Available online at www.sciencedirect.com
ScienceDirect
Livestock Science 103 (2006) 282–291
LIVESTOCK SCIENCE
www.elsevier.com/locate/livsci

Sustainable transparent farm animal breeding and reproduction ☆

A.-M. Neeteson-van Nieuwenhoven [a,*], J. Merks [b], A. Bagnato [c], A.-E. Liinamo [a]

[a] European Forum of Farm Animal Breeders, Benedendorpsweg 98, 6862WL Oosterbeek, The Netherlands
[b] IPG, Institute for Pig Genetics B.V., Schoenaker 6, 6641SZ Beuningen, The Netherlands
[c] Department of Veterinary Sciences, Technologies and Food Safety, University of Milan, Via Celoria 10, 20133, Milan, Italy

Abstract

Farm animal breeders are facing challenges. More and more powerful technologies are at their disposal for creating genetic change. At the same time, society is concerned about the impact of breeding practices and the use to which new technologies are being put. European breeders must compete in a global market. To meet these challenges, European farm animal breeders have conducted three projects to contribute to sustainable and transparent farm animal breeding and reproduction. In "Farm animal breeding and society", an overview is presented of farm animal breeding in Europe and its technical, ethical, legal and consumer constraints and possibilities. In 'SEFABAR', European breeders, scientists and socio-economists have worked towards sustainable breeding and reproduction scenarios. In 'CODE–EFABAR', breeders aim to develop, with experts on ethics, communication and certification, and in close contact with NGOs, farmers' organisations and policy makers, a Code of Good Practice for farm animal breeding and reproduction organisations. Along this Code of Good Practice organisations will be able to explain their goals and practices to the public in a transparent way. This paper reviews these projects.

Keywords: Animal breeding; Animal reproduction; Society; Ethics; Code of Good Practice

1. Introduction

Farm animal selection and reproduction are on the threshold of the application of new biotechnologies. Modern biotechnologies will allow advances to be made. In making these advances, it is important to realize that the issues surrounding these developments are the ones in which the public has a real stake (Keeble, 1999). Society is concerned with breeding practice and would like to be involved (Sandøe and Holtug, 1998; Sandøe et al., 1999). Technologies that might be adopted – e.g. genomic selection, transgenics, cloning – or targets of genetic improvement – e.g. increased efficiency, improvement food quality, disease resistance, maintenance biodiversity – may involve consumer interests, the moral values of society and legal rights of animal breeders and farmers. The increase in genetic progress raises questions regarding potential

☆ This paper is part of the special issue entitled Ethics in Animal Agriculture, Guest Edited by Dr. Michel Marie.

* Corresponding author. Tel.: +31 26 339 15 38; fax: +31 26 339 15 39.
E-mail address: Anne-Marie.Neeteson@effab.info (A.-M. Neeteson-van Nieuwenhoven).

1871-1413/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.livsci.2006.05.016

risks of breeding for a selective number of traits: balanced breeding (Rauw et al., 1998; Christiansen and Sandøe, 2000; Van Arendonk and Bijma, 2003).

Food production has moved from being supply side-driven to consumer-driven (McInerney, 2002). Not only the opinion of the farmers about product(ion) quality is important, but also the opinion of society and the trust they have in food products. This means, for organisations operating as from Europe, the need to maintain a 'license to produce', as Europe defines the legal and political framework within which production must take place.

For farm animal breeding and reproduction organisations (organized in European Forum of Farm Animal Breeders, EFFAB), operating globally, these developments were the reason to initiate three projects, studying and discussing the issues around society awareness. The aim of this paper is to review the results of these European projects, funded by the European Commission: (1) The future developments in farm animal breeding and reproduction and their ethical, legal and consumer implications – Farm Animal Breeding and Society, (2) Sustainable European Farm Animal Breeding and Reproduction – SEFABAR and (3) Code of Good Practice for European Farm Animal Breeding and Reproduction – CODE–EFABAR. They each address a step in the process from awareness building to transparency. The aims were to:

1. Make an overview of breeding technologies, and relevant issues regarding law, ethics, animal welfare, economics, consumers, public opinion and cultural differences;
2. Develop awareness and sustainable breeding among breeders and scientists, with critical ethical and welfare guidance;
3. Indicate farm animal breeding scenarios as a tool for dialogue with society and transparency;
4. Link society and breeding issues;
5. Develop a Code of Good Practice for farm animal breeding and reproduction organisations, based on 1–4.

2. Materials and methods

Breeders and breeding scientists have developed explanatory material on (sustainable) breeding and breeding scenarios, and a Code of Good Practice for farm animal breeding and reproduction organisations. They were guided by or received information from 'society partners': results of studies on ethics, consumers, public perception, animal welfare, cultural differences, legal aspects.

In "Farm Animal Breeding and Society" (1998), a dialogue started between breeders and societal experts. A survey of the state of the art in farm animal selection and reproduction based on literature, expert opinions, and an expert breeder's panel (ruminants, pigs, poultry, aquaculture), an overview of breeding technologies for the general public, and an inquiry among European consumer organisations were made. They were the basis for essays on the ethical and consumer implications of breeding technologies, and the legal rights of farmers and animal breeders with regard to biotechnology (Neeteson-van Nieuwenhoven, 1999).

SEFABAR (2000; Liinamo and Neeteson-van Nieuwenhoven, 2003) was a network of farm animal breeders, scientists, and socio-economic scientists/organisations. Working parties (ruminants, pigs, poultry, aquaculture) reviewed the state of the art, trends, research and business efforts, knowledge gaps, and sustainable future options, with comments from the socio-economic partners, and developed alternative breeding scenarios. Ethicists and an animal welfare organisation guided the process continuously. SEFABAR also made a) an overview of legislation concerning animal welfare in animal breeding, b) an inquiry among European animal welfare organisations, c) a public opinion study based on inquiries in supermarkets, focus groups studies among lay people in France and UK, and semi-structured interviews with breeders in Belgium, France, The Netherlands and UK, and d) an essay on cultural differences based on interviews with scientists, breeders, farmers, politicians and consumer organisations in France, Italy, Norway, The Netherlands, Thailand and USA.

The results were integrated into a comparison of the perception of and differences between breeders and society, with the animal welfare organisation as an example.

CODE–EFABAR (2004) will develop a Code of Good Practice for farm animal breeding and reproduction organisations with input from breeders, non-governmental organisations (NGOs), farmers' organ-

isations and policy makers for transparency and voluntarily certification or verification. Breeders' working groups (cattle, pigs, poultry, farmed fish) developed overviews of traits to be influenced by breeding, grouped along sustainability. A draft Code was made and discussed. The project is ongoing and will be finalised with a training for breeders, and dissemination of information to breeders and society in 2005 (CODE–EFABAR, 2004).

3. Results

The results are discussed according to subjects developed along the projects.

3.1. Ethics

Christiansen and Sandøe (2000) divided ethical concerns relating to animals into animal health and welfare, and animal integrity. Animal integrity, or intrinsic value, is naturally evolved, unharmed wholeness of an individual, species or ecosystem. According to some, the use of non-therapeutic surgery and invasive procedures to increase reproduction is violating the animal's integrity (Seamark, 1993; MAFF, 1995; Rutgers et al., 1996). Other ethical concerns relate to humans, biological and environmental issues or biotechnology. Regarding humans, the 'slippery slope' argument is the major one: the fear that what can be done with animals will also be done with humans (Schroten, 1997). Human health is another "hot" topic: e.g. does eating meat from genetically modified animals pose extra risks? Regarding biology and the environment the fear for the loss of diversity prevails. The opportunities of reproductive technologies for preserving biodiversity (cryoconservation semen, eggs, and embryos) are the other side of the picture. Concern regarding biotechnology itself may be due to 'fear of the unknown', misunderstandings, or because techniques are considered 'unnatural'.

In a dialogue about the acceptability of a particular biotechnology one may consider the implications for all partners involved: potential risks and benefits. In moral decision making these must be weighed, seeking a balance between intuitions, principles and relevant facts. A good starting point would be to set out and understand what people are concerned about. Breeders having a notion of what worries people, and the people's notion that breeders do listen to them, take their concerns serious, and explain to them how they weigh their decisions, may be a good modus in a dialogue with 'society'. Farm animals are domesticated and recognisable distinct from their wild relatives or ancestors. The key ethical question is not whether we should abandon animal breeding, but how we should breed (Gamborg and Sandøe, 2003). The general view in society (Christiansen and Sandøe, 2000) is that it is acceptable to use animals if it is done 'humanely'. This attitude is based on the ethical theories of utilitarianism (e.g. what decision gives greatest benefit?) and deontology (e.g. what do we *do* to an animal?).

Furthermore, the ethicists were active advisers, continuously observing project developments, coming forward with guidelines, protocols, methods for assisting the process of sustainability development, scenario building, and Code of Good Practice development (3.6).

3.2. Consumers and public perception

Consumers enter the debate on animal breeding in two ways – personally and through consumer organisations. People often express opinions they later abandon in the supermarket, so consumer opinion (citizens) and consumer behaviour (buyers) must be separated. Regarding food, consumer preferences reflect health-value, convenience, variety, price, animal welfare and environment. Food safety is a growing concern (Van Genderen and de Vriend, 1999).

According to Ouédraogo (2003), consumers identify breeding and reproduction as indicators of other more important issues related to food like food safety, quality and health, associating high technology with food risks and uncertainty, whereas 'traditional breeding and reproduction' are seen as natural and related to safe, healthy, quality food. High income groups want to pay more for food produced to higher standards, others will not.

Consumers claim to be uninformed about animal breeding practices and would trust breeders to provide more reliable information. They tend to not trust the government or food industry as sources of informa-

tion. Consumer attitudes to modern breeding goals and biotechnologies are continually developing: scientists, governments and industry have a real opportunity to respond to the public opinion. Consumer opinion tends, unsurprisingly, to be more positive where medical products of biotechnology are at stake. A human health benefit can push worries about price and animal welfare down the priority list.

Consumers are aware of the risks entailed with free markets, especially with products circulating freely among countries with different legislative standards. They would agree to protect European breeders through imposing EU standards and labels to all imports.

3.3. Animal welfare

According to animal welfare organisations, the general acceptance of farm animal breeding depends on the circumstances (Denmark, Germany, The Netherlands, UK), in particular the effect on health and welfare. Welfare organisations (e.g. Germany, The Netherlands, UK) regard traditional breeding acceptable if it does not cause welfare problems, i.e. does not result in physical damage, pain or distress. Breeding goals are accepted if not used to mask poor management systems or at the risk of adverse effects on other welfare aspects, e.g. because of increased inbreeding.

After analyzing EU-, Council of Europe-, and some national legal documents, they indicate that the legal requirements of the respective EU Directive and the Council of Europe generally outline the basic principle of animal welfare in breeding and reproduction (Council of Europe, 2001). These texts have (only) been translated into the national languages and published as a legal text in the (15) EU member states (Kolar and Rusche, 2003a,b).

3.4. Cultural differences

There are considerable national and regional differences in breeding practices and in public attitudes (Schakel and Van Broekhuizen, 2003). Each country tries to identify an equilibrium between local needs and global uniformity demands (Schakel, 2003). In Norway, collectivity, and a positive climate towards agriculture, led to a fair distribution of profits and work among farmers and breeders. In Italy, not the farmer, but the end product is the focus of agriculture and breeding programmes: gastronomic quality, cultural suitability and product diversity. In France, where also the end product prevails, breeding is best understood through the rules/organisations, together forming a national breeding culture. Dutch breeders are world players seeking to develop breeds suiting a wide variety of conditions. In Thailand, a newly 'agro-industrialised' country, producing four times as much food as needed, a balance must be found between short term gain, environmental damage and rural poverty. The USA food market is largely undifferentiated, and the USA have, contrary to Europe, limited societal resistance to technologies like genetic modification.

3.5. Legal aspects

With biotechnological developments and increasing research investments, the interest in and worries about patents grow. In animal breeding, most is arranged with contracts. Breeding animals are expensive – you pay for the animal and for the right to use it for breeding. European patents confer a 20 year monopoly to the inventor for a novel, inventive and industrially applicable invention, disclosed to the public. Patents are expensive to obtain (e.g. because of translation costs) *and to maintain.* Up to now it was not easy to make them profitable in animal breeding.

European patents can not be granted for essentially biological processes for the production of animals, but can for microbiological or technological processes. Methods to produce transgenic animals or to increase animal fertility, cloning techniques, or multi-step processes (e.g. inducing polyploidy in oysters) are patentable. Animals themselves *can* be patentable – in the practice this refers to genetically modified animals. Animal genes can be patentable, but patent holders cannot claim rights on farm animals naturally carrying a gene – only on the use they propose for a gene.

Another development comes from advising bodies, e.g. French CNAG or English FAWC (2004), regarding desirable directions of breeding programmes, with considerable importance to welfare considerations (Noiville, 1999). As an example, in 2004, the UK

based Farm Animal Welfare Council (FAWC) came out with a publication on animal breeding technologies (FAWC, 2004).

3.6. Breeding and reproduction

3.6.1. Overview for transparency

In the first two projects, animal breeders and scientists developed explanatory material for the 'society scientists' (Finocchiaro et al., 1999; Neeteson-van Nieuwenhoven, 1999; Liinamo and Neeteson-van Nieuwenhoven, 2003).

In the first project, future breeding scenarios were made: general descriptions of a conventional path (extension of today's practices and goals), a low cost path (aiming at reducing production costs as major goal), and a specialties/alternative path (aiming to produce for e.g. niche markets, organic products). In each scenario in principle all breeding and reproduction technologies were possible, but in the alternative path, animal cloning and transgenics were less likely to occur (Fig. 1). The low cost and specialties path could co-exist side by side, influencing each other's performance: 'low cost' aiming for improved quality and standards due to market or consumer requirements, and 'specialties' being forced to become as efficient as possible in order to survive.

3.6.2. Sustainable breeding and reproduction

Because of the unknown economic aspects and social risks, the scenarios needed to be worked out further. The Brundtland commission (Brundtland et al., 1987) stated that sustainable development should fulfil the needs of the present generation, without decreasing the possibility for future generations to fulfil their needs. This definition is wide, not including any choice. In SEFABAR, the ethicists taught the breeders to develop sustainable breeding into three layers, and to decide where breeding can make a difference (Gamborg and Sandøe, 2005). The general definition (first layer) was defined as: "Sustainability in animal breeding and reproduction means the extent to which animal breeding and reproduction, as managed by professional organisations, contribute to maintenance and good care of animal genetic resources for future generations." In the second layer, four themes were identified: 1) economic efficiency of farm animal production, 2) environmental impact, 3) product quality (including safety), and 4) farm animal welfare. They were equal for all species, although the order of importance differed, e.g. in aquaculture the environment plays a more prominent role. At the species level (third layer), these themes were specified with concrete characteristics (for example, the detailed definitions are given for pigs, in Table 1).

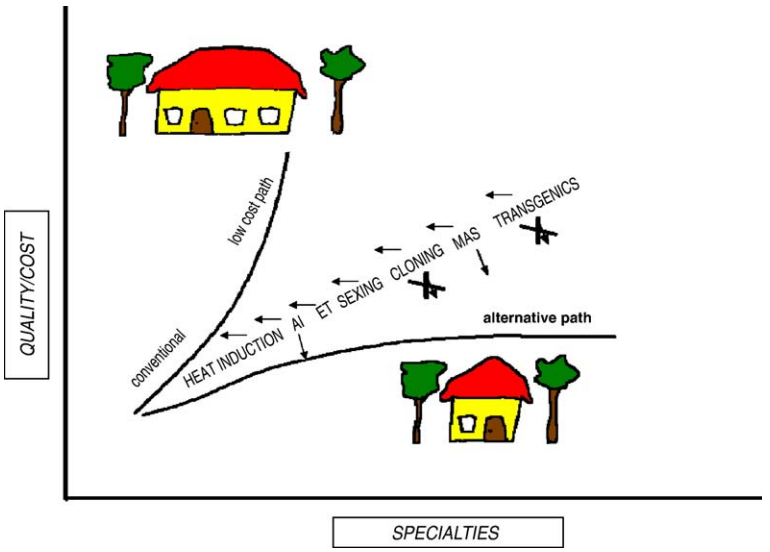

Fig. 1. Perception of breeding and reproduction technologies in low-cost, traditional and alternative path.

Table 1
Definitions of sustainable breeding and reproduction in pigs

Aspect	Trait	Sustainability
Efficiency	Energy/Protein use per kg pork	↓↓
	No. of slaughter pigs per sow per year	↑↑
	Survival birth to slaughter	↑
	Efficiency of 'home' grown feed use	↑
Environment	Nitrogen/Phosphorus emissions	↓↓
Quality	Uniformity of weight and lean content	↑↑
Welfare	Robustness	↑↑
	Halothane gene	↓↓
	Genetic defects	↓
	Leg problems	↓

The ethicists provided input to the sustainability development exercise of the breeders (Gamborg and Sandøe, 2005), and the welfare organisation provided a discussion podium, stimulating breeders to look into their proposals critically again and again (Kolar and Rusche, 2003a).

3.6.3. Sustainable breeding scenarios

Distinct scenarios as a tool for management and communication were built, based on an ethicists' guidelines. The scenarios included technical, socio-economic and value-based aspects. The goal was to materialize ideas on what the European market for animal products could look like in 20 years' time (Nagel et al., 2002; Nixey, 2003), in three stages: 1) definition "sustainable breeding and reproduction", 2) definition alternative future production markets of which breeding companies, and 3) building future sustainable breeding scenarios, providing animals for two different markets specified in stage 2. Although the eight groups (dairy cattle, beef cattle, dairy sheep + goats, meat sheep, pigs, poultry layers, poultry broilers, and aquaculture) were free to decide about the direction of the scenarios, they, independently, distinguished quite similar scenarios: high-tech/low cost (bulk) and low tech/high quality (niche). The scenarios for pigs describing the state of the art of the pig breeding industry in 2020 are presented here as an example (Table 2).

3.7. Integration

Scenario building is a valuable tool to clarify some of the current controversies and differences between technical (breeding) people and other representants of the network (welfare, sociology, ethics, economy). Liinamo et al. (2005) took the welfare partner as an

Table 2
Pig breeding scenarios

	Internationally oriented	Mix national and international
Description breeding industry situation 2020	Most pig breeding organisations operating worldwide with programmes fulfilling international market requirements. National programmes limited to countries not open for import of pork/dedicated to regional production (e.g. DOCs). Gradually international pig breeding organisations grow from 25–75% market share.	Several pig breeding organisations operating worldwide – programmes fulfilling international and national market requirements. Several national programmes with specialised programmes fulfilling market niches and regional specialties. Gradually international pig breeding organisations grow from 25% to 50% market share. Importance of national programmes remains at present levels, increases in some countries.
Reasons for situation	WTO not able to bring neither animal welfare nor food safety requirements as reason for import/export restrictions. Pork production worldwide competitive in open market. Most consumers select primarily on price if quality good and safety guaranteed.	WTO able to bring animal welfare and/or food safety requirements as reason for import/export restrictions. Governments introduced policy instruments to influence buying behaviour consumers. Pork production worldwide competitive – consumers select next to price on specialty and image of product. Importance local production systems and products increased, generating the need for specific genotypes and genetic lines.

example of 'other representants'. Breeders think of animals as populations with means and variances for traits, which can be adjusted by breeding to meet any requirement, whereas welfare groups see animals as sentient individuals with an intrinsic value. Breeders judge scenarios on feasibility or practicability, while NGOs as represented by the animal welfare group judge scenarios exclusively on desirability. This became clear in the choice of drivers for the different scenarios: producers regarded competitiveness and economic viability, and the welfare partner EU-legislation as the main driving factor(s).

Scenario building enhanced awareness of the sustainability aspects of current breeding practices and showed how breeding goals can change in response to societal demands.

3.8. Code of Good Practice for farm animal breeding organisations

Several instruments could be used to go into a dialogue or to become more transparent. Companies could invite citizens to their premises – practically disease risks would prevent this. Cameras in breeding/production units could be an option, or leaflets or comics in national languages explaining breeding and its role in the food chain attractively and understandable. Organisations could organize discussions with the public, or develop material for schools. These methods are laborious – time and money consuming. For breeding organisations, few in numbers and with low profit margins, they generally can not be applied in a feasible way. A Code of Good Practice for farm animal breeding organisations can act as an instrument in which breeding organisations can show in a transparent way their breeding, viewpoints, how they weigh possibilities, react to (cultural differences in) markets, and take into account society concerns about food safety, welfare, genetic or product diversity or wholesomeness, responsibility to the liveability of the countryside, survival of (local) farmers, and of course economic viability, and survival in the global open market. If such a Code is developed in dialogue with society organisations, and if possible updates take societal changes into account, it can serve as instrument in dialogue with society.

In 'CODE–EFABAR', breeders have defined sustainable breeding (cattle, pigs, poultry, and farmed fish) into detail, critically guided by ethicists, communication specialists and a certification specialist (EFB, 2003; Meuwissen et al., 2003; Olsson et al., 2004). The Code is still under development and will include an introductory part, guiding principles, and system demands. A draft is discussed with breeders, representatives of NGOs, farmers' organisations and policy makers. Important discussion items were the way to deal with new technologies and developments, the importance to be in line with other Codes and quality schemes in the food chain, and the dissemination to society and stakeholders. The Code will be set up as a management tool, and should be transparent and clear so that it can be used for communication. Implementation will be voluntarily.

Currently, system demands are worked out, and as an example, will be implemented in a few organisations. The draft is being fine tuned taking into account the discussions, and interviews with NGOs and farmers' organisations. The Code will be dated (1st Code: 2006/2007) and examined for updating every three years. EFFAB will take the responsibility for updating and maintaining the Code.

4. Conclusions

Breeding has an important impact on animal production, as breeding results are cumulative, permanent, and disseminated widely across farm animal populations. The challenge set by sustainability is to balance the various objectives connected with economic realities, the care of the environment, the impact of diseases, the preservation of genetic resources and maintenance of animal welfare.

Breeding organisations operate under increasingly fierce competition in a global market. Solutions to the problems of sustainability in which farm animal welfare remains paramount need to be developed under WTO. A dual market structure in animal food production is expected to emerge, within the EU as well as internationally, where a basic commodity market will exist alongside a highly differentiated market.

There are considerable cultural differences in breeding practices and public attitudes towards animal breeding, within Europe and globally. Most consumers are in favour of consumer education, compulsory

labelling and the imposition of minimum standards. The inclination to pay more for foods produced according to desired standards relates closely to income level.

When technical and lay people communicate, they tend to use different languages: the same words, with different interpretations. Farm animal breeders adapt the genetic make-up of livestock populations to improve the efficiency of food production to meet consumer requirements. Animal welfare organisations disagree with current intensive breeding practices and demand that the environment must meet the needs of the animals and not vice versa. Transparency of breeding practices and clear definitions of terminology will be essential for effective communication among all stakeholders. Scenario building can be used as a tool to start a successful dialogue, helpful in contrasting views on breeding techniques and goals, enabling to find ways of bridging the apparent gap between what seems desirable from a societal viewpoint and feasible from a producer's viewpoint. Scenario building taking into account measurable and non measurable elements were discussed but not worked out into detail in the projects. Such scenarios could be developed further in the future.

Exercises including technical and 'society' groups are complicated in many ways. There will be misunderstandings and different perceptions. However, the exercise is also *meant* to communicate, discuss and possibly overcome differences or at least to put them on the table in a safe environment with respect to each other's viewpoints. In SEFABAR, the safe environment was created in having all parties involved promise not to come out with intermediate results or opinions. Thus, parties could discuss among each others, and not with their respective followers in mind.

Socio-economic scientists study groups in society. If 'technical people' initiate exercises including socio-economic audiences, they are a full partner in the exercise. Society partners appreciated cooperating with breeders. It provided them with an abundance of information otherwise difficult to obtain. For farm animal breeders, they were important instruments to be pro-active in addressing society issues, and in identifying their role in nowadays' society.

Full agendas and shortage of time are problematic for exercises including huge audiences like the ones discussed in this paper. However, email and telephone can not replace meetings in person, as only then real dialogue takes place.

The projects were funded with public money; it enabled small organisations to participate in the project on the same level as large ones, scientists from all Europe had the same budget, and the partners from society had *independent funding*. The latter is important to ensure they can be critical and freely express their opinion. Equally important, it will prevent them from being 'looked at' as 'tempering with' the enemy or 'the industry'.

Careful and continuing dialogue with society will be necessary if dilemmas involved in balancing the various objectives of breeding are to be resolved. Breeders and breeding scientists must remain sensitive to public attitudes, the bioethical debate and economic advice and update society with developments in breeding. There must, in other words, be effective communication from, and into, the breeding sector. A Code of Good Practice seems to be a good and feasible instrument for this. The time will learn whether the Code of Good Practice for farm animal breeding organisations will be implemented widely, and can serve as a tool of transparency towards society, and a good management tool for breeding organisations.

Acknowledgements

* Farm Animal Breeding And Society (BIO4-CT98-0055). Linalux– Seghers Gentec–Danish AI – Danish Pig Breeders – Scanbrid – FABA – France Hybrides – Hubbard ISA–SYSAAF – UNCEIA – ADT – Lohmann – AI Neustadt – Schaumann Besitz – ZDS – IRLAI Cooperatives – ANAS – CIZ – Semenitaly – Altapon – Euribrid Nutreco – Hendrix Poultry – Intervet – IPG – VanHaeringen – AquaGen – Team Semin – Svensk Avel – ASR–BUT – Cotswold – MLC – Ross – UKMASCP, CeBRA, CDOParisI, Consumer Biotechnology Foundation. EU: LCordier.

** SEFABAR (QLG7-CT-2000-01368). Gentec – KU Leuven – Danish Cattle – KVL – CSIC – IRTA – France Hybrides – INRA – Hubbard ISA – SYSAAF – UNCEIA – MTT – ADR – Bonn Un – FAL – Halle Un – Hohenheim Un – Lohmann –

Mariensee Un – ZDS – Aquanet – NAGREF – Semenitaly – ASGWUR – CR Delta – IPG – Nutreco – AquaGen–Aviagen – BUT – MLC – PIC – Roslin – SAC – TLF, Akademie Für Tierschutz, CeBRA, Wageningen University, INRA Corela, University Exeter. Management Group: EAAP, EAS, WPSA. EU: A Vassarotti.

*** CODE–EFABAR (FOOD-CT-2003-506506). Svensk Avel, Semenitaly, IPG, IRTA, Lohmann, Badi Besbes, AquaGen, SYSAAF, Loredana Locatelli. CeBRA, EFB, SGS. EU: E Sachez.

**** Coordination projects: EFFAB (formerly: Farm Animal Industrial Platform). For *, IPG was official carrier for FAIP.

***** Johan van Arendonk, Dorothé Ducro, Egbert Knol.

References

Brundtland, G.H., Khalid, M., Agnelli, S., Al-Athel, S.A., Chidzero, B., Fadika, L.M., Hauff, V., Lang, I., Shijun, M., Marino de Botero, M., Singh, N., Nogeir-Neto, P., Okita, S., Ramphal, S.S., Ruckelshaus, W.D., Sahnoun, M., Salim, E., Shaib, B., Sokolov, V., Stanovnnik, J., Strong, M., MacNeil, J., 1987. Our common future. Report United Nations World Commission Environment and Development (WCED) 42nd session, Nairobi.

Christiansen, S., Sandøe, P., 2000. Bioethics: limits to the interference with life. Anim. Reprod. Sci. 60–61, 15–29.

CODE–EFABAR, 2004. Code of Good Practice for European Farm Animal Breeding and Reproduction, URL: http://www.sefabar.info/code-efabar.

Council of Europe, 2001. European Convention for the Protection of Animals Kept for Farming Purposes. URL: http://www.coe.int/T/E/Legal_affairs/Legal_co-operation/Biological_safety_use_of_animals/Farming/.

European Federation of Biotechnology, 2003. Who should communicate with the public and how? Report focus workshops. EC-QLG7-CT-2002-30162.

Farm Animal Welfare Council, 2004. FAWC Report: Welfare Implications of Animal Breeding and Breeding Technologies in Commercial Agriculture. URL: http://www.fawc.org.uk.

Finocchiaro, R., Bagnato, A., Haffray, P., 1999. Reproduction and selection technologies. In: Farm Animal Breeding and Society. URL: http://www.effab.info (Publications).

Gamborg, C., Sandøe, P., 2003. Breeding and biotechnology in farm animals – ethical issues. In: Levinson, R., Reiss, M. (Eds.), Key Issues in Ethics. Routledge Falmer, London, pp. 133–142.

Gamborg, C., Sandøe, P., 2005. Sustainability in farm animal breeding: a review. Livest. Prod. Sci. 92, 221–231.

Keeble, S., 1999. Farm Animals – Their Role in Society. In: Neeteson, A.M. (Ed.). Farm Animal Breeding and Society. URL: http://www.effab.info (Publications), pp. 8–12.

Kolar, R., Rusche, B., 2003a. Animal welfare aspects of farm animal breeding and reproduction: chances for a sustainable future? In: Liinamo, A.E., Neeteson, A.M. (Eds). Sustainable European Farm Animal Breeding and Reproduction. Proceedings. URL: http://www.sefabar.info (Publications), pp. 17–35.

Kolar, R., Rusche, B., 2003b. Qualzucht in der Landwirtschaft. Neue Herausforderungen für den Tierschutz. Kritischer Agrarbericht, pp. 1–6.

Liinamo, A.E., Neeteson-van Nieuwenhoven, A.M. (Eds.), 2003. Sustainable European Farm Animal Breeding and Reproduction. Proceedings. URL: http://www.sefabar.info (Publications).

Liinamo, A.E., Flock, D.K., de Greef, K., Komen, H., Nieuwhof, G., 2005. Sustainable farm animal breeding and reproduction: scenario building as a tool to improve communication between society and the food industry. Submitted to: J. Agric. Environ. Ethics.

MAFF, 1995. Report of the Committee to Consider the Ethical Implications of Emerging Technologies in the Breeding of Farm Animals. HMSO Publications Centre, London.

McInerney, J., 2002. The production of food: from quantity to quality. Proc. Nutr. Soc. 61, 273–279.

Meuwissen, M.P.M., Velthuis, G.J., Hogeveen, H., Huirne, R.B.M., 2003. Traceability and certification in meat supply chains. J. Agribusiness 21, 167–181.

Nagel, M., Van Arendonk, J.A.M., Liinamo, A.E., 2002. A quantitative approach to incorporate sustainability in animal breeding. MSc Thesis ASG Wageningen University.

Neeteson-van Nieuwenhoven, A.M. (Ed.), 1999. Farm Animal Breeding and Society – future developments in farm animal breeding and reproduction and their ethical, legal and consumer implications. URL: http://www.effab.info (Publications).

Nixey, C., 2003. Sustainability issues for the European turkey industry. World's Poultry Science Association Meeting Berlin–MG10.

Noiville, C., 1999. Farm animal breeding and the law. In: Neeteson, A.M. (Ed.). Farm Animal Breeding And Society. URL: http://www.effab.info (Publications), pp. 88–97.

Olsson, A.S., Gamborg, C., Sandøe, P., 2004. Taking ethics into account in farm animal breeding: what can the breeding companies achieve? Proceedings EurSafe 2004, pp. 21–24.

Ouédraogo, A., 2003. Symbolic goods in the market place: public perception of farm animal breeding and reproduction in France and United Kingdom. In: Liinamo, A.E., Neeteson, A.M., (Eds). Sustainable European Farm Animal Breeding and Reproduction. Proceedings. URL: http://www.sefabar.info (Publications), pp. 36–46.

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

Rutgers, L.J.E., Grommers, F.J., Colenbrander, B., 1996. Ethical aspects of invasive reproduction techniques in farm animals. Reprod. Domest. Anim. 31, 651–655.

Sandøe, P., Holtug, N., 1998. Ethical aspects of biotechnology in farm animal production. Acta Agric. Scand., A Anim. Sci. Suppl. 29, 51–58.

Sandøe, P., Nielsen, B.L., Christensen, L.G., Sørensen, P., 1999. Staying good while playing God – the ethics of breeding farm animals. Anim. Welf. 8, 313–328.

Schakel, J., 2003. Breeding and society: bridging the gap between two cultures. Proceedings EurSafe 2003, pp. 58–63.

Schakel, J., Van Broekhuizen, R., 2003. Breeding and society: the art of creating new and multiple equilibria. In: Liinamo, A.E., Neeteson, A.M. (Eds). Sustainable European Farm Animal Breeding and Reproduction. Proceedings. URL: http://www.sefabar.info (Publications), pp. 47–60.

Schroten, E., 1997. Animal biotechnology, public perception and public policy from a moral point of view. In: Nilsson, A. (Ed.), Transgenic Animals and Food Production. KSLA, Stockholm, Sweden, pp. 151–156.

Seamark, R.F., 1993. Recent advances in animal biotechnology: welfare and ethical implications. Livest. Prod. Sci. 36, 5–15.

Van Arendonk, J.A.M., Bijma, P., 2003. Factors affecting commercial application of embryo technologies in dairy cattle in Europe: a modeling approach. Theriogenology 59, 635–649.

Van Genderen, A., de Vriend, H., 1999. Farm animal breeding and the consumer. In: Neeteson, A.M. (Ed.). Farm Animal Breeding and Society. URL: http://www.effab.info (Publications), pp. 66–84.