



Farm animal welfare

CURRENT RESEARCH AND FUTURE DIRECTIONS





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PAVING THE WAY FOR FUTURE RESEARCH

Recent food scares in Europe have increased consumer concern about what they eat and how it has been produced. The public's demand for safe animal products produced in an ethical way has put the issue of animal welfare firmly on the political agenda. This is especially the case for the intensive methods of farming, such as the production of eggs in battery cages and the rearing of pigs and veal calves.

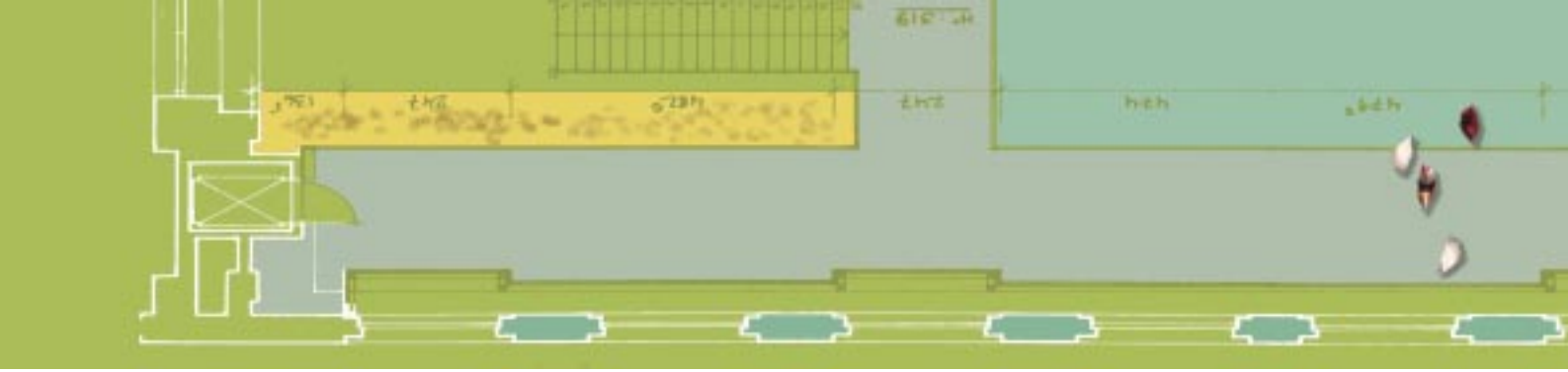
The Treaty of Amsterdam made it an obligation that the European Communities should take full account of animal welfare when determining policies. Animal welfare and consumer bodies rightly take a close interest in policies formulated by the European institutions, and several umbrella bodies, supported by counterpart organisations in the Member States, have been established in Brussels. As the European Commission's Research Directorate-General finds itself preparing for a new Framework Programme to run from 2002 to 2006, the time is ripe to examine how research can advance the welfare of livestock.

This publication reports on a seminar held in Brussels on the 23 April 2002. The meeting was organised in order to examine the support the European Union has given to research projects in livestock welfare and to suggest how research can support EU policy in the future. Thirty-four external experts with a broad range of experience in livestock welfare met with the Commission services to hear about current EU policies in research and livestock welfare and to listen to a series of presentations on Commission-funded projects. The participants then discussed how well this research addresses EU policy and how research should address – and help formulate – policy in the future. The work presented at that seminar, and the ensuing discussion, is recorded here. ■

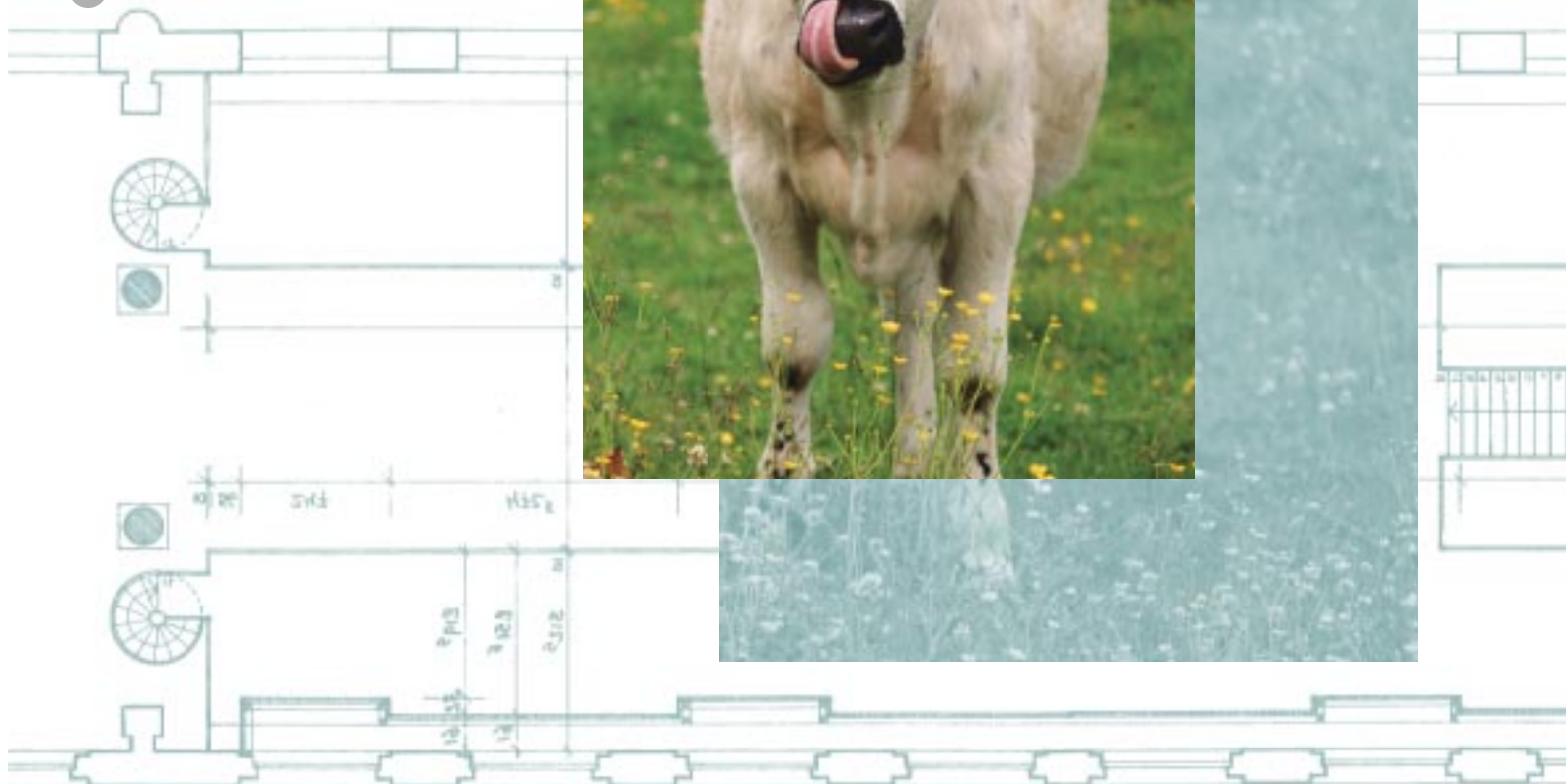


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ANIMAL WELFARE IN THE EUROPEAN UNION

“In formulating and implementing the Community's agriculture, transport, internal market and research policies, the Community and the Member States shall pay full regard to the welfare requirements of animals, while respecting the legislative or administrative provisions and customs of the Member States relating in particular to religious rites, cultural traditions and regional heritage.”

This excerpt from the Treaty of Amsterdam's Animal Welfare Protocol reflects the growing concern of EU citizens about how animals in general, and farm animals in particular, are treated. The concern stems from ethical considerations, but it is also closely linked to the notion that happy animals are healthy animals and that proper care of farm animals leads to safer, better quality meat, eggs and dairy products. Is this true? What are the welfare requirements of farm animals? How do animal welfare measures affect the competitiveness of EU products? Are consumers willing to pay more for foods produced under 'animal-friendly' conditions? To develop sound policies taking animal welfare into account and to defend those policies in international negotiations, EU policy-makers need objective answers to these questions. This is where research comes in.

The European Commission has been supporting animal welfare research since the start of the Fourth Framework Programme for Research and Technological Development (FP4). To date, the Commission has contributed €11.5 million to research projects related to this issue. Under FP4, which ran from 1994 to 1998, and FP5, which covered 1998 to 2002, the Commission

funded 11 projects with a strong animal welfare component. Several of these are now finished or are nearing completion. Many other animal health projects also impact on animal welfare.

The Sixth Framework Programme (FP6), which will run from 2002 to 2006, will include animal welfare research as part of a policy-oriented approach. Animal welfare will also have its place under the Food Quality and Safety thematic priority, as well as being open to support aimed at strengthening the European Research Area (ERA).

Linking research and policy

To examine how past animal welfare research has addressed EU policy and to help prepare for FP6, the Commission's Research Directorate-General hosted a workshop entitled 'EC-supported research in farm animal welfare: current work and future directions'.

This was the first time scientists carrying out this research were able to meet with representatives of animal and consumer groups to discuss how research can best contribute to shaping animal welfare policies. The event included an introduction to EU animal welfare policy and research, the presentation of eight completed or ongoing research projects, and a discussion about how to optimise the contribution of research to EU policy. ■



SEMINAR HIGHLIGHTS

The seminar covered many topics from the cost of animal welfare to EU legislation in force and the kind of research needed in the future. Here are the main highlights:

Stakeholders

The seminar participants agreed that many different stakeholders should be encouraged to participate in animal welfare research.

- **Farmers and industry**, because these are the people who actually deal with animals and animal products, because they must balance productivity, cost, consumer, and animal welfare considerations, and because their participation is essential to large-scale field trials;
- **Consumers**, because their buying behaviour is critical to animal welfare policy;
- **Environmental groups and 'consumers of the environment'**, because agricultural practices have an environmental impact;
- **Animal welfare groups**, because they represent the animals, because they voice and contribute to shaping societal concerns, and because the public trusts them; and
- **Retailers and caterers**, as indicators of new trends in consumer behaviour and as a driving force for improving animal welfare.

Animal welfare or human health?

Is human health the *de facto* driving force for any livestock research? Some participants expressed this view, while others felt that good animal welfare should be a goal in itself. Research presented at the meeting shows that, although good health is certainly an aspect of well-being, increased comfort for animals does not necessarily go hand in hand with

better health. This highlights the need for research aimed at developing practices that meet both objectives.

Counting the cost

Calculating the cost of animal welfare is a complex task. Some animal welfare measures increase the cost of production, but this may be offset by higher product quality or fewer losses due to disease or injury. There are ways to improve animal welfare that do not compromise productivity and are not necessarily costly. It is important to explore the economic and societal impact of animal-friendly measures and production alternatives, so as to reconcile animal welfare and economic imperatives.

Policy clash

Several participants stressed the need to take a broader look at animal welfare in relation to EU policy. Some asserted that the Common Agricultural Policy has negatively affected animal welfare. Others mentioned conflicting policies, such as a move to less-intensive pig production alongside a policy for reducing ammonia pollution that encourages reduced straw use in pig yards. One participant asked how the Commission approaches its obligation, under the Treaty of Amsterdam, to take animal welfare into account. These issues are a proposed focus of future research.

Timely answers

The seminar concluded that two kinds of research are needed: targeted research providing timely solutions to pressing problems, and more generic, fundamental, long-term research laying the ground for future policy. ■

ANIMAL WELFARE AND EU REGULATIONS

As the world's number one importer and exporter of agricultural products, the European Union has both a political and an ethical responsibility in food development and production. With growing attention in many countries on how animals should be treated, the Commission has given priority to animal welfare in food production. The EU Member States have been striving to harmonise legislation governing the treatment of farm animals and they have begun to set minimum welfare standards applicable across the EU. For instance, traditional battery cages for laying hens are being phased out. By 2012, cages allowing less than 750 cm² of cage area per hen will be prohibited.

Facts, please!

"I am one of the first clients of your work." This statement by Alejandro Checchi Lang from the Commission's Health and Consumer Protection Directorate-General to the researchers at the seminar underlines the importance of research in the development of animal welfare standards and policy. To legislate wisely on animal welfare and to explain to third parties why animal welfare is important, it is crucial to reason and negotiate on the basis of sound scientific evidence. Providing this evidence is the one of the roles of EU-funded animal welfare research and of the EU Scientific Committee on Animal Health and Animal Welfare (SCAHAW).

International angle

Countries outside the EU often perceive animal welfare regulations as a barrier to free trade. This makes it necessary to explain the link between animal welfare and food safety – not an easy task. However, there have been some recent breakthroughs:

- Last year, the Office International des Epizooties (OIE), which includes 158 member countries, approved a five-year work plan to establish where international animal welfare regulations are necessary. An ad hoc group composed of representatives from all five continents unanimously agreed that certain animal welfare aspects are intimately related to animal health. The EU will press for rapid advancement in this area.
- The EU is preparing agreements with Latin American countries on food-related sanitary questions. In this context, the animal health and food safety argument has led to a few positive results in the area of animal welfare.

The Commission needs more science to feed discussions currently under way to prepare international standards. As more complex issues are tackled, the need for objective evidence increases.

Harmonious links

Animal welfare policy in the EU is firmly grounded in food safety strategy. We need to establish a harmonious link between how we produce food and how we want to live. In this context, more work is needed to ensure that farming methods become more socially acceptable. ■



EU FRAMEWORK FOR ANIMAL WELFARE RESEARCH

The European Commission has supported animal welfare research since the start of the Fourth Framework Programme in 1994. Under FP4, the research was conducted mainly as part of the Agriculture and Fisheries (FAIR) Programme, with other research projects funded under the Biotechnology (BIOTECH) Programme.

Under FP5, animal welfare was supported within the Quality of Life thematic programme, under Key Action 5 – Sustainable agriculture, fisheries and forestry, including integrated development of rural areas.

Wide research focus

The animal welfare projects selected for FP4 and FP5 cover a wide variety of topics: the animal welfare aspects of organic farming; genetic selection of breeds less susceptible to certain health problems; the role of biotechnology; abnormal development linked to embryo manipulation (*in vitro* fertilisation and cloning); and how to minimise stress and avoid injury on the farm and during transport. Other projects look at animal welfare from a human perspective: consumer attitudes and behaviour, and the ethical, societal, and legal aspects of farming.



FP4 and FP5 projects with a strong animal welfare component:

FRAMEWORK 4 – FAIR AND BIOTECHNOLOGY

FAIR-00075 Genetic solutions to health and welfare problems in poultry caused by painful skeletal disorders

FAIR-03576 Feather pecking: solutions through understanding

FAIR-02049 Chain management of veal calf welfare

FAIR-03678 Consumer concerns about animal welfare and the impact on food choice

FAIR-04339 Embryonic origin of health and welfare: a new concept for understanding the susceptibility to diseases

FAIR-04405 Network for animal health and welfare in organic agriculture

BIO4-00055 The future developments in farm animal breeding and reproduction and their ethical, legal and consumer implications

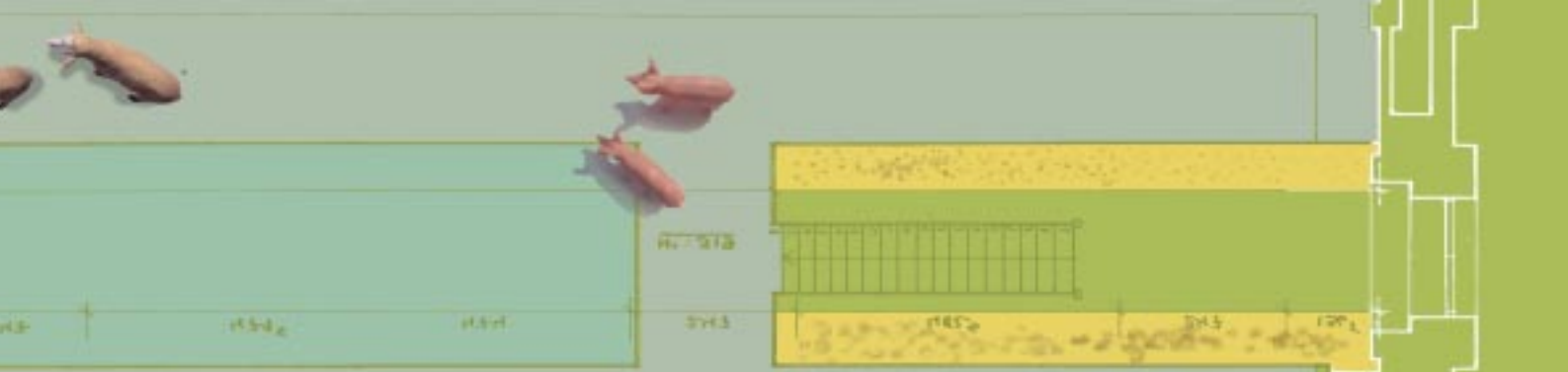
FRAMEWORK 5 – QUALITY OF LIFE

QLK5-01507 Minimising stress inducing factors on cattle during handling and transport to improve animal welfare and meat quality

QLK5-01549 The role of selection and husbandry in the development of locomotory dysfunction in turkeys

QLK5-01732 Broiler breeder production – solving a paradox

QLK5-01888 New gene tools to improve pig welfare and the quality of pork



Structuring the ERA

The European Commission views science and technology as tools for meeting societal needs, as driving forces of economic growth, and as essential inputs into the processes of policy-making and setting standards. It is also aware of the need to avoid wasting time and resources and to reinforce cross-fertilisation and synergies that maximise the benefits of research for society.

For this reason, successive Framework Programmes have followed a trend of increasing integration and networking. The creation of a European Research Area (ERA) is also part of this strategy. The Sixth Framework Programme aims to structure the ERA, to strengthen its foundations, and to integrate European research.

A major innovation of FP6 is the way European researchers will work together on a selected number of priority research themes in a more integrated way than before and with streamlined administrative procedures. To implement the thematic priorities of FP6, two new instruments have been put in place – networks of excellence and integrated projects.

These instruments will address societal needs and will increase European competitiveness. Networks of excellence will contribute to the structuring of the ERA by bringing together a critical mass of resources and expertise needed to provide European leadership in a given topic. Integrated projects will combine research and non-research activities needed to reach an ambitious research goal.

Future research under FP6

The priority thematic areas to be addressed by FP6 are: Genomics and Biotechnology for Health; Information Society Technologies; Nanotechnologies, Multifunctional Materials, and New Production Systems

and Devices; Aeronautics and Space; Food Quality and Safety; Sustainable Development, Global Change and Ecosystems; Citizens and Governance in a Knowledge Society. In addition, under the heading Supporting Policies and Anticipating Science and Technological Needs there will be room for exploring new and emerging areas, providing scientific support to Community policies, and addressing emergencies. Within the thematic priorities, animal welfare has its place mainly within Priority Area 5 – Food Quality and Safety.

Priority Area 5: Food and Safety

Priority Area 5 will take a broad look at food safety: epidemiology of food-related diseases; the impact of food on health; traceability; analysis, detection, and control; the impact of animal feed on health; environmental health risks; and safer and environmentally friendly production methods and healthier food stuffs. Under this last heading, topics directly related to animal welfare will include comparative assessment of different production methods, improved food animal production and animal welfare, and application of plant/animal science and technology, including genomics, to improve food quality. ■



PROJECT HIGHLIGHTS

During the seminar, eight EU-funded research projects were featured. A summary of these projects – which are either finished or are nearing completion – is given here. More detailed project reports can be found on pages 16-30.

Going organic

Is organic farming more animal-friendly than conventional farming? It is considered a more 'natural' approach to farming; however, it is not an animal welfare scheme as such. One research project shows that while organic systems offer animals more freedom of movement, a better environment, and permit more natural behaviour, animal health on organic farms is no better than it is on conventional farms. Health problems on organic farms may arise mainly due to restrictions on the use of veterinary medicines or from problems reflected in the feed. *(See page 16)*

The consumer mind

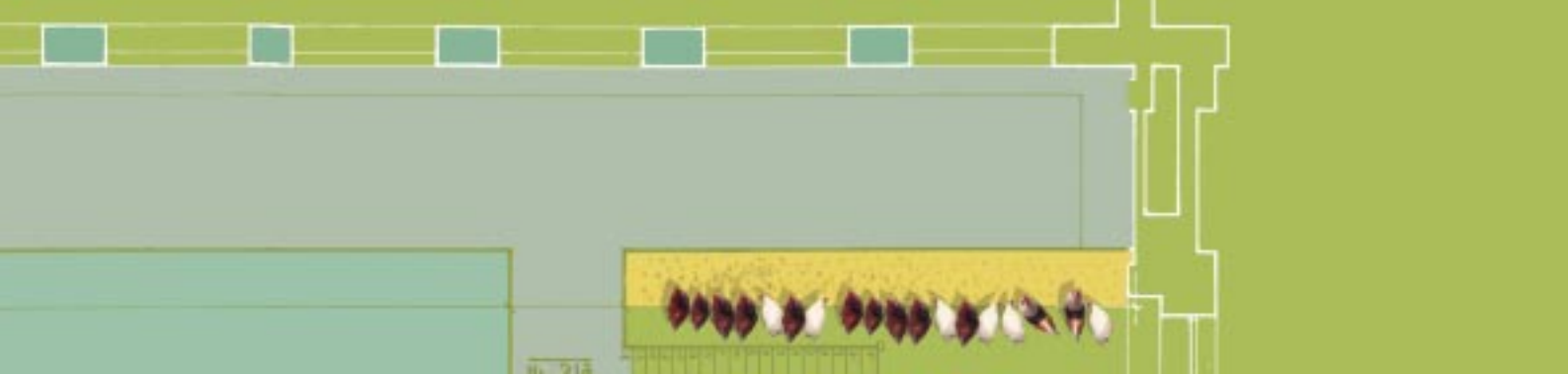
Experience with BSE and genetically modified organisms highlights how essential it is for the food industry to gain consumer trust and acceptance. For this reason, the EU has funded a research project looking at consumer attitudes and behaviours in relation to animal welfare. The project shows that consumers are ill-informed about production practices. They want more information, but they want product labelling to be simple – like laundry symbols! At the same time, consumers try to ignore or forget the reality of slaughter. They are concerned for animal welfare both on ethical grounds and because it may affect product safety and quality. Although consumers express a willingness to pay more for animal-friendly products, their behaviour seems to be driven more often by other considerations, such as value for money. *(See page 18)*

Understanding biotech

One project has dealt with the ethical, legal and consumer implications of farm animal breeding and reproduction, particularly in relation to biotechnology. The work shows that public concern in this area focuses on animal health and welfare, environmental biodiversity, and the unknowns associated with biotechnology. From a discussion of three production models, it emerged that low-cost and alternative systems are not as divergent as they may seem, since survival of the former depends on product quality and animal welfare, and survival of the latter depends on reducing costs. The research highlights the importance of creating a dialogue between breeders and society, and stresses the need for more research to develop economically sound farming systems that are acceptable to consumers. *(See page 20)*

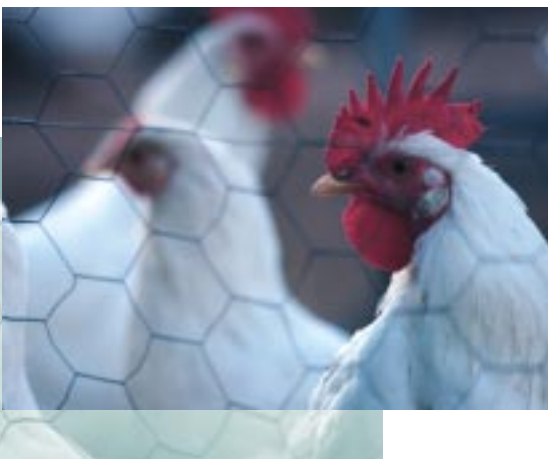
The human touch

While many consumers view veal as a high-quality product, there is a lot of public concern over the welfare of veal calves. A project has shown that when farmers have a positive attitude towards their calves and treat them in a humane way, the production level is increased, loading and unloading into lorries is easier, and there are fewer incidents at slaughter. The team recommends selection and training of stockmen and women to create positive attitudes. The project partners also noted a reduction in abnormal oral behaviours, such as tongue rolling, continuous biting and sucking on materials, and increased rumination when roughage was provided, accompanied by fewer hairballs in the rumen. Some forms of roughage increased the severity of abomasal ulcers, but hay did not. Italian taste panels found no difference between meat from animals which had been fed roughage and those which had not. *(See page 22)*



An end to hen pecking

Traditional battery cages will be banned in the EU from 2012, but alternative production systems could increase the risk of feather pecking. This behaviour, which involves pecking and pulling at the feathers of other birds, causes increased food intake, injures birds, and may even lead to cannibalism. EU-sponsored research has shown that gentle rather than aggressive feather pecking is socially transmitted. Furthermore, a piece of white or yellow polypropylene baling twine suspended in the cage elicits preening-like manipulation of the string and reduces feather pecking dramatically. (See page 24)



Rest, revive, survive

Each year more than 30 million cows, beef cattle, and calves are transported within the EU. Transport can cause severe stress to animals, leading to poor welfare and affecting meat quality. A project addressing this problem highlights the stress-inducing effects of loading and unloading, the importance of allowing more frequent breaks for feeding and watering when

the journey lasts longer than six to eight hours, and the harmful effects of bad driving. A preliminary conclusion is that transportation must address animal needs more closely. (See page 26)

Focus on fractures

Some 30% of battery hens suffer from bone fracture during their lifespan, owing to the loss of mineralised structural bone once they begin laying eggs. The frequency of fractures in processed carcasses is 95%. A project team has successfully bred lines of laying hens with much stronger bones that are less prone to fracture. Egg production is not altered and eggshell strength is only slightly affected. (See page 28)

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All in the genes

In vitro fertilisation is used in farming to speed up genetic progress and to overcome infertility problems in livestock. It involves culturing an embryo in the laboratory for a short period, before transferring it to the uterus of the surrogate mother. Problems with *in vitro* fertilisation include low efficiency and, in 20 to 40% of cases, abnormal embryo development. A team is working on the hypothesis that embryo manipulation and culturing may lead to persistent developmental changes linked to altered expression of certain genes. Research aims to identify those genes in order to better understand what goes wrong and ultimately to improve embryo technologies. (See page 30) ■

CURRENT RESEARCH AND FUTURE DIRECTIONS

The main purpose of the seminar was to help prepare the ground for animal welfare research under the Sixth Framework Programme. The idea was to bring together the stakeholders involved to examine how to optimise the link between animal welfare research and policy.

How well has current research supported EU policy?

One answer to this question was supplied by the project presentations themselves: current research has addressed many aspects of animal welfare policy and has yielded practical solutions to some of the main problem areas. Research has also provided data on consumer attitudes and behaviour, on the health and welfare status of animals on organic farms, and on the factors that increase or diminish animal welfare in a variety of situations. And it is helping to define breeding goals to take into account both animal welfare and the broader societal context, while also contributing to the optimal use of new biotechnologies. A second response to this question called for clarification of how the Commission interprets its obligation under the Amsterdam Treaty to take animal welfare into account. Underlying this call is a perceived ambiguity. On the one hand, there is the ethical statement that animals are 'sentient beings' whose welfare must be considered; on the other hand, farm animal welfare comes under the human-centred policy area of food quality and safety.

One area was identified where current animal welfare research has not adequately addressed policy: there has been no systematic investigation of the impact of EU policies across the board on animal welfare. The Common Agricultural Policy was mentioned as the EU policy having had the greatest – essentially negative – impact on farm animal welfare. The CAP is perceived to have favoured intensive farming methods while

export refunds have led to increased transport of farm animals over long distances.

In addition, seminar participants emphasised that different policies may have conflicting effects. For example, EU price support for exporting live animals overseas conflicts with a policy to reduce the distance travelled from farm to slaughter. Several participants called for greater integration of environmental and animal welfare concerns at both research and policy levels.



How can we use research to develop and implement policy?

"Scientific evidence often arrives too late. By the time research results are produced, policies have already been defined and standards set," was the problem underlined by one participant. Referring to his own field of expertise, a scientist echoed this view. "Current EU legislation on farm animal transport is not substantiated by scientific data."

Is it possible to reconcile the need to make timely policy decisions with the inherently slow pace of scientific research? From the discussion it emerged that it is essential to support both short-term, targeted, applied research and longer-term, generic, fundamental



research. This should make it possible to act quickly in response to arising needs while building the expertise base and knowledge required to support future policy.

A member of the Scientific Committee on Animal Health and Animal Welfare (SCAHAW) explained the committee's role in identifying areas where targeted research is urgently needed because there are deadlines to be met. It should be remembered that it is not mandatory for the European Commission to follow SCAHAW's suggestions for research prior to implementing legislation. A scientist referred to the activity reports that EU research project coordinators produce for the Commission. These reports contain a wealth of suggestions for future research that should, perhaps, be more systematically exploited.

A recurrent question throughout the seminar was whether animal welfare research should focus primarily on human interests or on animal well-being for its own sake. There were conflicting views on this ranging from "Animal welfare should be for the animals, not the consumers" to "When I buy meat, I want to be sure it will not harm my health; human health should be the ultimate goal of this research," and "All livestock research should be framed in terms of consumer demand."

At what cost?

The need to improve production and cut costs is clearly important in livestock farming. Some farmers fear the cost of improving animal welfare will prove prohibitive. However, it is important to take all factors into account when estimating this. Research shows that major welfare improvements can sometimes be achieved at very low expenditure. It may turn out that improving animal welfare seldom entails a net increase in production costs. In addition, improved product quality can make it profitable to

invest in animal welfare as farmers can charge more for their animals.

The role of biotechnology

Biotechnology provides new tools for livestock breeders and farmers, but the use of some recent technologies must be optimised. At the seminar, participants stressed the need for more research in this area. One scientist asked a particularly interesting question: "In the present climate of public wariness towards GMOs in food, would genetic modification aimed at improving animal welfare be accepted by society?" Some participants were optimistic on this issue saying that "GMOs for medical applications would be accepted," while others disagreed saying that "currently there is too much public opposition."

Integrating research

Seminar participants repeatedly advocated better integration of animal welfare, human health, and environmental concerns in livestock research. "This means measuring both the positive and the negative impact of animal welfare on animal health, consumers and the environment," said one participant. "The working environment should also be considered," suggested another, "because effects at this level could have important implications for health and safety policy."



Educating and informing those who deal with farm animals...

Research has shown that both farm animal welfare and product quality improves when the people who care for, transport and handle the animals are well trained, have a positive attitude towards their jobs and the animals, treat the animals with care, and are attentive to their needs. It is therefore important to educate and inform these professionals.

...and consumers

The importance of informing consumers was also stressed during the seminar. Consumers need information on farming systems, on animal welfare issues, and on factors that affect product quality. Research is needed to answer consumer questions, and when objective data is lacking this should be made evident as this is the only way to build consumer trust. Public mistrust of the food industry, official sources of information on animal welfare and food safety is a serious problem. With research showing that

consumers tend to trust animal welfare and consumer groups, a SCAHAW member stressed the need to provide these groups with reliable information.

Building a network

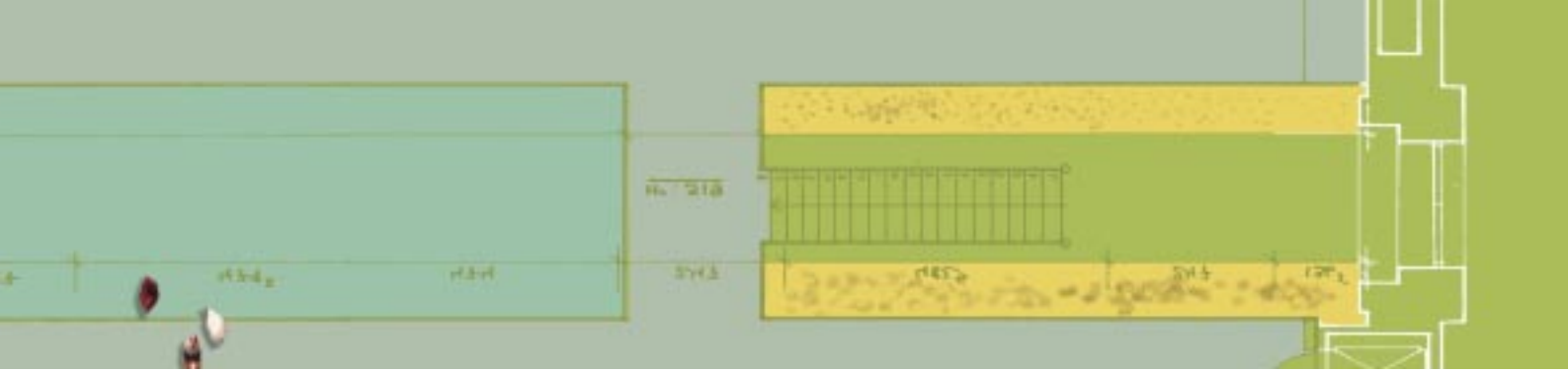
The discussion led to a proposal that a Network of Excellence under thematic priority 5 of FP6 could address these needs. Participants felt that such a network could address many of the issues raised at the seminar. It could pool expertise in many different disciplines, and combine research with education by involving a wide range of stakeholders. Thanks to the grant-based structure of Networks of Excellence, such a network could pursue both long- and short-term research goals.

Key stakeholders

Seminar participants felt very strongly that animal welfare should be integrated with other policies and objectives. Special attention was given to identifying the stakeholders that should be included in future animal welfare research.

One of the most critically important stakeholders are consumers, as their decision to buy or not to buy animal products can have dramatic consequences for the industry. Consumer concern for animal welfare can also have a huge influence on policy.

Seminar participants also highlighted the importance of including environmental groups and 'consumers of the environment' in future projects. There are two reasons for this – the environment impacts on animal welfare and animal welfare measures may affect the environment.



As already mentioned, the Treaty of Amsterdam recognises animals as ‘sentient beings’ whose welfare should be taken into account. While animals are obviously passive stakeholders in future research, animal welfare groups should be included as representatives of animal interests. The public trusts these groups more than it trusts national, EU or farming/industrial bodies.

Farmers and the food industry are obviously key to any future research as they are directly involved in rearing and processing farm animals. They are also essential participants in large-scale trials. As one participant explained, these trials are indispensable: “There is a world of difference between a few chickens in a box and thousands in a shed.”

Is the food industry interested in animal welfare? This is certainly the case, insofar as it affects production and product safety and quality. To illustrate the industry’s interest in animal welfare, a participant from the UK Department for Environment, Food and Rural Affairs described a national programme called LINK, which aims to make UK products more competitive and to strengthen ties between research and industry. LINK includes several projects aimed at improving farm animal welfare.

The final stakeholder groups singled out by participants are retailers and caterers – key indicators of consumer trends representing a powerful driving force for animal welfare improvement.

SEMINAR CONCLUSIONS

- Objective data is needed to substantiate policy decisions affecting animal welfare.
- EU-supported animal welfare research has addressed EU policy to some extent, but future projects should focus on the impact of animal welfare measures on a wider range of EU policies. This should include an analysis of areas where different policies have conflicting effects.
- Because research progresses slowly and there are pressing deadlines, future research should combine efforts to build a base of expertise over the long-term with short-term efforts to provide timely answers to specific questions.
- It is important to involve a wide range of stakeholders in animal welfare research.
- EU-funded animal welfare research has provided a wealth of information and some practical solutions to major welfare problems. Whether it has struck the right balance between human- and animal-centred concerns remains an open question.
- It is important to estimate the true cost of improving animal welfare, taking all factors into account – the costs could be lower than previously believed.
- The use of new biotechnologies needs to be optimised taking into account animal welfare. They should be introduced in a way that is acceptable to society.
- Education and information – directed notably at farmers and consumers – are essential to improving animal welfare and exploiting the findings of animal welfare research.
- Many of the issues raised at this seminar could be addressed within a multidisciplinary approach under FP6. ■



ANIMAL WELFARE ON ORGANIC FARMS

ANIMAL WELFARE, CONSUMERS AND PERCEPTIONS

The goal of farming is to produce safe, healthy food in sufficient amounts and at a price that is fair to both the producer and the consumer. For farmers, this means reconciling many factors: complying with standards and regulations, optimising productivity and production costs in a context of global competition, preserving the environment, exploiting new technologies, and adapting to changing consumer needs, preferences, and demands. Taking animal welfare into account is another piece in this complex puzzle. Three EU-funded research projects focus on how it fits into the broader context. (pages 16-21)

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The *Codex Alimentarius*, a food code put together by the Food and Agriculture Organisation and the World Health Organisation in the 1960s, defines organic farming as a system which enhances biological diversity within the farming system, increases soil biological activity, maintains long-term soil fertility, avoids wasting non-renewable resources, minimises the use of renewable resources through recycling of plant and animal waste, promotes the healthy use of soil and avoids pollution, maintains the organic integrity and vital qualities of food products, and becomes established on any farm, after a period of conversion.

Organic farming is the only farming system in the EU defined by regulation. It is governed according to a legal framework adopted in the early 1990s (Regulation (EEC) No 2092/91 and 1801/99). The Regulations lay down minimum rules for organic livestock production – for instance, livestock must have access to a free-range area and the number of animals per unit area must be limited; medicinal inputs and food supplements are restricted; and much of the food that farm animals receive is produced on the farm itself.

People perceive organic farming as more animal-friendly than conventional farming because it allows animals more space and appears more 'natural'. Is this perception accurate? It is important to bear in mind that organic farming is not an animal welfare scheme

as such. Of the 17 objectives laid down by the International Federation of Organic Agriculture Movements, only three concern animal welfare – maintaining genetic diversity, giving farm animals access to natural behaviour, and balancing crop and livestock production. There is a lack of data on the long-term effects of organic husbandry on animal welfare and health. Providing such data was the aim of the EU-funded project 'Network for animal health and welfare in organic agriculture' (NAHWOA), which involved 17 research institutes in 13 European countries.

Good marks and grey areas

One conclusion of the NAHWOA project is that on organic farms, animal welfare is indeed better in terms of freedom of movement, access to natural behaviour, and the production environment in general. However, project partners noted that organic standards tend to include animal welfare implicitly rather than explicitly. In some situations, other objectives of organic farming may even conflict with animal welfare objectives.

The main welfare problem connected with organic farming is animal health. A growing body of evidence suggests that animal health is no better on organic farms than on conventional ones. Differences between



farms are greater than differences between systems. Most of the health problems identified on organic farms – for example, external and internal parasites, mastitis, and nutritional deficiencies – appear to result from the restricted use of veterinary medicines and food supplements and to the requirement for free-range husbandry.

Recommendations and further research

In the light of their findings, the NAHWOA partners recommend:

- Defining an ethical basis for animal welfare in organic farming to ensure more transparency in this area;
- Identifying areas where animal welfare objectives conflict with other objectives of organic farming, in order to strike an optimal balance; and
- Developing mechanisms that guarantee good animal health on organic farms. This means that in addition to organic farmers, various other specialists, such as ethologists, and public health and veterinary experts, should be involved in defining organic standards.

The partners have also pinpointed a number of areas where further research is needed:

- Ethical issues and consumer perceptions;
- Identification and monitoring of conflict areas and development of optimal systems;
- Research to clarify the suitability of different breeds and breeding aims in organic systems; this is considered particularly important in poultry production to avoid the inherent animal welfare problems that are prevalent in conventional poultry systems;
- Development, implementation and monitoring of positive health planning, with an obligation to demonstrate a gradual improvement of health and welfare status on organic farms;
- Research into the benefits and drawbacks of the reduced use of conventional veterinary medicines; and
- Development of complementary medicine.

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CONSUMER CONCERN AND BEHAVIOUR



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There is growing evidence that European consumers are increasingly concerned about farm animal welfare and that patterns of animal-based food consumption are changing. In response to these developments, the EU is developing and setting farm animal welfare standards. All this is taking place against a backdrop of intense international competition and trade negotiations. These facts form the rationale of the research project 'Consumer concerns about animal welfare and the impact on food choice'. The project's eight partners, based in the UK, Ireland, France, Italy, and Germany, aimed to develop strategies to address consumer concern for animal welfare. Researchers examined the nature and level of consumer concern for animal welfare to find out whether it is knowledge-based, and to see if there was any trade-off between this concern and other product attributes, such as price.

The team reviewed the relevant literature, held focus group discussions, conducted a telephone survey and in-depth interviews, and assessed strategies for addressing consumer concerns for animal welfare.

Nature and level of concern

The study revealed that for most consumers, the concept of animal welfare rests on self-evident notions such as 'natural' and 'humane'. Few consumers expressed concern for animal welfare spontaneously, although many did when prompted. Human health, product safety and quality were often the first points raised in relation to food production. It emerged that consumer concern about farm animal welfare is multi-dimensional, based on concern for human health on the one hand, and avoiding cruelty to animals on the other. Both types of concern are constant across Europe. Consumers often stressed the importance of giving animals adequate space, outdoor access, natural feed, and the ability to behave normally. As a result, they criticised battery cages and veal crates in particular. When asked to rate production methods by product on an 'acceptability scale', veal and poultry production were rated lowest while milk and lamb production came in highest.

Information and trust

The study found that consumers feel ill-informed about farming practices. For instance, many consumers incorrectly think that production methods for laying hens and broiler chickens are the same, when in fact they are completely different. Consumers do not trust governments, the EU or the food industry as sources of information on standards of animal welfare. They are much more willing to trust consumer and animal welfare organisations.

Consumers want more information on farming practices and farm animal welfare, but there is ambiguity here. While consumers want more information in a simple form – akin to the well-known washing instructions on laundry labels – they would prefer to disassociate the meat from the animal and voluntarily



ignore the reality of slaughter. Consumers are also unaware of World Trade Organisation (WTO) rules and the impact they have on animal welfare standards. They believe, therefore, that EU standards and labels should apply to all imports.

Consumer contradictions

The project looked at the impact of public concern for animal welfare on consumer behaviour. To pinpoint contradictions, the project compared consumption levels with market figures for meat, egg, and dairy products. It emerged that even though consumers expressed great concern for animal welfare and a willingness to pay more for free-range products, in fact their concerns, on the whole, were not translated into buying behaviour. When they did buy 'animal-friendly' products, such as free-range eggs, this often reflected other motivations, such as concern about product safety and quality.

Lack of information is the biggest barrier to buying and eating animal-friendly products. Others include lack of availability, the tendency to disassociate the product from the animal, the belief that consumers do not have the power to change the system, and price premiums.

When asked what type of strategy could best address their concern for animal welfare, consumers said they preferred a combined strategy involving minimum standards and financial incentives to farmers to convert to management systems that improve welfare. Compulsory labelling and education of consumers should also be encouraged.

Conclusions and recommendations

In conclusion, consumer concern for animal welfare is multi-dimensional:

- It is based on self evident beliefs rather than scientific information;
- The level of concern is similar across Europe;
- Production methods are generally considered unacceptable, except for milk and lamb production;
- Concern is not generally translated into food choice, unless there are additional perceived benefits for the buyer;
- Consumers favour a combination of producer incentives, minimum standards, compulsory labelling, and education of consumers to improve standards of animal welfare;
- The project partners stress the need to take the contradictions between consumer beliefs and behaviour into account and to examine how to address their concerns; and
- A wide range of policy measures should be considered, from EU-based information campaigns, agricultural reform, and legal definitions for labelling, to advocating farm animal welfare in negotiations on agriculture at the Millennium Round of the WTO.

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ANIMAL WELFARE, BIOTECHNOLOGY AND ANIMAL

The role of animal breeders is to provide livestock farmers with 'genetically improved' animals, but what does this mean? Improvement is defined according to the economic, ethical, and legal framework in which breeders do their job. This framework was the focus of the project 'The future developments in farm animal breeding and reproduction and their ethical, legal and consumer implications'. The researchers aimed to make farm animal breeding more transparent.

Three options

As a basis for discussion, the research teams defined three scenarios for the future, each implying different breeding goals and technological choices:

A **'conventional'** scenario, more or less extending current practice and driven by animal health, product quality, and production cost considerations. Breeding goals would reflect these concerns. The system is expected to use currently accepted biotechnologies such as artificial insemination and embryo technology.

An **'alternative'** scenario, emphasising animal welfare, environmental concerns and disease resistance. This would be driven by consumer demand and willingness to pay. Breeding would aim at moderate production levels, specific products for niche markets, animal health and welfare, and improved feed efficiency. A **'low-cost'** model, driven by the competitive global market. Reducing production costs would be the main breeding goal. Biotechnologies such as cloning and transgenics could find their way into the system if accepted by consumers.

The project partners stress that some goals are the same in all three scenarios, for example, product quality and animal health. Also, the systems might not diverge as much as it seems - survival of the 'low-cost' system depends on product quality, animal health and welfare, while survival of the 'alternative' model depends on keeping production costs as low as possible.

Changes in breeding goals take years to show their effects. The partners therefore advocate timely discussions among the various stakeholders, enabling breeders to adapt to society's wishes.

Ethical aspects

Ethics deals with citizens' concerns. People disagree as to how the ethical aspects of farm animal breeding should be handled, particularly as regards animal welfare and the new biotechnologies. The research teams identified important issues:

- Good animal health and welfare: balanced breeding goals, solving undesirable side effects of breeding, such as skeletal fragility in poultry, mastitis in dairy cows, impaired calving in double-muscle cows, and heavy calves in biotechnologies;
- Animal integrity;
- Human concerns: animal health influencing human health, and the slippery slope argument





BREEDING

meaning that technologies once applied to animals would easily be extended to humans;

- Environmental concerns: the fear of losing biodiversity or that transgenic organisms will upset the ecological balance; and
- Advances in biotechnology: fear of the unknown.

The project partners call for transparency and dialogue in addressing these issues. They stress that farm animal breeders today do not clone or genetically modify animals for food production - they use biotechnology only to accelerate genetic progress or increase the rate of reproduction.

Legal issues

More investment in research may lead to increased numbers of patents in farm animal breeding, although until now contracts have proved to work effectively and to be much less costly than patents. In the case of biotechnology patents, broad intellectual property claims may be a problem, but they do not affect traditional selection, which has been used in animal breeding for many years.

The partners foresee that animal welfare will influence the future of farm animal breeding more and more. An example is a measure systematically introduced into each amendment of the Council of Europe's European Convention for the Protection of Animals, stipulating that "no animal shall be kept for farming purposes unless it can be reasonably expected, on the basis of its genotype and phenotype, that it can be kept without detrimental effects on its health and welfare". Case-by-case assessment may be a practical solution for implementing welfare in future animal breeding.

Encouraging dialogue

Research has shown that consumer behaviour is largely dependent on education and social class and is subject to sudden changes, particularly when food scare crises create panic reactions. Consumers are most concerned about human health, animal welfare, and GMOs, which they find acceptable for medicinal purposes, but not in food. The partners conclude that breeders should take societal concerns seriously and maintain a dialogue with welfare organisations.

The next step: SEFABAR

A new network – Sustainable European Farm Animal Breeding and Reproduction (SEFABAR) – has been created to build on the findings of this project. It aims to find economically sound and socially accepted breeding scenarios for ruminants, pigs, poultry and farmed fish. ■

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APPLIED RESEARCH IN VEAL CALF PRODUCTION

FROM HUSBANDRY TO SLAUGHTER

Farm animal welfare depends largely on how animals are fed, housed, treated, handled, transported, and eventually slaughtered. Assessing the animal welfare implications of different farming practices is not an easy task. How much food, drink, or space does an animal need? What is healthy, comfortable, painful, or distressing for each type of livestock? Assessment relies on indicators such as animal productivity, health and behaviour, and physiological signs like heart rate, stress hormone levels. Three EU-funded research projects focusing on these issues have brought to light some important results. (pages 22-27)

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Veal is a light-coloured meat from calves, mostly bull calves surplus to the dairy industry. To produce meat that is pale and tender, veal calves are kept for four to six months in close confinement and fed an all-liquid diet that is low in iron. This prevents synthesis of the muscle pigment myoglobin. This farming method has been strongly criticised and as a result the EU is currently phasing out the veal-crate system.

The challenge is thus to produce veal under conditions that take calf welfare into account. The 'Chain Management of Veal Calf Welfare' project studied the various steps of veal production to identify strategies that improve veal calf welfare while producing meat that conforms with market demands. The main focus was on transport, housing, feeding, and stockmanship. Work on these last two aspects was presented at the seminar.

Positive attitude, caring contact

One task was to examine the relationship between farmers' behaviour and calf welfare, transport stress and meat quality. In field trials carried out on 50 farms, researchers used questionnaires to assess farm-

ers' attitudes towards their work and livestock. At the same time, they observed the farms, farmers and calves, recorded technical results, and came up with positive and negative correlations between farmer attitudes and behaviour, animal health and behaviour, production levels, and meat quality.

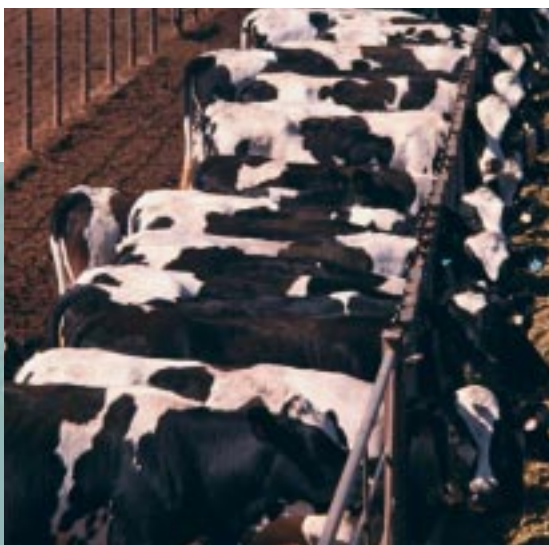
Researchers demonstrated that farmers who were concerned about cleanliness and the health of their animals had healthier calves. This had a favourable impact on production level. Furthermore, farmers with a positive attitude towards their calves developed caring behaviour with them. Consequently, their animals were less fearful of people, showed less resistance to loading and unloading, exhibited lower heart rates during loading and unloading, and caused fewer incidents during slaughter. As a result, the meat from these calves was of better quality.

Rating roughage

Another approach was to see how the provision of roughage to veal calves affects their behaviour and the health of their digestive organs. In a series of feeding trials, calves living in group housing received either an all-liquid diet or a diet which included roughage of different types and in different amounts.



As indicators of calf welfare, the partners looked for normal and abnormal oral behaviours, such as tongue rolling, tongue playing, and continuous biting and sucking on materials, and for pathological signs in the calves' digestive organs. In calves receiving no roughage, frequent abnormal oral behaviour was evident. Such behaviour was reduced in animals receiving roughage, particularly straw or hay. In addition, calves receiving straw or hay showed increased rumination, more normal calf behaviour, and had no hairballs in their rumen. In contrast, hairballs were found in 85% of the animals receiving milk only.



On the other hand, animals receiving some forms of roughage showed more abomasal ulcers, the one exception being calves eating hay. Ulcer formation is probably not due to the roughage itself, but to the large volumes of liquid that veal calves ingest. Some forms of roughage – for example, maize, straw, maize cob silage – however, appear to aggravate the problem.

Italian taste panels detected no effect of roughage provision on the taste, juiciness or tenderness of the meat.

Conclusions

Researchers concluded that the selection and training of farmers to create positive attitudes should be encouraged, as positive attitudes lead to positive contacts, which has been proved to produce good technical results. The project partners therefore recommend farmers to develop gentle contact and voice communication towards calves and to avoid violent physical contact and shouting.

A second conclusion is that adequate roughage improves calf welfare by providing fibres for rumination as well as proteins and carbohydrates which favour rumen function. Based on their findings, the partners recommend the adoption of new feeding strategies, in particular, providing calves with roughage that promotes normal behaviour but does not increase the incidence or severity of abomasal ulcers.

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PRACTICAL SOLUTIONS FOR FEATHER PECKING

Feather pecking occurs when chickens peck and pull at the feathers of other birds. The practice can damage plumage, cause injury, and can even lead to cannibalism. To avoid feather pecking, farmers resort to low lighting or debeaking, practices which compromise the birds' welfare. Feather pecking can be a particular problem in production systems replacing traditional battery cages, to be banned in the EU from 2012. Finding practical solutions to this problem was the aim of the EU-funded project 'Feather pecking: solutions through understanding'.

Associated traits

Feather pecking has genetic, social and environmental components. Researchers looked at feather pecking in high- and low-pecking lines of hens in order to identify the behavioural and physiological traits involved. 'Low peckers' were more social in that they showed a greater tendency to stay close to each other. For example, in tests where birds were isolated from their peers and then timed as they ran along a runway to join the group, 'low peckers' ran faster. They also reacted more passively to restraint. There was little struggling involved, although this group showed a high level of plasma corticosterone, an indicator of stress. These observations could provide a basis for strain selection in future breeding programmes.

Pecking lines

One research team examined the chicken group behaviour that might cause the spread of feather pecking through a flock of birds. First, a hen's feathers were trimmed so as to mimic the effects of feather pecking. This elicited pecking at the damaged area, even by birds which previously showed no such

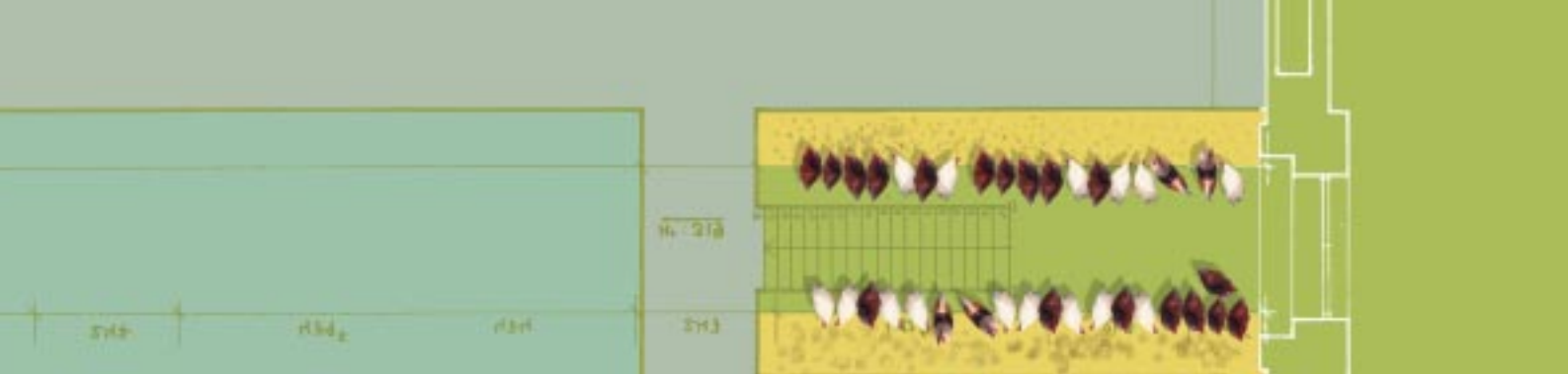
behaviour. Instances of cannibalism were recorded. Another question posed by researchers was whether hens of the high-pecking line transmit the behaviour to hens of the low-pecking line. This was proved to be the case for gentle pecking, but not so for severe pecking. Researchers point out that high frequencies of gentle pecking might lead to the opportunistic development of severe pecking.



Interesting environment

Environmental enrichment can reduce boredom, fear and feather pecking in poultry. It is even reported to improve growth, food conversion efficiency, reproductive performance and health. Yet research results are inconsistent. The problem, it seems, is to find enrichment stimuli that attract and sustain the birds' interest. Chickens ignore many 'enrichment' devices which are chosen according to cost, availability, and human preconceptions about what should interest them. The researchers therefore focused on finding reliable enrichment devices that distract chickens from feather pecking.

In one experiment, chicks exposed to bunches of string or feathers were found to peck more often at the string. Pairs of chickens were presented with a



range of pecking stimuli, including lengths of beads, chains, baubles, and string (polypropylene baling twine). In each case, and on every day of the test, the chickens pecked sooner and more often at the string than at any other device. With repeated exposure, the chickens showed increasing interest in all stimuli, but particularly the string. This strong attraction to string was noted in two different strains.

Interpreting the preference

Why are chicks so strongly attracted to string? One hypothesis is that string might resemble some 'supernormal' stimulus such as straw, grass or worms. However, the project partners prefer another explanation, based on a peculiar habit of the chicks in response to the device: in addition to pecking and pulling at the string, as they did with the other devices tested, the birds drew the string through their beaks and teased the strands apart. This behaviour, reminiscent of preening, suggests that the string might provide more positive feedback than other, more solid enrichment devices.

Keep it simple

In other experiments, the team tested many variations on the 'string theme': different colours of monochromatic string, using two or more colours in the same device, combining string with silver beads, and causing the string to be set in motion by the birds themselves or by external means. All these imagined 'improvements' made no difference: the chicks clearly preferred static, monochromatic white or yellow string without silver beads. What is more, this simplest of all tested devices was still attracting interest after continuous exposure for 122 days!

String on trial

Teams then put their device to the test to see whether it actually reduces feather pecking. Groups of chicks from a high-pecking line were provided with string, while others were not. Presence of the device led to a dramatic reduction in feather pecking, both gentle and severe. In another experiment, the devices were tested on birds which were kept in cages on a commercial farm and which had not been debeaked. After 30 weeks, birds exposed to the string showed significantly less feather damage than non-exposed birds. In addition to providing insights into possible causes of feather pecking, this work shows that a simple, low-cost, readily available and durable device may provide a highly effective solution to a major animal welfare problem. This removes a major obstacle to the development of non-cage housing systems for poultry.

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CATTLE WELFARE DURING TRANSPORT

Each year, about 45 million cows, beef cattle and calves are transported within the European Union. A third of this activity is transport between farms and two-thirds is transport from farm to abattoir. In some cases, transport to the abattoir is direct from the farm, but in others animals are unloaded at a market, then loaded back on to vehicles before continuing to their final destination.

In addition to this type of transportation, the EU imports and exports live cattle. About 300 000 cattle each year are sent from the EU to North Africa and the Middle East, the main exporters being Germany, Ireland, UK, France and the Netherlands.

Transport of live cattle has increased in recent years because of market globalisation, centralisation and rationalisation of abattoirs (reducing their numbers), and EU export refunds.

The EU has put in place rules governing animal welfare in transit (Directive 91/628/EC, as amended by Directive 95/29/EC). The directives include provisions for EU-wide maximum journey times, feeding and watering intervals, and rest periods.

Animal welfare during transport is important for ethical reasons and because transport affects both animal health after arrival on a new farm and product quality when the destination is the abattoir. Stressed animals are more prone to disease, and consumers are unwilling to buy meat that is bruised or biochemically altered by stress or energy depletion.

Reducing stress levels

To improve the welfare of farm animals during transport, to avoid transport-related ill effects on product quality, and to properly develop future legislation in this area, objective facts are required. The aim of the project 'Minimising stress-inducing factors in cattle during handling and transport to improve animal welfare and meat quality' is to provide such facts.

It focuses on the road transportation of cattle. Ten scientific and industrial partners in eight countries are combining their expertise in animal health and welfare, meat quality, dynamics, measurement technology, transport, and logistics.

The work, which includes both laboratory and field studies, is based on the observation that aversive factors for cattle are loading and unloading, bad handling, inappropriate driving performance, poor road conditions, poor climate conditions, high stocking densities, mixing of groups that are not familiar with each other, deck height, lack of water and food, vibration, vehicle motion, and journey length. The project focuses on:

- The effect of transport time on the welfare of cattle;
- Damaging vibration levels;
- Optimising pre- and post-transport facilities;
- Assessing air quality and its effects; and
- Developing an on-line animal welfare surveillance system.

To determine the stress animals suffer under various conditions, research teams are looking at many different factors – temperature and humidity, stocking density, social grouping, respiration rates, postural stability, and behaviour – using video recordings, metabolite and stress indicator levels. Stress levels are also linked to hide condition and meat quality.

Break time

Researchers found that the strongest physiological stress reactions occur during loading and unloading and shortly after the start of the journey. After a while, the animals show signs of adapting, but if the journey lasts more than six to eight hours, animals such as heifers start to develop an energy deficiency. More critical than journey time, however, is whether water and food supply are sufficient. Bruising and



injury seem to be more frequent in short-distance transportation. Poor driving and bad road conditions quickly fatigue the animals. Bulls, steers, and heifers respond differently, with steers from pastures being quieter than bulls from confined buildings. It would seem that meat quality is not significantly affected by transport if resting conditions are satisfactory and bulls are prevented from mounting.

lasting more than eight hours; very long journeys should be avoided; and

- Monitoring continuously the animals' environment and physiological status during the journey. For this purpose, project teams are developing a monitoring system that allows transmission of data to a recorder or distant control centre. ■



Preliminary recommendations

In the light of their current findings, the partners recommend:

- Observing more closely the needs of the animals in the organisation of transport, loading, and unloading;
- Taking factors besides journey time into account;
- Good training of the personnel dealing with the animals;
- More frequent breaks for feeding and water than required under current legislation in journeys

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GENETIC SELECTION FOR IMPROVED WELFARE

GENETICS AND WELFARE

Genetic improvement of farm animals through breeding and selection is a long-standing practice. In recent years, progress in the life sciences - notably in molecular biology, genetic engineering, genomics, and embryo technology - has provided tools for accelerating this process. It is now possible to identify and screen for genes with desirable traits and to produce more offspring from animals presenting such traits. It is even possible to create and clone a genetically modified animal, although such practices are not currently used in livestock farming. Both traditional selection for high productivity and some of the new biotechnologies have led to animal welfare problems. Two EU-funded research projects are addressing these problems. (pages 28-30)

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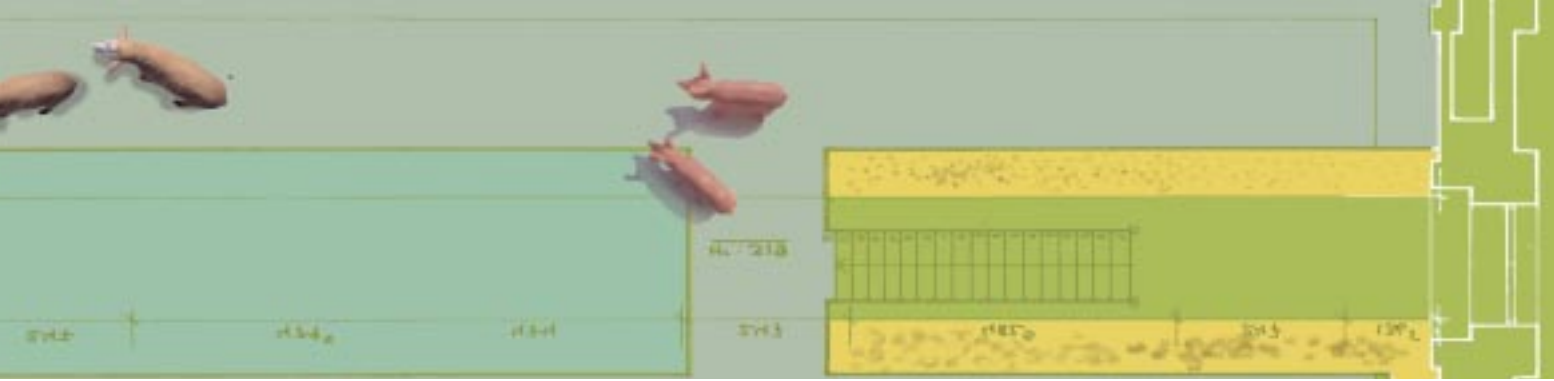
Genetic selection for high productivity has created some serious animal welfare problems. In dairy cows, for instance, selection for high milk production has increased the frequency of mastitis; in 'double-muscled' cattle breeds selected for high meat production, calving is impaired; in broiler chickens, selection for fast growth and high body weight has resulted in, among other problems, bone and cartilage disorders; in laying hens, selection for high egg production has led to osteoporosis, resulting in frequent bone fractures.

In recent years, research has focused on how to achieve more balanced genetic selection, taking both economic considerations and the welfare of farm animals into account. The project 'Genetic Solutions to Health and Welfare Problems of Poultry caused by Painful Skeletal Disorders' aimed at eliminating, through genetic selection, some of the major skeletal problems encountered in chickens. Particularly successful has been an effort to reduce osteoporosis in laying hens.

Fragility and fracture

Some 30% of all battery hens suffer at least one bone fracture during their lifetime. About 95% of carcasses show bone fractures after processing. This bone fragility is due to osteoporosis, which is a loss of structural bone that begins when the hen starts laying eggs, and continues throughout its life. Bone degradation releases calcium, which is needed to build eggshells. Bone fractures are painful for the hens and, even if they do not occur until after slaughter, they result in bone fragments in the meat which affects the quality of the end product. The frequency of bone fractures depends on the type of housing,





how the birds are handled, and bone strength. Researchers aimed to improve bone strength in laying hens by selecting for high bone density.

The strategy

The work began with a commercial pure line of White Leghorn chickens. In two preliminary strains, the partners measured a number of quantifiable characteristics associated with osteoporosis at the end of the laying period and identified the three most heritable of these characteristics: keel radiographic density (KRD), tibia strength (TSTR), and humerus strength (HSTR). They combined these features in a 'bone index', to be used for divergent selection of high- and low-bone-strength lines. The idea was to improve bone strength by maximising this index. Body weight was included in the index, so as to keep body weight constant through the selection process. Then the selection began. It was carried out in birds housed in two different systems: battery cages and an aviary system.

Results

After three generations, hens of the high-index line showed on average 19% higher KRD, 13% higher HSTR, and 25% higher TSTR than hens of the low-index line. They also showed six times fewer humeral fractures during the production period and depopulation. Egg production, egg weight and food consumption remained unaltered. Eggshells were softer and showed more candling cracks, but the effect was slight. Today, selection has reached the eighth generation, with further bone strength improvement in the high-index line and only a minor increase in body weight.

Teams also compared metabolic markers in high- and low-index hens to try to find metabolic predictors of

osteoporosis. Unfortunately, the results were the same in both lines.

While looking at the timing and causes of bone fractures, the partners noted the importance of the depopulation conditions: there were far fewer fractures when the birds were removed gently from the cages and killed by CO₂ asphyxiation than when depopulation was carried out under commercial conditions. This points to other, complementary strategies for improving the welfare of laying hens and reducing the frequency of bone fractures.

Conclusions

In conclusion, osteoporosis in laying hens is heritable. The bone index developed within the project is a good tool for selecting lines with stronger bones and fewer fractures. Selection for high bone strength is equally effective whether the birds are housed in battery cages or in an aviary. It does not alter egg production or food consumption but leads to slightly more fragile shells.

A future step should be to identify genes responsible for better bone strength, for use in marker-assisted selection.

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EMBRYO TECHNOLOGIES: UNDERSTANDING

In vitro embryo production (IVP) is a biotechnology used to accelerate the genetic improvement of mammalian farm animals. It involves collection of unfertilised eggs, *in vitro* maturation and fertilisation, culturing the resulting embryos, freezing and storing them, and then finally transplanting them in a recipient uterus. A novel variant of this technique, which is not currently used in food production, is cloning. The difference is that the embryo is created by introducing the nucleus of a tissue cell into an unfertilised egg deprived of its nucleus.

A two-and-a-half-year research project, entitled 'Embryonic origin of health and welfare: a new concept for understanding susceptibility to diseases', focuses on IVP in cattle.

Problems with IVP

Limitations on the use of IVP in cattle include considerable embryonic, foetal and neonatal losses and the occurrence of developmental anomalies in 20 to 40% of the offspring. This can result in a high birth weight, enlarged kidneys and abnormal muscle development. These anomalies are grouped together under the name 'large offspring syndrome' (LOS). This project aims to

understand the mechanisms that lead to these problems so as to devise strategies to avoid them.

Differences between IVP embryos and their *in vivo* counterparts have been observed as regards morphology, timing of development, resistance to freezing, and metabolism. The partners have found aberrant gene expression patterns in IVP embryos. This is very important because both development and health depend on correctly timed and regulated gene expression.

Altered DNA methylation?

The partners' current working hypothesis is that embryo manipulation alters a phenomenon called DNA methylation, which determines imprinting – the silencing or expression of certain genes according to whether they come from the father or mother – and also controls the expression of some non-imprinted genes.

One task is to study the methylation process in normal and IVP embryos. Another is to try to correlate LOS with the altered expression of specific genes in these embryos. Expression studies first focused on a few genes which are known to be imprinted in some species and whose abnormal expression in animals or humans leads to developmental disorders. Now the partners want to broaden their investigation with the help of microarrays which make it possible to monitor the expression of thousands of genes at a time.

The knowledge gained should contribute to optimising embryo technologies used in cattle, and may also have a bearing on assisted reproduction technologies in humans. ■

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THE PROBLEMS



For further information on European Commission research activities,
visit the Research Directorate-General's website:
http://europa.eu.int/comm/research/index_en.html
More information on EU-funded animal welfare research projects can be found
on the Cordis website: <http://www.cordis.lu>



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