptance, local customs and the knowledge level of the farmers. Both increased breeding efforts and intensified production systems were seen as possibilities to promote the environmental profile of the industry, but also as going counter to values underlying the low input production systems. Participants generally acknowledged that changes would have to be accepted by both farmers and consumers and therefore should be introduced slowly.

Regional differences would play a large role in which strategies would be acceptable to producers and consumers. There was general agreement that what was labelled “sensible intensification” through breeding and management changes would be more acceptable in Southern Europe than in Northern Europe.

3 Ethical considerations

The main ethical problems that can be lifted from the discussions at the workshop about creating greater economic sustainability in sheep production in Southern Europe are that:

A: There are different views on what is animal welfare. Thus what can be seen as increased animal welfare from the perspective of the researchers—breeding for heat resistance or intensification of production systems through increased housing of animals—from another perspective can be seen as diminishing the natural species-specific behaviour of the animals and thus decreasing the welfare. An elaborate scoring system for evaluating animal welfare based on an interpretation of the classic definition of *the five freedoms* was suggested in one of the presentations. The discussion clearly revealed that this understanding presumed a certain understanding of the concept of animal welfare that was not shared among the researchers.

B: The notion of animal welfare as only a part of what is ethically relevant in relation to the animal is not a notion that resonates in the researchers. They readily accepted that notions such as integrity or naturalness plays a role both for consumers and producers, but found it hard to incorporate this into the research aims of the project.

C: Using breeding and management strategies to obtain what was labelled ‘sensible intensification’ that can lead to both higher production efficiency, higher animal welfare—at least from some perspectives—and lower environmental impact is not necessarily acceptable for producers and consumers because of 1: The loss of local breeds and traditions, 2: Perceived loss in product quality and 3: The loss of values underlying low input production.

D: All changes in production systems must at the same time lead to an increased economic sustainability of the industry. For the researchers this constituted a fact that although regrettable was undeniable. The search for improvement in e.g. animal welfare is therefore limited to win-win situations with the economic factor always gaining the upper hand. Ethical considerations thus become something that is done within the perceived economic interests of different stakeholders and not something that can be used to frame the economic activity.

Report of the Pig Breeding Group

TASSOS MICHALOPOULOS[1]

1 The presentation of perception of problems

Interaction within the expert group on pig breeding proceeded in two phases. First, the objectives of the project were presented. Then, the invited commenter presented an analytic account of ethical dilemmas in pig breeding. That account was largely structured along the lines of the 'Ethical Matrix' shown below. The critical commenter followed with comparisons between different regulatory systems, and framed ethical issues in pig production as trade-offs between pig welfare, benefits to humans, and environmental impact. The plenary group discussed many of these issues in more detail. That discussion was characterized by a pragmatic mentality, meaning that participants were generally keen to accept practical and technological solutions to the satisfaction of the environmental and other goals of the considered production systems. There was also an inclination to support 'global' breeding goals, such as reduced environmental impact, as compared to 'local' goals such as economic and rural development. However, the pragmatic attitude of the group led to a consensual agreement that local goals actually drive production, the advance of global goals would require either state or consumer support. The project should aim the development of a flexible breeding tool, which would avoid as much as possible controversial value judgments about what ought to be the proper low input or organic pig breeding goals. That tool could be then used by different farmers in different contexts to advance their particular goals. Two specific issues related to the operation of the "Flower Breeding System" were identified during the session:

1. Ownership: Who would be the owner of breeds developed using the Flower Breeding System?

2. Autonomy: How easy will it be to achieve consensus among farmers about breeding goals, and how to manage trade-offs between breeding efficiency and farmer autonomy?

[1] Tassos Michalopoulos, Applied Philosophy Group, Wageningen University and Research Centre, Hollandseweg 1, 6706KN Wageningen, The Netherlands, Tel. +31 317 4 84178, E-mail bea.prijn@wur.nl

2 The presentation of research aims (Jan Merks, Institute for Pig Genetics IPG)

The first presenter gave an overview of the research aims and the methods to be used in subproject 3 of the LowInputBreeds project for low input and organic pig production systems. Low input systems were defined to refer to characteristics like smaller herd size, more space per animal, lower capital investment, often outdoor management, provision of bedding, greater labour requirement and focus on animal welfare. Organic systems were described to include additional constraints demanding for instance low stocking densities, access to outdoor runs, restricted level of purchased and non-organic feeds. These usually result in higher management and feed costs and more limited dietary composition choices for organic than for other low input systems. The main issues addressed in the LowInputBreeds project for pigs were described to be:

1. Lack of appropriate breeding infrastructure for the organic and low input pig production sector.
2. Piglet survival and associated traits, such as piglet losses until weaning.
3. Abiotic stress factors in particular heat stress. For example, pigs raised in outdoor production systems are often exposed to greater challenges by both abiotic and biotic stress factors that adversely affect production.
4. Nutritional and sensory quality of pig meat affected by (a) breed/genotype and (b) dietary regimes.

Three work packages (WP) aiming to address these issues were presented:

› **WP3.1** Development of a ”Flower Breeding System” to improve pig survival and robustness related traits in small populations.

› **WP3.2** Development of management innovations (gilt rearing and lactation systems) on mothering ability of sows and losses of piglets.

› **WP3.3** Effect of traditional, improved and standard hybrid pig genotypes and feeding regimes on carcass, meat and fat quality.

The expected achievements of these WP’s for SP3 partners were described to be:

1. Indication of European breeds/genotypes that show the “best” performance (with respect to desired robustness, animal health and welfare and product quality traits while economically competitive) under low input conditions.

2. To quantify to what extent and what kind of specific breeding programmes are needed, specifically Flower Breeding programmes for (a) different types of organic and low input production systems (b) different macro-climatic/geographic regions in Europe and (c) to reduce piglet and finisher mortality.
3. Gilt rearing system(s) and piglet environment during lactation that suit best for the health and welfare and productivity of pigs in low input systems.
4. Determine the effects of breed/genotype (traditional and modern breeds/genotypes and crosses between modern and traditional breeds/genotypes) and different feeding regimes on performance, carcass quality as well as nutritional and sensory quality aspects of fresh and processed pork and sausage characteristics.
5. Determine the effect of pig genotypes and feeding regimes on nutritional and/or sensory quality characteristics of pork meat in three different macro-climatic zones organic and low input systems in Germany, Spain and the United Kingdom.

The methods employed for the achievement of these results were described as a combination of experimental research, literature review and model analysis. These include traditional selection and breeding methods for achievements 1 and 2, available genetics for the other achievements, and SNP technology for parental identification of deceased pigs in achievement 2. The optimisation of 1 and 2 uses actual breeding goals based on mainly economic values. These economic values are determined by the actual prices for labour, feed, housing and other factors in the region where the breeds are selected and maintained.

3. Comments from the invited commentator (Sandra Edwards, Newcastle University)

The invited commentator brought into attention an inclusive account of ethical conflicts in pig production with relevance to breeding. These were identified with the use of the 'Ethical Matrix', based on a previous analysis by Mepham and Millar (2001), Figure1. The matrix is a widely used framework for the analysis of ethical issues in terms of established common morality principles and with respect to their effects on different stakeholders. The ethical conflicts identified with the use of the Matrix were classified in six categories.

Figure 1: An ethical overview, based on Mepham and Millar (2001)

Respect for	Well-being	Autonomy (choice)	Justice (fairness)
Animals	Animal welfare	Behavioural choice	Intrinsic value (integrity)
Farmers	Satisfactory income and workplace	Managerial freedom (independence)	Fair trade rules
Consumers	Food quality and safety	Choice and democracy (public wishes)	Affordability
Environment	Conservation	Biodiversity	Sustainability

Animal welfare v farmer income & affordable food: The animal welfare of pigs can be affected as a side-effect of two common breeding goals: Breeding for prolificacy, and breeding for lean tissue growth rate. Breeding for prolificacy may negatively affect piglet survival rate and sow longevity. Breeding for lean tissue growth rate aims the fast and efficient growth of lean carcass, which might affect the robustness of the breed, and also its ability to adapt to low input conditions. Lean tissue growth rate breeding can also affect the metabolic function of the animals, and their ability to function with low quality diets; their immunological function and natural ability to resist disease; and their skeletal function and predisposition to OCD and leg weakness. Other effects include the alteration of the thermoregulatory function of pigs, which might be especially important in low input systems: Loss of fat insulation expectedly affects especially piglets and pregnant sows, while loss of heat tolerance is more problematic for finishing pigs and lactating sows.

Animal welfare v management choices: Management choices can affect the welfare of pigs by modifying their social organisation. This can happen by modifying the size and composition of pig groups, also affecting group stability. Breeding could improve social problems in pig farms through the modification of behavioural characteristics like aggression, resulting for instance to less tail biting. Other management-related welfare problems however, like those associated with early weaning age and barren housing conditions, were viewed to be outside the reach of breeding.

Animal integrity v product quality: Castration was identified as the main practical conflict between meat quality and animal integrity, as mutilation is commonly used to reduce boar taint in meat. This problem was regarded to be greater in low input systems because of the use of traditional, early maturing breeds with slower growth and imbalanced dietary protein.

Environmental impact v “naturalness”: The use of traditional breeds with slower growth and greater fatness by low input systems result in low feed conversion efficiency. Less efficient use of feed in more natural environments leads to greater waste production and an overall greater impact on climate change. Participants suggested that special attention should be paid to correlates of breeding for efficiency.

Animal integrity v technological advance: Technological advances in animal breeding are considered to affect animal integrity due to the replacement of phenotypic information as used in traditional selection, with genetic markers and SNP information in the case of genomic selection. A possible introduction of technologically advanced GM animals with enhanced traits into low input systems would also affect animal integrity.

Product quality v Genetic diversity: Genetic diversity was regarded to conflict with product quality in the case of fat composition and its impact on human health. This is because fatter animals from traditional breeds have more saturated fat, which increases human health risks. Breeding for unsaturated fatty acids, especially omega-3 acids would be positive goal in this respect.

4 Critical Comment (Anna Wallenbeck, Swedish University of Agricultural Sciences)

The critical commenter framed ethical issues in pig production as trade-offs between pig welfare, benefits to humans, and environmental impact. As such, it was recommended that impacts to the environment should receive adequate attention, alongside animal welfare and consumer demand goals. Among the ethical issues identified in pig production were artificial insemination, which was regarded as unavoidable; and castration, which could be technologically tackled by using immunocastration. Herd size was identified as a factor affecting liver damage in organic production, which is higher in organic systems due to parasites.

Moreover, it was remarked that substantial national regulatory differences exist between different pig production approaches. For instance, it was remarked that “low input systems”, as described within the project, resemble conventional production in the Swedish context. Therefore, it was recommended that the project should be guided by principles and goals, instead of by national regulations.

5 Discussion

The in-depth group discussion briefly discussed the proposed "Flower Breeding System" and then proceeded along the lines of a series of distinctions that were identified from the plenary sessions and the group presentations. Positive comments on its principle and the presented outline described it as 'flexible' and as allowing 'many small breeders to compete with large corporations'. There were no critical comments on the principle and the presented outline of the system. Instead, the discussion focused mainly on its application and especially on the philosophy permeating the selection of breeding goals. Nevertheless the differences in participant support to different goal-selection approaches discussed in the remaining of this section, all participants agreed that the main objective of the project should be to develop a flexible tool that can accommodate a variety of different breeder goals. Thus, the project should remain as much as possible neutral with respect to controversial value-judgments regarding what a low input or organic breeding goal ought to be.

Two specific issues related to the operation of the "Flower Breeding System" were identified during the session:

- 1. Ownership: Who would be the owner of breeds developed using the breeding system.
- 2. Autonomy: How easy will it be to achieve consensus among farmers about breeding goals, and how trade-offs between breeding efficiency and farmer autonomy should be managed.

The group made recurring references to a distinction between pragmatic versus ideologically 'fixed' or 'dogmatic' approach to breeding. Group participants were generally predisposed towards the pragmatic stand. This reflected to group support on a series of related issues, such as the differences between organic and low input production. Organic production was perceived to be defined by certified fundamental values, while low input production was perceived to be 'at a continuum with conventional', lacking 'ideologically-fixed points'. The breeding goals for low input and organic systems were perceived to be the same, however for organic production it was essential that breeding programmes should be executed under organic circumstances.

This reflects in the approach of the two systems towards technological solutions. For low input all innovative technological solutions were perceived to be welcome, as long as they do not compromise animal welfare. The adaptation of technological solutions in organic production was understood to be more difficult. In particular, it was commented that in organic production it is difficult to define the boundary between ideology and pragmatism, as exemplified by the existence of non-consistent objections: “Artificial insemination and castration are permitted, so why should gene selection not be permitted?” For this reason the suggested breeding programme should pay attention to the use of technologies and practices like sperm sexing and genomics.

Much of the ‘ethical tension’ in the issues discussed was repeatedly attributed to the operating definition of ‘naturalness’. The definition of naturalness as ‘behavioural freedom’ as ‘society defines it’, and also as ‘genetic integrity’, was regarded to result in a series of ethical dilemmas. For instance, naturalness appears to conflict with environmental and economic goals: pigs should be kept outside, and this is problematic because such systems are not very efficient as compared to conventional production systems (systems with high feed conversion efficiency).

The adoption of an alternative operational definition of naturalness was suggested as the way to limit these conflicts. One definition suggested for ‘naturalness’ was ‘biological appreciation of the animal - satisfying its needs’.

Environmental impact was understood to conflict with naturalness, but not with economic impact. This is mainly because they both favour minimization of inputs and waste. However, at least one persisting conflict was identified between environmental goals to preserve historical breeds and genetic diversity and economic optimization through breed efficiency. Participants favoured the adoption of environmental goals by the breeding scheme, such as the minimization of waste by-products, however it was not clear how these goals could be supported in case that they were not demanded by farmers without state or consumer support.

Economic goals were considered to generally conflict with animal welfare goals, specifically with farmer income. The discrepancy between the economic optimum and the animal welfare optimum was considered to increase when animal welfare is defined as naturalness and depends on the operational definition of what is natural. Such conflicts become evident in practices that increase the market value of pork like castration, and also breeding for prolificacy that reduces piglet survival and sow longevity. Nonetheless, breeding was regarded to also have a positive potential for reconciling economic and animal welfare goals.

Tension was also identified between ‘global’ versus ‘local’ breeding goals. Global goals were understood to include issues such as impact on climate and food security, while local goals referred to – for instance, rural development. Although the group was positively predisposed towards global goals it was recognized that the primary goals of farmers are local: how to optimize their farm results depending on consumer demand. Global issues were described as 'political', and farmers that pay attention to such issues presumably go bankrupt in the absence of relevant consumer demand or state support. Participants suggested that the project should focus on developing a tool that allows farmers to optimize their farm results without making value-judgments on what these results should be. Furthermore, because the optimization of farm results depends on local and national circumstances, it was proposed that the "Flower Breeding System" should include 'international petals'.

Some Ethical Considerations Concerning Poultry Farming

FRANCK L.B. MEIJBOOM[1]

What is the moral problem?

In the discussions during the conference of the LowInputBreeds project a number of problems related to keeping laying hens were discussed, such as feather pecking, the killing of male chickens, and foot problems. The question was why these questions should be considered as moral issues. During the two days, it became clear that all agreed that laying hens have moral standing. In a minimum sense this implies that they have more value than the instrumental value they have for the production system. Even if the economic value granted, it was agreed on that the value of the hens do not coincide with this economic or instrumental value. Thus the assumption that underlies the discussion was that hens have a moral status, i.e., that we should take their interests into account for their own sake.

Plurality and practical implications

In spite of the above-mentioned common point of departure, there was a striking plurality in terms of the way practical issue have to be addressed, for example, is beak trimming an acceptable solution to problems of feathering pecking? In the discussions it became clear that the diversity of views was not only the result of different scientific points of view, but were directly related to the arguments that underlie the common claim that hens are worthwhile taking seriously for their own sake. At this point the classical distinctions drawn in animal ethics could easily be recognized.

Some stressed the importance of welfare and started in –an implicit – idea of sentience. The hens are worth of moral consideration for their own sake because they have the capacity to feel pain or even experience positive feelings. Consequently, the issue of feather pecking is a genuine problem rather than collateral damage of a production system. These persons argue that this problem ought to be addressed in an effective way. If beak trimming is such an

[1] dr. Franck L.B. Meijboom, PhD, Assistant Professor , Human Animal Relationship , Veterinary Medicine, Utrecht University, Androclus Building, Yalelaan 1, De Uithof, 3584 CL Utrecht, Tel. +31-30-2537694 / +31-30-2532033, E-mail F.L.B.Meijboom@uu.nlm

effective method, and if this can be done with as less welfare impact as possible, then this solution is unproblematic.

At the same time others in the discussion seriously objected to this treatment and considered it to be no solution at all. These people stressed that sentience is an important start to take hens seriously, but the emphasis on welfare never can imply that (a) the welfare of the individual animal can be compromised and (b) that natural/ species-specific behaviour should be promoted. This implies that the evaluation of beak trimming is no longer defined in terms of overall welfare only, but is discussed in terms of respect for the individual animal and its ability to express its species-specific behaviour. Consequently, the option of beak trimming is considered as an issue that may solve a general problem, but results in a new one: an impact on the animal's integrity and the reduced ability to express normal behaviour.

In the discussion it appeared that these fundamental differences are not easy to bridge. In practice both groups may agree on certain treatments, but it becomes especially problematic if one starts talking about breeding goals.

The role breeding can play: constraint plurality

One of the central issues participants discussed was whether to search for the solution or for the origin of the problem. All who participated in the meeting were aware that the current of poultry farming, either conventional or organic raise a number of questions. The discussion focused on two issues:

a) The discussion on the influence breeding can have. All agree that breeding can be relevant, but it was also stressed by a number of participants that management style is at least equally important. An improved management can address many of the current problems. Therefore, the focus should not be limited to breeding. Some even argue that one better improve the management rather than improve the breeding that may result in masking shortcomings in the way animals are kept. Here again the difference in focus becomes explicit. If animal welfare - in a strict sense of animal functioning - is the only criterion, breeding that improves the welfare of the animal even if the applied management is not discussed is not a real moral issue. If one start form respect for the inherent value of the individual animal, no form of mismanagement can be justified by improvements of welfare by breeding. From this perspective, the results might be less bad, but the acts towards the animals are as problematic as before.

b) A more general issue of discussion focused on the breeding goal. There was the discussion whether we should strive for one practice of poultry farming, e.g., organic farming or that the current plurality has value in its own sense. Most participants opted for some plurality. This did not result in an anything goes view. They considered it to be essential to define limits to the freedom of the breeding process. Constraints identified included:
    - animal health;
    - animal welfare;
    - environmental impact; and
    - economic feasibility.

These should be taken seriously together in defining breeding goals rather than considered as issues that ask for a trade-off. There was, however, less agreement on the way these constraints should be weighed if they conflict.

Annex

Programme of the First LowInputBreeds Symposium on Ethical Consideration in Livestock Breeding

<u>March 15, 2011</u>

11.00-13.00

Plenary session: Ethical aspects related to methodologies in breeding and reproduction

› Welcome
  Veronika Maurer, FiBL, scientific coordinator of the LowInputBreeds project
› Ethical Concerns in LowInputBreeds: Background Paper
  Karsten Klint Jensen, Danish Centre for Bioethics and Risk Assessment (CeBRA)
› Reproduction methods in breeding, effects, risks and benefits
  Jozsef Ratky, Research Institute on Animal Breeding, Hungary
› Genomic selection and the alternatives, risks and benefits
  Jack Windig, Wageningen UR Livestock Research
› An organic perspective on reproduction methods and (genomic) selection
  Anet Spengler Neff, FiBL, and Wytze Nauta, Louis Bolk Institute
› Discussion
  Moderator: Karsten Klint Jensen, Danish Centre for Bioethics and Risk Assessment (CeBRA)

14.00-15.30: Parallel sessions for each species group in LowInputBreeds

14.00-14.15: Aims of the Breeding Research in the LowInputBreeds Project and the Methods to be Used

› **Subproject 1: Dairy Cows and Beef Cattle**
  Filippo Biscarini, University of Göttingen and Sven König, University of Kassel
› **Subproject 2: Sheep**
  Hervé Hoste, INRA
› **Subproject 3: Pigs**
  Jan Merks, Institute for Pig Genetics IPG

- **Subproject 4: Laying hens**
  Ferry Leenstra, Livestock Research, Wageningen University

14.15-14.30: Ethical Problems and Breeding Goals

- **Subproject 1: Dairy Cows and Beef Cattle**
  Henner Simianer, University of Göttingen
- **Subproject 2: Sheep**
  Smaro Sotiraki, NAGREF
- **Subproject 3: Pigs**
  Sandra Edwards, Newcastle University
- **Subproject 4: Laying hens**
  Veronika Maurer, FiBL

14.30-14.45 Critical Comment

- **Subproject 1: Dairy Cows and Beef Cattle**
  Wytze Nauta, Louis Bolk Institute, coordinator ECO-AB
- **Subproject 2: Sheep**
- **Subproject 3: Pigs**
  Anna Wallenbeck, Swedish University of Agricultural Science
- **Subproject 4: Laying hens**
  Gerard Albers, ISA Hendrix Genetics

14.45-15.30 Questions and discussion (summarizing problem areas for workshop on March 16)

Moderation by Karsten Klint Jensen, Danish Centre for Bioethics and Risk Assessment (Ce-BRA)

16.00-17.15: Plenary sessions, input from outside LowInputBreeds: Specialization and high input vs low input

- Breeding Goals
  Anne-Marie Neeteson, FABRE TP

- Contribution of low input livestock farming to biodiversity conservation
  Irene Hoffmann, Food and Agriculture Organisation of the United Nations (FAO)
- Animal welfare
  Marijke de Jong, Dutch Animal Protection
- Utilisation of resources
  Tom Dedeurwaerdere, University of Louvain

Evening

- LowInputBreeds: General assembly
- ECO-AB: General meeting

<u>**March 16, 2011**</u>

9.00 -10.00: Low input breeds, utilization of resources and climate change

- **LowInputBreeds and climate change**
  Jorgen Elvind Olesen, Aarhus University, Denmark
- **Livestock production systems and future food security?**
  Gillian Butler, Julia Cooper, Steve Wilcockson and Carlo Leifert, Newcastle University/Nafferton Ecological Farming Group
- **Discussion**

10.30-12.00: Parallel workshops, discussion of *ethical* aspects, 4 groups, species oriented

- Setting the scene, compilation by moderator of input from previous sessions
  Moderator from work package 5.2 of the LowInputBreeds project
- 10.40-11.50 Discussion
- 11.50-12.00 Conclusions, remaining questions

13.30-14.30: Plenary session, reflection

- Reports from the parallel workshops (five minutes each)
- Reflection by ECO AB
  Anet Spengler, FiBL and Wytze Nauta, Louis Bolk Institute

- Reflection by EU policy (264 KB)

  Anne-Sophie Lequarré
- Discussion

  Karsten Klint Jensen, Danish Centre for Bioethics and Risk Assessment (CeBRA)

About the LowInputBreeds Project

VERONIKA MAURER[1], HELGA WILLER[2] AND GILLIAN BUTLER[3]

The LowInputBreeds project aims to integrate livestock breeding and management strategies to improve animal health, product quality and performance in European organic and low input milk, meat and egg production. The project's objectives are:

› To develop and to analyse innovative breeding concepts for their ability to deliver genotypes with 'robustness' and quality traits required under organic and 'low input' production conditions;

› To integrate the use of improved genotypes with innovative management approaches suitable for organic and 'low input' systems;

› To carry out economic, environmental, genetic diversity and ethical impacts assessments to quantify the performance of improved breeds/genotypes and management innovations against different societal and consumer demands;

› To establish a training and dissemination programme aimed at facilitating rapid exploitation of results by the organic and 'low input' industry. This will involve close collaboration with established technology transfer networks in Europe.

LowInputBreeds is a five-year EU Collaborative Project (2009-2014), funded under the Seventh Framework Programme of the European Community for Research, Technological Development and Demonstration Activities. The public website www.lowinputbreeds.org is updated regularly. It contains a list of partners and contact details. In addition, bi-annual newsletters are produced.

Work performed and results achieved

Dairy cows and beef cattle production systems

Phenotypes from 1200 Swiss Brown (SB) cows from 40 farms are recorded. Over 1 000 cows have been genotyped either with a high density (ca. 777K; 803 cows) or the 54K (288 cows) SNP chip and genomic breeding values for production traits have been estimated.

[1] Research Institute of Organic Agriculture (FiBL), Animal Husbandry, 5070 Frick, Switzerland, www.fibl.org
[2] Research Institute of Organic Agriculture (FiBL), Animal Husbandry, 5070 Frick, Switzerland, www.fibl.org
[3] University of Newcastle, Newcastle upon Tyne, NE1 7RU, UK, www.ncl.ac.uk

Individual milk samples for fatty acid analysis have been collected. Multivariate analysis of female fertility shows expected heritabilities: their correlation with production traits will be estimated. Three additional partners with substantial expertise in dairy R&D programmes and phenotypic data have been recruited via an open call. Feeding linseed altered milk fat profiles although yield, fat and protein content were unchanged.

Sheep

Monthly recording of performance and functional traits in 20 commercial Sfakiano dairy sheep flocks has taken place during 2 years in Crete. Data analysis is in progress and phenotypes will be linked to genotypes of the ewes. *In vitro* assays and feeding experiments have been performed to assess the anthelmintic activity of tannin-rich concentrates and forages combined with the use of parasite tolerant breeds and pasture management. Experiments linking pasture availability to meat quality indicate that lamb meat tenderness and odour can be improved by grazing management.

Pigs

A literature analysis showed that productivity and carcass quality of traditional breeds are unsuitable for the commodity pork market. A trial investigating production systems using heavy pigs for regional premium products is on-going. Modelling studies were performed to evaluate the suitability of flower breeding (FB) systems and a preliminary FB system is currently established in the NL. An array of around 130 SNP's was designed for parental identification and is used to select for improved finisher survival in FB systems. Genetic parameters for heat stress resistance were estimated for farrowing rate and litter size, using large datasets from farms in Portugal and Spain.

Laying hens

A survey of 276 farms in The Netherlands, France and Switzerland gives an insight into management, genotype, production and health in organic or free-range systems. The three countries differ in flock and farm size and housing system. In production, differences are minor, except for organic hens in The Netherlands with significantly lower egg production and higher mortality. The number of genotypes was unexpectedly large. Overall, white hens and mixed flocks performed relatively well. Workshops with stakeholders identified similar properties of 'the ideal hen'. A subset of today 80 farmers participates in a performance and health recording network and some of them test new genotypes.

Impact assessment, training and dissemination

Relevant production systems have been identified for each species to carry out a multi-criteria impact assessment. Members of the species-specific work packages have participated at the first LowInputBreeds conference (March 2011 in the Netherlands) to identify and assess potential ethical issues. The second conference took place in spring 2012 in Tunisia, and the third is planned 2013 in conjunction with the European Federation for Animal Science (EAAP) conference in Nantes.

Expected final results and their potential impact and use

By supporting the development and integrated use of (a) genotypes selected for performance, robustness and product quality traits, and (b) agronomic innovations that improve 'low input' systems the project will make a significant contribution towards regionally-adapted breeding strategies that are compatible with sustainable production, high product quality and organic principles.

Further information

Further information is available at the website of the LowInputBreeds project www.lowinputbreeds.org. At the website it is possible to subscribe to the project's newsletter (http://www.lowinputbreeds.org/lib-newsletter.html).