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animal disease genomics: a case study**

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PRINCIPLES FOR ETHICAL DELIBERATION IN BIO-SCIENTIFIC PROJECTS

Animal disease genomics: a case study

Gitte Meyer

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Animal disease genomics: a case study

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**European Animal Disease Genomics Network of
Excellence for Animal Health and Food Safety,
EADGENE**

**Principles for ethical deliberation in
bio-scientific projects**

Animal disease genomics: a case study

Second report on ethical and societal aspects

September 2005

The Danish Centre for Bioethics and Risk Assessment, CeBRA

The report *Ethical deliberation: Principles* is the second report on ethical and societal aspects of the research efforts of the European Animal Disease Genomics Network of Excellence for Animal Health and Food Safety, EADGENE.

The report was prepared August 2005 by Gitte Meyer in close collaboration with Christian Gamborg and Peter Sandoe, all from the Danish Centre for Bioethics and Risk Assessment, CeBRA. Together they form the CeBRA team referred to in the report. The interviews that constitute the main source of the report have been conducted by Gitte Meyer in collaboration with the interviewees.

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1. Introduction and summary

This is a report on principles that may guide efforts of scientific researchers, working in the field of genomics relating to infectious farm animal diseases, to act as responsible and trustworthy members of society. The report continues the considerations that were presented in the first report (delivered by the Danish Centre for Bioethics and Risk Assessment, CeBRA, February 2005) on ethical and societal aspects of the research of the EADGENE network. The aim of the latter report, drawing on literary sources as well as on the experience and common sense of the CeBRA team, was to pin down ethical challenges that originate from the research efforts as seen in the context of society. It provided tentative answers to the question: what kind of ethical challenges does the EADGENE network have to respond to? The aim of the present report, the primary source of which is interviews with scientific researchers related to the network, is to discuss, and to inspire discussion on, how those challenges may be faced in practice.¹ The interviews — with nine scientists from eight European countries — are used dynamically, at the same time as a medium and as a source of an ongoing reflection.²

The report outlines elements of professional ethics which are based on the assumption that the research efforts of the EADGENE network should be seen, not as 'pure' science, but as research that is aimed at the development of technology. The development and use of technology are actions that apply scientific knowledge; and actions come with ethical challenges — to be reflected upon continuously — concerning how to act in the right way towards fellow citizens and other living beings. To this purpose the report proposes a series of principles which are meant to be used as a framework for reflection and discussion within the network.

At first sight, the principles may appear as rather simple rules of conduct, to be agreed upon and obeyed — or, for that matter, to be disagreed upon or disobeyed — in a straightforward manner, regardless of the context. That would, however, miss the point of the report; the aim of which is to contribute to practical, ethical reasoning; that is, to principled reasoning on concrete and specific challenges. To use the principles means precisely to take them into context and to make interpretations that recognize the complexity of real life challenges. The tasks of the network, therefore, should be seen as interpreting and integrating the principles into research and communication efforts along the road. The series of principles may be seen as a skeleton. To provide it with flesh and muscle and, indeed, to make it come to life and enable it to move, is the task of the network. It may be supported from outside — that is the endeavour of the present report — but actual interpretation and integration is a continuous task and cannot be subjected to outsourcing.

Four principles for deliberation and action are being proposed: a principle of moderation; a principle of openness; a principle of making animal welfare a research purpose and a goal in its own right; and a principle of continuous reflection on responsibilities. Thus, the proposed principles cover, but are not restricted to, the issue of *how to discuss scientific research in public*. Questions that concern *the use of scientific knowledge* and *the purposes and aims of research* are also included. It follows that the proposal *in toto* represents a break with the convention that scientific research proper should be left untouched and unchanged by considerations of the societal context of that research.

¹ As stated in the detailed work plan for Task 12.1, D.12.1.3, it is a task of CeBRA to present a document regarding future ethical deliberations within the network and in public. The document should form the basis for future attempts to maintain the awareness of scientists on ethical and societal aspects of the research efforts, and to improve the science-society interaction.

² At the EADGENE days 18-19 May 2005, in Brussels, a questionnaire on the ethical and societal aspects of the research efforts was presented to the participants. The response rate was too low to support conclusions. A summary of the responses, and the original questionnaire, can be found in the appendix.

Challenges concerning the relationship between scientific research and private interests are discussed specifically in section 4.3 (Openness about relations with vested interests) and in section 6 (A principle of continuous reflection on responsibilities). This issue does, however, also function almost as a *leitmotif* of the report — and a crucial challenge that must be faced directly — making itself seen in interview statements about many of the other issues.

The principles are interrelated in several ways, but they are presented and discussed, and may be read, one by one. Each of the presentations is followed by a brief summary of possibilities for, as well as obstacles to, including them in the network's ethical foundation for action. In conclusion, it is emphasised that there is a need for further reflection by the network of ethical and societal challenges. It is argued that the scientific members of the network appear to constitute a very heterogeneous group, bound together by common funding and shared responsibilities, and that common reflection seems to be the only way of meeting — and, indeed, of identifying — those responsibilities.

2. A process of practical, ethical reasoning and exchange

It should be emphasized that the report claims to be no more and no less than a qualified contribution to a process of practical, ethical reasoning. The interviews³ — and thus the nine interviewees from eight European countries — play key roles in the process. Rather than being turned into objects of study, the interviewees served as partners in discussion, pointing to different aspects, reacting to statements and provocations, and voicing differing concerns and opinions and, sometimes, proposals. Thus, the interviews were conducted in the original sense of the word: interview, a meeting of views. Each of the interviewees appears more prominently in some sections of the report than in others; thus mirroring their different priorities and attitudes.

In order to depict and inspire discussion, the resulting interview documents have been used in the present report — edited, interpreted and confronted with one another — in much the same way: views are brought to meet. The CeBRA team has worked — while starting from the conclusions of the first report on ethical and societal challenges — not as pure and distant observers trying to produce a scientific description of how things are, but rather in a multi-faceted function, as catalysts, as mediators and as provocateurs serving the purpose of common reflection on how to act.

In effect, the proposed principles originate from the interview process in different ways. The principle of moderation was mentioned — but not elaborated upon — by one of the interviewees, and in subsequent interviews it was presented to other interviewees. The principles of openness and of making animal welfare a research purpose and a goal in its own right, both originate from the first report on ethical and societal aspects, and the interviews contributed to throwing light upon such principles from different perspectives and revealing areas of possible consensus, as well as areas of disagreement. The proposed principle of continuous reflection on responsibilities originates in the observation from the interview process that there seem to be, among members of the network, many different — and to some extent conflicting — assumptions and values at play about society, politics and the public and, accordingly, about the relationship between science and society at large.

³ Qualitative interviews: The interviewees were selected with a view to gaining a multi-faceted overall picture, encompassing as many different perspectives as possible regarding, for instance, countries and institutions of origin. Each interview lasted about an hour and a half. During the interviews comprehensive notes were taken by the interviewer. To make the interviewees feel as secure as possible — and because the interviewer was rather experienced as regards note-taking — the possibility of using a tape-recorder was dismissed. Afterwards, the notes were transformed into interview documents, intended to provide as accurate a snapshot of the conversation as possible. The interview documents were sent to the interviewees for confirmation and/or correction, and corrections were made according to the comments of the interviewees (inter-subjective validation). As to the affiliation of the interviewees, all of them are attached in some way or another to public research institutions. Their contacts with industry and agriculture vary from no contact to rather close contact.

Therefore, continuous reflection on the societal responsibilities of scientific researchers, allowing different assumptions and values to be voiced and discussed, appears to be needed.

In order to secure a free and open exchange on controversial issues, the interviewees were promised anonymity, and care has been taken to eradicate hints (including hints about country of origin) that could lead to them being identified. All of the interviewees were provided with pseudonyms. Thus, in the present report they appear under the names Fred Carey, Allan Innes, Harold Brix, Benny Hamilton, Ian Andersson, Greg Gladstone, Dan Edwards, Earl Doolittle and Carl Forbes⁴.

3. A principle of moderation

A principle of moderation in relation to technology means that no technology should be taken to its ultimate, logical conclusion. Thus, the principle prescribes that one should abstain from seeking perfection and complete control, and it should be seen as a response to concerns about irreparable consequences.

The principle is based on the widespread assumption that the consequences of (technological) action cannot be completely foreseen and, therefore, that to apply science in the shape of technology means, in a certain fundamental sense, not to know what one is doing. It is also based on the assumption that visions of technological precision, originating from ideas about controllable mechanisms of one cause and one effect, cannot match the complexities of practical life where negative and positive effects may easily be caused by one and the same phenomenon: to practical purposes, therefore, expectations about being able to achieve some wanted effects without, at the same time, causing some unwanted effects, are hardly realistic. Against this background it seems wise to put restrictions on the use of one's powers and to abstain from realizing the full potential of any technology.

There is an obvious kinship between a principle of moderation and (all sorts of interpretations of) the precautionary principle. In both cases a principle is formulated in order to respond to the condition of scientific uncertainty (see also section 4.1: Openness about disagreement and uncertainty). A principle of moderation should, however, not be seen as just another interpretation of the precautionary principle. It is not directed at specific technological actions, making the case that they should be avoided due to recognized uncertainty about consequences; that is, recognized risks that may subsequently be subjected to scientific scrutiny and to battles about evidence or lack of evidence. Rather, by a general promise to be moderate in the use of technology — and thus to abstain from the rewards of completion — it epitomizes a humble and caring attitude towards practice.

The proposed principle originates from the interview with Fred Carey. He was asked to comment upon the possibility that one may inadvertently eradicate something beneficial (e.g. the positive effects of mild infection) in the process of getting rid of something harmful (e.g. infection as a negative). He answered: "With breeding you are never completely successful. And you never advocate following a strategy completely to its end. We have seen how extensive use of chemicals has resulted in worms that are resistant to those chemicals." To the question of whether this norm of moderation was a general attitude, he stated: "It is accepted by some, but not by others. One of my missions in life is to make it part of the central dogma of our profession!"

The principle was presented to Harold Brix, and he was asked whether he, too, would be in favour of a principle of that kind. He said: "I would be in favour of such a principle. As I have told you, some of my research has been aimed at using genomics in order to preserve natural resources.

⁴ Note that some of the interviewees were women, although to secure the anonymity all pseudonyms are male names.

Some breeds are not important to today's purposes, but still, we would like to preserve them. They might become important to us later on, for reasons unknown to us today."

The possibility of acting too rashly and ignoring doubts about consequences, was touched upon during most of the interviews. In order to prompt reflection on this, many of the interviewees were presented with an example of genetic variation that has a dark as well as a light side — the example of sickle cell anaemia and resistance to malaria which are related to the same genetic variation — and they were asked to reflect upon the possibility that one may inadvertently eradicate something beneficial in the process of getting rid of something harmful.

Benny Hamilton reacted to the example by stating: "In this example you would find that you had lost more than you had gained. We have to realize that selection is always about getting rid of some variance. This means that there is also always the risk of losing something we would have liked to keep." Later in the interview he talked about the need to be careful, and he agreed with the remark that the notion of 'care' is crucial.

Carl Forbes reacted to the example by saying: "That is the reason why we have to take environmental factors into account. It is not sufficient just to look at the genes. In the example of sickle cell anaemia and resistance to malaria it would be a disaster to lose that genetic variation in malaria-ridden areas, but it would not be a big problem in other areas ... We have to take notice and take care."

'Care' was a key notion to Earl Doolittle as well: "We have to be very careful with that instrument [the instrument of genomics]. That is, in fact, another reason why we are doing basic research at this institute. We have to study the interplay of the genes. We have to understand the traits, and how they are interrelated. In the end, such knowledge is part of the assistance we can give to breeders. We can inform them about which *other* traits might be affected if they base their selection on a certain trait." Earl Doolittle responded to the comment that researchers would still have to add a reservation like 'as far as we know at present': "Of course — such information is always 'as of today'."

How far then, should scientific researchers go? Do they and should they try to eradicate some traits completely?

Allan Innes argued: "[I]f you become more effective, you also run the risk of making more serious errors. For that reason we must be sufficiently careful, and we must be able to identify and investigate the most crucial aspects." Responding to a question, Innes confirmed — "of course" — that it is only possible to provide answers to and knowledge about those particular aspects that one is actually looking for. On the other hand, Allan Innes also argued that the existence of genetic knowledge about many different traits would force researchers and breeders to weigh the traits against each other. Thus, breeding based on genomics would come close to classical breeding, and he did "not believe in the horror scenario that because we are becoming so effective we will also easily do a lot of damage. Classical breeders are often making that case, but I don't think it will happen."

Carl Forbes provided an example: "In this country it was decided that we should get rid of all sheep that were susceptible to scrapie. The same decision has been made on a European level. It is, in fact, an easy task, because a variant of a gene has been discovered that makes sheep completely unsusceptible to scrapie. So, in relation to one disease in one kind of production animal, we actually already do the kind of thing you are asking about. We should remember, however, that this particular task was a very easy one. Salmonella is not that simple. It is, in fact, very complicated. Many genes and environmental factors are involved."

Carl Forbes also reacted to a question about the possibility of knowing the consequences of one's actions and, in particular, the consequences of choices done in breeding. He stated: "You can never predict one hundred percent the consequences of what you are doing. But did breeders earlier on know what they were doing when they were selecting for more milk production?" He elaborated on this a little later in the interview: "But what I don't understand is this: why do we have these discussions now? These questions were not discussed earlier on in relation to classical breeding. It was never discussed when we selected on the basis of phenotypes — but we didn't know what we were doing then either. I do not understand why society did not ask these questions earlier on, in relation to classical breeding ... The kiwi fruit is a nice example. There we have a complete mixing of genomes, but nobody asked whether that was safe. In the new ways of breeding we are able to select for one single DNA variation, and then society says: 'You don't know what you are doing'."

Carl Forbes was asked in which context he had been presented to that sort of criticism, and he also — as did Allan Innes — referred to groups of breeders. He said: "I was presented to it in a working group that was linked to the scrapie project, and earlier we have had the the same kind of discussions on recombinant DNA. People in the working group worried about bio-diversity — the farmers, some breeders did so. They argued that while selecting for one thing we might throw away something useful, and that there may be unexpected consequences in the long run ... I visited several small sheep breeding organizations. They were concerned about the risk of BSE and their own responsibilities as breeders. I said: We have one solution, but I cannot guarantee that the only effect on the animals will be that they become unsusceptible to scrapie ... These discussions will become much more difficult in cases where the goal is only to secure the profit of the producers."

3.1. The assumption and ideal of precision

Some of the interviewees seemed to share an assumption that precise, scientific knowledge of a growing amount of components may be put together in order to approach precise knowledge about the whole and about interplay — thus facilitating an ability to foretell consequences and to separate positive and negative qualities of traits." This appears to be *an assumption that science should be seen as the means to meet the condition of (scientific) uncertainty*.

Allan Innes argued: "By means of genetic knowledge we are able to distinguish between many single components. The vision is that it could become feasible to sort out what has negative effects and, thus, that our ability to compare negative and positive aspects could be improved. I believe that, other things being equal, it will improve the foundation of breeding. It must lead to improved conditions for effectivity." Allan Innes also said: "Even though complexity is boundless, we are learning all the time. What we need to decide upon from case to case is how much we need to understand in order for action to be warranted. It is a good question — how much we have to understand."

Carl Forbes argued along similar lines: "The idea is that we will be able to do more things simultaneously — selecting for one trait, but avoiding at the same time to reduce the welfare of the animal. We will be able to measure many more parameters at the same time — thousands or tens of thousands of variations."

It should be remembered, however, that none of the interviewees denied the existence of a fundamental, scientific uncertainty. Rather, the striving for more precise, scientific knowledge of components appeared to be seen by some as the best, but still imperfect, remedy to the condition of (scientific) uncertainty. A direct discussion of the topic would probably show varying degrees of optimism regarding this strategy, and different opinions on whether and how it might be combined with other strategies.

3.2. Moderation as imposed by nature

Several interviewees argued that complete effectivity would not be feasible anyway; that technological effectivity would be defeated by nature fighting back and, thus, that moderation is in fact already imposed by nature.

Ian Andersson was posed a question about breeding based on genomics and the possibility of eradicating traits like susceptibility to a particular infectious disease in pigs. He answered: "I don't think it would be possible to eradicate such traits completely. It would be possible to improve the resistance of the animals, and it would help the economy for as long as it lasts, but then the virus would adapt, and in ten years time we would have to do something about it again — and in the meantime we would have discovered new things about it." He also said: "We always try to make things as good as we can, but it very rarely happens that you can eradicate something. It would actually be very difficult to do." Reference was made to the proposed principle of moderation, indicating that researchers and breeders should not try to eradicate traits completely, and Ian Andersson was asked for his opinion. Would he be in favour of such a principle of moderation, or would he find it to be unnecessary, because complete eradication would not be possible anyway? He responded: "If there is a pathogen which kills 80 percent of my animals, and if I find ways of getting rid of the animals that carry the pathogen, then I would get rid of them. But I would have to know that it might come again and, thus, I would have to know more about it, and I should keep records and samples, if possible." Should this be taken to mean, Ian Andersson was asked, that he expected nature to put restrictions on the effectivity of technologies? He concurred. Subsequently he was asked whether it was correctly understood that he, as a researcher, while aiming at gaining control over nature, was at the same time fascinated by the fact that he would not be able to gain complete control? He answered: "You can only get temporary control. Honestly — if we had been able to get complete control, then we would have done so a long time ago. We get temporary control, and then we have to start again. I think that this is one of the reasons for the existence of research."

Allan Innes made a somewhat similar argument: "I don't think that anybody is planning to eradicate some traits completely. [...] Nobody would try to do that. It would hardly be feasible, either. But it is probably realistic to imagine that the first generation of genetic markers for disease resistance could be brought into use quite rapidly. Things might move too fast. It would be unwise to act on the assumption that we understand the general picture, and to clear the populations for all those animals that were unwanted in that particular respect. It is difficult to talk about this in general terms, because it also depends on the particular pathogen in question." Allan Innes also argued that it would hardly be possible to force researchers into delivering unripe technology: "It just doesn't work if you go out with something prematurely. At the very most it may result in problems of ineffectivity."

Benny Hamilton was asked whether it would be possible to completely eliminate traits that, for instance, make chickens susceptible to salmonella. He answered: "That would not be feasible. It would be fantastic to eliminate salmonella, but it is not realistic. But it will be possible to reduce the incidence a lot."

Carl Forbes was asked a similar question and responded: "[I]t would be impossible to select for animals that are completely unsusceptible to salmonella ... we are not talking about the creation of new kinds of animals, but only about how to find ways to select the best variations among those that already exist in nature."

3.3. Moderation: consensus and disagreement

It is the overall impression of the CeBRA team that the interviewees — and, presumably, the other scientific researchers participating in the network — might, as a group, consent to a principle of moderation as a supplement, rather than an alternative, to the scientific strategy of seeking more

precise knowledge about components, and to natural barriers that may impede the effectivity of technology in ways not possible of being foretold.

There is general agreement that uncertainty is a fundamental fact of scientific endeavours, and none of the interviewees rejected the claim that technological options might be acted upon too rashly. Rather, the possibility of such action was treated as one that deserved serious consideration.

Moreover, the widespread reluctance among the interviewees towards genetic engineering and the production of transgenic animals appears to a large extent to be founded upon an acknowledgement of the uncertainty of the consequences of technological action.

Benny Hamilton said: "I cannot say that we should never go down that path. I'm not against it for religious reasons, but doing it on the basis of what we know now — it is so rough. We know far too little. And it is also important how people think and feel about it. This is related to the intrinsic value of the animal ... There already exists so much variation that we *can* use at the moment."

The acknowledgement of uncertainty was linked to the absence or presence of worthy purposes. Thus, both Dan Edwards and Ian Andersson argued that the purpose of the uncertain endeavour of producing transgenic animals would have to be more worthy than for mere gain. Ian Andersson reasoned: "As to transgenesis, it is my opinion that it should not be used in Europe, because here in Europe it would only be about making more or less money. The use of transgenesis or cloning here would only be about improving production. I find that immoral — if there is no other purpose than to improve production. There might be reasons, though, to use it in other countries — in Africa, for instance — where there is a lack of food, and where there is a real need to increase production. Moreover, there could be a purpose of improving human health, of providing better medicine. That could be a very strong reason to investigate these things, and the use of genetically modified animal models could be helpful."

4. A principle of openness and sincerity

A statement about a principle of openness and sincerity might well be seen as — and, indeed, become — no more than an empty gesture, imitating sincerity rather than enforcing it. This risk has been reinforced by the present PR culture which has also invaded the world of science: information activities that are directed in a simple and straightforward manner at image-building neither inspire trust nor feelings of responsibility. Rather, they inspire suspicion and cynicism, at the receiving as well as at the remitting ends of the lines of communication. The merely instrumental use of references to norms about openness and sincerity — norms which are, as argued in the first report on ethical and societal challenges, crucial to trust — would be likely to intensify suspicion and cynicism in the general public and among researchers.

Therefore, *the network is presented with the challenge of demonstrating openness and sincerity about being open and sincere.* In order to do so, the principle must be spelled out, interpreted and put to use in relation to specific issues and problems. Moreover, a willingness to engage in discussions concerning substantial disagreement would be a forceful way of practising and demonstrating openness and sincerity. The latter variety of openness — indicating a willingness to open oneself to the perspectives and views of others — can be seen as the most radical and the most demanding kind of openness. It should be remembered, however, that it also carries the most far-reaching possibility of reward; that is, the possibility of widening the horizons of oneself as well as those of others on issues of common concern and consequence.

4.1. Openness about disagreement and uncertainty

As argued above, *openness towards engaging in discussions that include substantial disagreement may well be seen as the most demanding and, potentially, the most rewarding variety of openness.*

The existence of substantial disagreement among citizens is one of the conditions of public, political discussion in modern society. The purpose of politics may, indeed, be described as the civilized management of disagreements and conflicts. Showing themselves to be ready to recognize this condition of political discussions on how to act, scientists provide a place for themselves in such discussions — not as knowers who know for certain and without doubt, but as informed and specialized citizens. It is, however, a precondition for such openness that the existence of substantial disagreement is recognized as a feature that characterizes not only wider society, but the scientific community as well. Otherwise, the widespread assumption that scientists should be seen as a block that confronts the public at large (another block), and that substantial discussion is alien to science, would likely be reinforced.

Internal discussions among scientists — and thus within the network — about substantial disagreement can be seen as a proper training field for participation in public discussions on the purposes and uses of animal breeding technologies that are based on genomics. It should be noted that such discussions, internal as well as public, would be likely in a longer perspective also to affect, in ways that cannot be foretold, the actual, scientific research.

Against this background, attitudes towards the issue of substantial disagreement in general, and among scientists in particular, is of interest. Some knowledge of this has been provided by the interviewees.

Benny Hamilton, for instance, responded to the cue of disagreement among scientists by saying: "There is disagreement among scientists about how to use the knowledge we produce; which steps to take on the basis of our findings. Some scientists are very eager to move to the production of transgenic animals. We are more interested in using the knowledge to select animals for breeding. That is a difference of opinion."

There is actually, as will be seen from the present report as a whole, disagreement on a whole host of other issues that are relevant to the research of the network. It is, in fact, a far from homogeneous group.

The statement made by Benny Hamilton points to the existence of a willingness to recognize the existence of disagreement among members of the network. On the other hand, other statements from the interviewees indicate that there is also a tendency to feel alienated from political discussion, because such discussion is conditioned by the existence of substantial disagreement. There is a tendency to shy away from disagreement proper, and to regard such disagreement as the breeding ground of unsolvable, war-like conflicts.

Dan Edwards, for example, used the terms 'communication' and 'accept' as intimately linked. He argued "We must communicate with society, with consumers, industry and so on. We will not experience any progress in communication and acceptance unless we actually meet and talk to one another." He was asked whether it would be correct to say that he saw the aim of communication with the public as one of persuading people that he and his fellow scientists were doing the right things, and he responded: "That is part of it, but we also have to learn to become more modest and more transparent ... We use challenge tests on animals when we do experiments. It is painful to the animals concerned. It hurts them. We do so in order to be able to make more healthy animals, but we have to be honest about the dilemma: To reach the honorable aim of making more healthy animals, we have to do bad things to animals." Dan Edwards was asked to comment on the possibility that communication may disclose disagreement rather than result in acceptance. Disagreement is a fact of life, it was argued. He responded: "That is correct, but some times people think they disagree, but the disagreement is not real — it is due to misunderstandings. Many people misunderstand what scientists from the field of animal genetics are doing. They believe that we are doing terrible things. Such misunderstanding is an obstacle to communication and acceptance. But it might occur that people actually knew what we were doing, and they still disagreed. For instance

they might disapprove of the selection strategies of animal breeding because these strategies include routines of letting some of the animals die. But breeders have always chosen among animals. To disagree on that would be real disagreement, and I don't think we can do much about that. But we can at least make sure that we communicate well."

As elaborated upon in the section discussing a principle of moderation, none of the interviewees denied the existence of scientific uncertainty. Does this indicate a willingness also to be open about uncertainty, recognizing that scientific uncertainty — including uncertainty about the consequences of technological actions — is a common condition for all citizens and thus provides a common field for discussion?

Openness about uncertainty can be viewed as a possibility for scientists to get out of the isolation of 'The Expert', lose the impersonal authority of 'pure' science, but at the same time gain personal authority and trust.

Quite another perspective on openness about scientific uncertainty was, however, voiced by one of the interviewees in particular. Thus, Fred Carey expressed unease concerning the prospect of openness about uncertainty. He argued: "Scientists have become almost victims of the way the media work. Openness about uncertainty could easily end in the conclusion that 'these people do not know what they are talking about' ... If I talk to farmers, knowing there is ambiguity to our results — there is much variation in our results as regards resistance to nematoids — I would try to make the advice consistent with the ambiguity. I will say, then, that we believe that this or that works pretty well most of the time." To the question of whether direct reference was made to scientific uncertainty and ambiguity, Fred Carey answered: "I don't say directly — 'well, there's a lot of ambiguity here.'" Why not, he was asked, and he responded: "It would be discomfiting and unconvincing, I guess. There should be a clear message. If you started getting mixed messages, support would evaporate rather quickly. As a society, we want quick, simple messages."

The latter statement leaves an open and very tricky question for further reflection: who does, in fact, crave for quick, simple messages? The public at large? Politicians? Scientists? All of them? None of them? Some representatives of all groups? Moreover, it raises the question whether a principle of openness and sincerity can be combined with a practice of discretion concerning scientific uncertainty?

4.2. Openness about basic assumptions and moral values and ideals

Substantial disagreement discloses itself, as a rule, as disagreement on specific courses of action and/or on interpretation of events. Digging a bit deeper, though, one is likely to find that such specific disagreement originates in differing basic assumptions — beyond the possibility of proof — about how things are.

Specific, substantial disagreement also originates in differing moral values and ideals — somehow related to the aforementioned assumptions — about how human beings ought to act, and how things ought to be. In order to come closer to the identification of the substance of disagreement, therefore, there is a need to be as open as possible about assumptions, values and ideals. This is a very difficult task because everyday actions tend to be characterized by unawareness of such assumptions, values and ideals, and to originate in them rather than to subject them to inspection.

The present report builds on assumptions, values and ideals about, for instance, public, political life. It also presents a whole range of other assumptions that originate from the interviews. Two examples are the assumption and ideal of scientific precision, as referred to in sub-section 3.1, and the assumption that moderation is imposed by nature, as referred to in sub-section 3.2. Other

examples appear in the following sections of the report: Sub-section 5.1 discusses the assumption that application and commercialization should be seen as two words for one phenomenon; Sub-section 5.3 discusses the assumptions that there are no conflicts of interest between breeders and farmers on the one hand, and farm animals on the other, and that economic interests must rule; Section 6 discusses assumptions about society, politics and public discussion. All such assumptions may be discussed —and perhaps modified by the recognition of disagreement — as is the case with the following examples of assumptions that are not mentioned elsewhere in the report.

It is at the same time an assumption and a moral value and ideal — with far-reaching consequences for scientific practice — that economic and material growth should be seen as the most important, societal goal, and that the most important purpose of science is to serve that goal. According to this assumption, every new piece of scientific knowledge should be seen as a sign of progress because it is assumed to carry the potential of technological development. This political conviction is widespread — and contested — among politicians and among members of the public at large, scientists included. It also appeared among the interviewees from the EADGENE network.

As part of an exchange on patenting and confidentiality, Allan Innes was presented with a remark about traditions for celebrating knowledge as a common good. He responded: "Some times the common good may be served by the protection of information. Otherwise it might become difficult to get research funding, whether from national or from commercial sources. It is in our interest as a society that research can actually take place. A precondition for this is the existence of risk capital."

Carl Forbes argued: "The combination of public and private money has resulted in an enormous growth of new knowledge. In the end this is positive for society. And it is a condition for the development of new products that are safer and cheaper."

Dan Edwards was asked whether he found that 'more research' should be seen as a good thing in itself. He answered: "I do. But it should be good quality research, properly checked and validated." Asked why he found research to be important, he said: "Without research we would have stayed in the middle ages. Electricity. Vaccines. Progress. A better quality of life. Many things came from science."

Earl Doolittle argued along the lines that critique of an ideology of growth is dangerous. He commented on public discussions on biotechnology: "Public opinion has been misled. Risks have been exaggerated — and scientists have, in fact, been co-responsible for the focus on risks. At a scientific meeting in the US in the early days of biotechnology, scientists themselves talked about 'playing God', and about transferring 'dangerous genes'. In exaggerating the risks, these American scientists raised their own value and significance, but ... Many members of the public don't understand the basics of genetics." Earl Doolittle then referred to "a science horror show, made many years ago, about 'the cloning of genes'. Comparisons were made between gene cloning and nazism, but the show itself was actually propaganda that used effects similar to those used in nazi propaganda. Public opinion has been poisoned for decades." To the question "poisoned by whom?" he said: "A minor fraction of society. The book from the Club of Rome about 'limits to growth' was a very dangerous book. Then, a few years later, we witnessed upheavals against nuclear power. There was Harrisburg and Chernobyl. Public opinion was marked by distrust regarding the application of science. Fears were raised. It was very neurotic."

Other examples of assumptions that popped up during the interviews, are assumptions about science.

One of these sprang from questions about the temptation to over-sell potential outcomes of research. Statements about this frequently moved along lines that under certain conditions scientists might be tempted to promise to realize some technological endeavour *faster* than it could actually

be done. Confidence was expressed that the routines of peer review would be a remedy to such over-optimism. The possibility that scientists — including reviewers — might hope for and promise to do something that simply transcends the abilities of science, appears to lie outside the scope of these statements.

Greg Gladstone did not, however, fit into the above scheme. Rather than sharing the above assumption, he made the case that there is a tendency to promise *too much*. To the cue of overselling the potential outcomes of research projects, Greg Gladstone said: "They are tempted to do so in order to justify the enormous amounts of money they are using. But the data are in contradiction with the technology claims ... When I began to work in the field of genetics, the human genome was assumed to contain somewhere between 70,000 and 110,000 genes. Today, however, it has been found that it contains no more than about 30,000 genes — no more, actually, than a small worm. This tells us that problems related to human diseases are *not* simply effects of genes. Rather, they are caused by complicated relationships between genes and other factors. Nevertheless, we see a continuation of the claims that gene technology will be able to solve all sorts of problems. It is because they have to feed the platform [a platform of united scientific and commercial actors in the area of gene technology]. "

The last example of assumptions from the interviews to be mentioned here is the assumption that it is somehow irrational, from a scientific or an economic point of view, to take an interest in the individual farm animal.

Fred Carey was posed a question about breeding traditions and whether breeding for disease resistance was a new strategy? He responded: "The idea has been around for a long time. It is far from new. But the recognition that it is actually possible to do something focused about it is rather new, and as late as in the 1990s only a very limited number of diseases was mentioned in literature — for instance Marek's disease in chickens, mastitis in dairy cattle and nematode infections in sheep." Was it because of a lack of knowledge, Fred Carey was asked. He answered: "I don't think it is as simple as that. Rather, I would point to a variety of reasons. One reason is that it is quite difficult and expensive to select for disease resistance. Another reason is the division between veterinarians and animal scientists. Veterinarians work with animal diseases, while animal scientists are oriented towards livestock production. Traditionally, there hasn't been much contact between the two groups." This statement led to an exchange about different attitudes towards animals among veterinarians and animal scientists respectively. Fred Carey said: "Animal scientists tend to think in terms of animal populations. They are interested in the performance and efficiency of a herd, a flock of animals. Veterinarians are more interested in the individual animal, the individual case." A little later he elaborated on the differences between the two groups of professionals: "When doing research, veterinarians normally use fewer animals than animal scientists do. The latter would say that often too few animals are included to make the results sufficiently robust." Do animal scientists tend to alter their parameters when working with veterinarians, Fred Carey was asked. He responded: "The underlying parameters remain constant. They is a central dogma upon which the profession is based. For example, it would be a compromise to accept the use only of a small number of animals. It would be very dangerous. But research might include more detailed measures of the health and diseases of animals."

Harold Brix argued from the point of view of economic rationality: "We cannot afford to have personal treatment of each animal."

Greg Gladstone, on the other hand, was unhappy with that sort of rationale, stating (while referring to a specific disease of pigs): "The individual animal has no value. If you want to combat a disease, then you can just kill all the animals. Afterwards, there is no interest in research that is aimed at developing a vaccine ... There is a different attitude to racing horses and pets. I don't know why. It is not easy to explain." To a remark that he seemed to be uneasy with the way of thinking

that informed political decision of the above kind, he responded: "The reasons were economic. We tried to use science to fight the disease by developing a vaccine, but that is, of course, not interesting when you can choose just to kill all the animals, not only on the particular, infected farm but on all farms within a radius of 3-5 kilometers. That is an effect of only thinking about the animals in terms of 'population' rather than as individual animals."

4.3. Openness about relations with vested interests

Currently, one of the main challenges to the scientific community is that of developing norms and routines for responding to the existence of vested interests within the world of science; that is, norms and routines that do not reduce science — de facto, and to the public eye — to a handmaiden of vested interests, thus inspiring doubt about the value and ideal of science as a servant of the common good. Due to its structure of mixing scientists and breeding companies, the EADGENE network is faced very directly with this problem.

One way of facing the challenge is to formulate and stick to a principle of openness about relations with vested interests. Specifically, a rule might be decided upon that there should be no confidentiality clauses on publicly funded research.

In order to prompt reflection on the relationship between scientific researchers and commercial interests, an anecdote was presented to many of the interviewees. It was about a coincidental meeting with a British customs' officer who reacted to the cues of 'journalism', 'science' and 'gene technology' by stating that he 'respected anthropologists and archaeologists who had to make do with small, publicly funded budgets while working with very complicated problems', but he was rather less enthusiastic about researchers from the field of gene technology, expecting them to be 'in bed with big money'. The interviewees were asked to comment on the anecdote. Marked differences of opinion were expressed.

Benny Hamilton said: "In the news we hear about pharmaceutical companies and seed companies and patents and pricey products. I can understand why people might react to it, but in general, research at universities is available to the public ... It may be a concern in some fields, though. I don't know."

Carl Forbes responded: "Ten years ago, big science still took place at the universities. That is not the case any more; not in genomics at least. It is dependent on the availability of huge amounts of money ... It is not a coincidence that the sequencing of the cattle genome has, to a large extent, been paid for by Texan money ... Pharmaceutical companies profit a lot from the availability of information on the human genome ... I think that we — in our country and in Europe — should use not only private money to fund research. Rather, we should use public and private money together to ensure that as much information as possible will be accessible in the public sphere." Carl Forbes was also asked to ponder whether a climate of suspicion is likely to evolve in relation to biotechnology because of links to commercial interests. He said: "It depends on the scientist ... The sequencing of the yeast genome was done for private money, but the information was placed in the public domain ... Science could probably not have done the job without private money ... We are talking about a two-edged knife. It is a difficult discussion."

Dan Edwards' immediate reaction to the anecdote was a question: "Did he think that we don't do interesting observation in genetics? Or was he afraid of genetics?" Asked to consider the anecdote as an example of a reaction to science, linking — perhaps even prostituting — itself to powerful commercial interests, and deviating from the ideal of knowledge as a common good, Dan Edwards responded: "We have had some discussions about the responsibility of doing public research. A group of researchers started a spin-off company. They did not become popular. They were criticized for prostituting themselves, as you say, in order to make money out of their research."

It has been a big discussion at the institute whether it should be made easier and more common to create such companies. The same critics argued that it shouldn't. They thought that we should only work for science and the great public good. Others asked what was so very wrong about it. They argued that if some researchers were clever and found a way to make money — money that could even be used to fund more research — why shouldn't they be allowed to do so? ... People are now travelling around in Europe and they see things that they haven't seen before, and they come back with new thoughts ... Personally, I don't have a clear-cut answer. I think it is a problem to do scientific research only for money and forget about science as a search for knowledge. But, on the other hand, if you can use the money to fund more research, then why not? There is, after all, no reason to do research, if there is no application of the result."

During the interview, Dan Edwards also stated, while referring to the production of transgenic animals: "We would not be able to foresee the consequences that at the moment are that small, but very wealthy groups would invest in such enterprises."

Earl Doolittle found the anecdote repelling and argued: "The times are gone when we could do research in an ivory tower. Society has a right to ask for revenue from the money spent on public research. Money is earned by companies. Governments can only spend money that has been earned by companies. If companies don't earn money, we won't have any money to spend. Who else should pay?"

Ian Andersson reacted to the anecdote by pondering briefly before saying: "It is not so wrong, unfortunately." Had he himself, as a researcher in the field of biotechnology, experienced reactions like the one presented in the anecdote, he was asked. He said: "I have no experience of it as a person, but you can feel that it is unpopular. You can just look at what has been presented in the media about human cloning, for instance. There is distrust. And the distrust is not without reason ... Compared to ten years ago, we have today, I think, a lot of proof that GMO's are basically healthy, but we should remember that we didn't have that evidence ten years ago. At that time we said that everything was just fine — but actually we did not know, and people were aware of that ... With genomics we are opening a jar. You can pretend that you can handle it, but you cannot know for certain ... Moreover, I also think that distrust has increased because there are today a lot of commercial interests in science. I can understand why people are distressed. There are real problems which are related to the subject of biotechnology itself. The media do not help, but they are not the origin of the problems. Neither are the scientists to blame. It is the subject itself that makes a lot of mess."

Greg Gladstone was inspired by the anecdote to make a critique of the pursuance of self-interest linked to commercial interests in the field of gene technology. He said: "I don't think that we will be able to solve any important problems simply by means of gene technology. Genetics is only part of the problems. But when geneticists try to get funding, they will attempt to persuade the government and the public that genetics is actually able to solve all sorts of problems. 'We will solve the problems of Alzheimer's and so on' ... The background is that genomics is becoming more and more complicated and costly, with bigger and bigger research departments, with more and more people involved, and with more and more costly instruments and devices involved. Thus, a platform has evolved, consisting of a large group of researchers and companies." Was he implying, Greg Gladstone was asked, that it has become a purpose in its own right to keep this new platform going? He answered: "That is my point. And behind all this, you find the science, the research ... To justify the enormous quantities of money that are put into it, claims are made that we will be able to solve the problems of cancer, of Alzheimers and so on."

Harold Brix responded to a question elaborating upon the point of the anecdote, about what scientists might do to avoid the suspicion that they have been bought by vested interests. He answered: "It is much easier in public institutions. There is greater transparency. We have to write

our project proposals, and then they must be evaluated by peers in order to secure that only sound projects get funded. That is one part — transparency. Another part is that we have to consider, as a society, whether some small steps forward in knowledge are worth the costs, because huge investments may be needed in order to take such small steps. This is also relevant to the field of medicine. I will try to construct an example out of the blue: If you managed to make something that would slightly improve the life of Parkinson's patients, but which would be very costly to do so — wouldn't it be better, then, to use the money to vaccinate children?" A little later in the interview, Harold Brix expanded upon the latter question by stating: "But generally speaking, wouldn't it be right from case to case to look into the numbers of persons being helped, or to try in some way to measure improvements in the quality of life? How could we do this? What should public health systems do? These are important issues for discussion." A comment was made by the interviewer that animal production and agriculture in general are not public, but private systems, and to exemplify, a reference was made to the small group of very large companies that dominate the breeding of chickens. Harold Brix responded: "Things do differ in Europe. In my country we still have national selection programs for the breeding of many different farm animals — pigs, cattle, horses and so on. Not in poultry, though, because of the existence of those huge, international companies. But we are fighting for the survival of the other, national selection programs." While discussing these issues, Harold Brix pointed to them as aspects of a larger, societal challenge concerning the relationship between money and knowledge.

Many of the interviewees had more or less made up their minds concerning the issue of confidentiality clauses in relation to research funded by private companies.

Allan Innes was a bit ambiguous, though, arguing about confidentiality and patenting: "[I]t should be kept in mind that patenting provides opportunities for publication. I prefer that to a practice of hiding one's hand. I believe that fewer initiatives — beneficial to all of us — would be taken if all information was simply free and available to everybody ... I'm aware that this is an idealistic view on patenting."

Benny Hamilton, having cooperated with a major breeding company for 15 years, found confidentiality claims to be unproblematic in practice. As a rule he found that such claims did not present an obstacle to the publication of findings of relevance to fundamental research. He also argued " [T]here is a lot of openness in biotech research at universities, though it is, of course, not complete. Some confidentiality is needed in order to get sufficient funding for research, but it is still possible to be independent. I am not working *for* the company. I have my own interests ... This is about not compromising on what you are doing."

Dan Edwards said: "We have trapped ourselves by cooperating with private companies. Some of us are really publicly oriented, and we want to publish in journals that are open to anybody. But we also want companies to invest in research, and they want some confidentiality. So we are a bit trapped. But the final results should be accessible — otherwise, our work could not be put to use." Referring to a specific project, the question was asked whether it should be seen as a public or a private project. The project was funded by public money and involved scientists from public institutions, but it also involved private companies. Said Dan Edwards: "In my view, such a project should be seen as a public project. In so far as it succeeds in developing new tools that would have been very expensive to develop without the cooperation, solutions will have to be found regarding who should pay how much for using them. Society gains from having the tools developed. Participants in the project should, perhaps, be granted the advantage of paying less than others for using them." Asked about the possibility of patenting the tools, he responded: "In that way we would block ourselves from cooperation with the rest of the world."

To the remark that amazingly few scientists have taken part in the European discussion on patents on genes, animals and plants, Earl Doolittle said: "If I were working in a private company, then I would fight for protection of intellectual property rights, but I have always worked for public money. That is the reason why I want to be able to make my research results public. I'm paid by the public. I'm not in favour of extending confidentiality about research results into public research institutions. I wouldn't like it. Not in my position. On the other hand, how many patents we are able to get is a criterion for us as a research institution."

Carl Forbes argued: "New knowledge developed in EU network projects should be publicly available." He responded to a remark that there may be disagreement on this in networks: "At least the knowledge should be owned by the members of the network when it has been generated completely by means of EU money. But that is the problem of network projects — that they build on current research and on research groups that have many different links. Still, as a rule research done for public money should be publicly available."

Fred Carey was asked whether commercial funding came with or without strings attached as regards publication of results of research. He answered: "Money from breeding companies will come with strings attached, but the strength of the strings depends on the kind of company. As a rule, you will not be asked to keep results confidential when funding comes from sheep breeders, but it is different with pig breeders and aquaculture breeders." Asked about differences between sheep breeders on the one hand, and pig or aquacultural breeders on the other, Fred Carey explained: "[S]heep breeding is not highly structured, and there are many small breeders, while pigs and aquacultural species are bred by big companies that are competing on a global scale." He was also asked how demands for confidentiality are put into practice. He said: "There will be a collaboration agreement between the scientists and the industrial partner. In this agreement it might be stated that everything we want to publish should be looked into by the commercial partner. In some cases, then, the scientists might be told to wait for a certain period of time. Or, perhaps, the company wants to apply for a patent and wants to postpone publication until an application for a patent has been made. This can cause problems. We are scientists. We depend on how much we publish and how much we communicate. We use different parameters than commercial companies. Their attitude is something like — 'we have paid for this research to be done, and we also have the right to keep it confidential if it proves necessary to get our money back'. But scientists do research and release the results into the public domain, believing that it will benefit the greatest number."

The comment was made by the interviewer — and not contested by Fred Carey — that publication seems to be important to scientists for both idealistic and pragmatic reasons at the same time.

4.4. Openness and sincerity: consensus and disagreement

It is the overall impression of the CeBRA team that the interviewees as a group were in favour — although not unanimously and not without qualifications — of a norm prescribing that results from publicly funded research projects should be made publicly available and, thus, that such projects should not be subject to confidentiality clauses.

Conflicting views were expressed on the issue of the proper relationship between science and commercial interests. This disagreement does not necessarily, though, have a bearing on attitudes towards a principle of openness about such relations. Rather, it is likely to result in disagreement about the purposes and aims of the research.

On other aspects of a principle of openness and sincerity, there was also disagreement. Everybody recognized the existence of scientific uncertainty, but the argument was made that such openness would be likely to give scientists a bad image, as people who did not know what they were talking about.

Regarding discussions on substantial disagreement, the view was expressed that nothing could in fact be done in the instance of such disagreement.

As to openness about assumptions, values and ideals, no such proposal was presented to the interviewees, nor was it obtained from any of them. It has been included in the present report because the series of interviews as a whole showed the existence, among the interviewees, of a range of unspoken — and to some extent conflicting — assumptions and values, that could easily lead to specific disagreements with persons of other persuasions. It is difficult to be open about such assumptions and values because they tend to be acted, but not reflected, upon. The proposed principle of continuous reflection on responsibilities — to be discussed in section 6 — has been designed to confront this difficulty.

5. Animal welfare as a research purpose and a goal in its own right

In the first report on ethical and societal challenges it was argued that the core of much public criticism of the use of biotechnology in relation to farm animals is the ethical concern that animals should not be treated merely as instruments. The proposed principle, that animal welfare should be made a research purpose and a goal in its own right, is intended to meet that criticism. The proposal builds on the assumption that an instrumental relationship does not have to be merely instrumental.

The proposal also builds on the impression, originating from the series of interviews as a whole, that *there is a need for such a principle to be stated — and, of course, to be acted upon — if strictly instrumental research aims should not be allowed to dominate concerns about animal welfare*. Thus, it should be seen as informed by statements like the following which was made by Allan Innes on the cue of animal welfare: "Everybody agrees that the animals should be well; and production animals lead comfortable lives. As soon as they start coughing they will be given antibiotics — but the overall consumption of medicaments constitutes a serious problem. The purpose of reducing the amount of medication is an important driver behind attempts to fight these diseases. Another important driver is the purpose of improving the efficiency of production."

Other interviewees provided evidence of the absence of knowledge and research on animal welfare aspects. For instance, Fred Carey was asked how infection with nematodes affects the welfare of sheep. He responded: "The welfare problems have not been particularly well stated. I have thought about it: do they suffer? It must hurt in some way, because infected animals tend to get diarrhoea and lose weight. You can see a difference in growth if you compare an infected group of sheep with a control group. On the other hand, though, some argue that a certain degree of infection could be beneficial."

Dan Edwards was asked about different varieties of salmonella infection, how they affected the animals, and how much research funding they attracted. He explained: "There is more than one sort of salmonella in chickens, and they are genetically different from one another. Some types are deadly to small chickens. Other types do not seem to cause pain to the animals. They are just carriers of the pathogens, and they pass them on in their eggs — causing risk to human beings. In current research, the carrier status is the most important, but from a chicken point of view we should, of course, do something about the other varieties. It is a little sad, but that is how it is: There is more money for research on the carrier status."

5.1. The purposes of breeding

There was general agreement among the interviewees that the purpose of the research efforts is to serve the aims of producers; that is, of farmers and breeding companies. The research was assumed to be the first link in the breeding chain, and distinctions between serving the interests of producers and being responsible for the foundations of breeding were rarely made. In effect, the overall purpose of the research efforts seemed to be taken to be one of serving private interests that could

not or should not be distinguished from responsibilities relating to the breeding of farm animals as a public affair.

Speaking about the purposes of breeding, Benny Hamilton referred to "breeding companies", and he argued: "Today, the breeding companies don't want to go back in production. We have to build on that when we are looking for ways to improve health, fertility and welfare, and to produce more robust animals — whatever that means — by way of breeding."

Carl Forbes, discussing susceptibility to salmonella in chickens, said: " We want to understand the mechanisms, the processes. We try to find the reasons by studying these chickens and comparing our findings to other findings that relate to a control group. Afterwards, the information we have obtained can be used by breeders. They can analyze different lines of chickens for variability in these genes in order to decide which lines to use in further breeding."

Earl Doolittle explained about the use of genomics in animal breeding: "Let's look at the example of a breeding bull. It is the result of selection that has been done by farmers. The bull is their treasure. By using knowledge about the bull at the DNA-level we are able to help the farmers to improve the speed and the intensity of their selection." A little later he added: "It is about helping breeders to select more efficiently."

Fred Carey said: "Most of my research aims at finding solutions to problems that farmers have."

What was the purpose of his research at the concrete level, Ian Andersson was asked. He responded: "It is to help the economy of the region, of the farmers and the breeders." Referring to an infectious disease of pigs, he also stated: "They have big losses in this region from this infection. It would be very useful to do something effective at the very beginning of the production chain." A little later he added: "We would also have liked, as part of the population study, to include investigations in relation to salmonella, but we have not been allowed to do so. The farmers say that if we prove we have a problem — well, then we are *really* in for problems, and they [the problems] will be in relation to the whole of the EU. I try to convince them that they will have to prepare for European legislation in this field, but they are hiding their heads in the sand ... But, then, they allow us to investigate *some* things. And I do understand their point of view. They might go bankrupt."

Dan Edwards stated: "Science should be used. In my case it should be used by animal breeders." He also argued: "The aim is to make production animals that are more disease resistant, and which can cope with the environment. That will reduce the number of outbreaks of disease. Thus, producers will not have to use many chemicals to treat the animals, and human beings will be protected from the secondary effects of such chemicals."

The series of interviews show a rather high degree of identification with producers among scientists. However, it also provides evidence of scepticism regarding the conventional aims of producing more and producing faster.

Dan Edwards, for instance, was asked to reflect upon the possibility of changing the basic conditions of the production animals; that is, the aim of producing more and producing faster all the time. He answered, while referring to the European discussion on battery hens and to legislation demanding that chickens should be allowed to walk on the soil, thereby coming into contact with parasites: "It is a problem that we have been losing breeds which were more resistant to disease, to stress and so on than current production animals. I know about some Egyptian chickens that are still resistant to parasites. Those traits have been lost in our European chickens of today. They are the result of selection strategies that have been aimed at fast production. Now we are trying to get the resistant chickens back into production, but it is difficult. They are great eaters, but they are not very productive. They are not even used very much in the countries of their origin. These countries

actually import the European, high productive breeds. The local chicken cannot compete productionwise. It is a little sad."

5.2. Farm animals as instruments or as more than instruments

According to the purpose of serving the interests of producers, interviewees described the animals as instruments of the producers, and the status of the animals was described as so distinctly different from that of human beings that comparisons could not be made.

Carl Forbes tried to use a human example when explaining about selection strategies: "If we were talking about human beings, a parallel might be that we would like new individuals to be like those people who are the least susceptible to some kinds of influenza — but it is a bad example because of course we cannot select human beings in that way."

Earl Doolittle was asked for how long the experimental animals have to suffer during a specific challenge test. He said: "The duration of the experiment is between 24 and 72 hours. It depends on the pathogen. I'm deeply convinced that these experiments are good and morally justified. In order to understand what is going on, we must conduct our studies in experimentally controlled situations." He confirmed that his reasoning was that some animals must suffer in order for other animals to be protected from suffering. He was asked to consider why he wouldn't — probably — reason in the same way about human beings, and he responded: "Of course I wouldn't. We are not nazis." Then he was asked to elaborate upon the reason for doing it to animals, and he said: "There is a real need to understand these chronic infections." The comment was made that the same kind of argument might be used in relation to human diseases, and the question was posed whether the difference was lying in the assumption of a hierarchy of living beings, with humankind on top of it? Earl Doolittle answered: "To me that is obvious. The world serves man. I would be stupid to deny that."

Harold Brix told about a successful selection strategy that had been aimed at avoiding a genetic marker for susceptibility to stress in pigs. The remark was made by the interviewer that the selection strategy might inspire criticism because it was aimed at adapting the animals to the conditions rather than at adapting the conditions to the needs of the animals. Harold Brix responded: "This is interesting, because some years ago I did a course for a group of high school teachers, and one of the participants argued in a somewhat similar way. He said that what we did was unethical because we took away the possibility of the animals reacting to their living conditions."

Harold Brix was asked whether he had been pondering that criticism. He said: "What is the purpose of pig breeding? The purpose is to produce meat. We cannot ignore that purpose." The question was posed as to whether the purpose of meat production must overrule all other concerns, and Harold Brix answered: "No — it is the final goal. We can select the environment and the breeding strategies in order to make their lives as painless and as agreeable as possible, but we cannot go on eternally — there are limits." Which limits, Harold Brix was asked. Economic ones? He responded: "Not only. We need a certain number of animals. Obviously, it would not be enough to have just two animals in each country. We have to operate with large numbers of animals, and this fact dictates, to some extent, the conditions. We cannot afford to have personal treatment of each animal. And probably it is not necessary, either, in order to secure animal welfare. We can use ethology. If you see that pigs behave normally, that they take care of their piglets, that they do not repeat the same movements over and over again, and so on — then you can be fairly certain about their welfare. We must aim at developing animals that can cope, biologically, with their conditions. If we don't, they will develop a stress-induced hypothermic condition that may result in a variety of symptoms; one of which is increased body temperature. Finally, they may die from it. It will be beneficial to the animals if we can select animals that do not react in this way. I know it is hard, but

we have to be pragmatic. The final station of these pigs is the slaughterhouse. Until then, we can try to make their lives as enjoyable as possible."

Some interviewees, however, expressed unease concerning the living conditions of production animals. While discussing the issue of animal welfare, Ian Andersson exclaimed: "I hate to see animals on farms. I think it's horrible. Think about sheep in New Zealand or Scotland — that's different. They live outside. Then they die — but we all have to die. But this industrial way of keeping animals is quite another thing, and I do not like it." A few moments later he was asked to reflect upon the aim of improved longevity of animals. He answered: "I would prefer to die at birth if I were a pig." Had he discussed animal welfare with farmers and breeders, he was asked. He responded: "No ... Actually they do have some programs going about animal welfare ... But I'm not in a position to open such discussions ... And they are in the midst of such a crisis — I don't think it would be helpful. You could do it over a glass of wine, but then — that is not the situation."

To Greg Gladstone, the uneasiness was related to the lack of interest in the individual farm animal: "It is difficult to value the individual farm animal. It is an instrument, more than it is a living being." To the comment that human beings have turned animals into instruments, he responded: "Yes, we have. But that is how it is." The question was posed whether he had observed a change of attitude in himself, and/or his colleagues, towards individual farm animals during experiments that provide a closer contact between the researcher and the individual animal. As part of the question, a reference was made to the often close relationships between dog-owners and their dogs. Greg Gladstone said: "I think that we have to respect the animal, but — it is difficult. We buy an animal to use it for experiments and kill it ... I don't know why we have a different attitude to dogs, but it *is* different with dogs. We do not see pigs, goats and other farm animals as individuals. It is complicated. It lies in our perception, of course."

Asked to propose a definition of the notion of 'sustainable breeding', Benny Hamilton said: "It is a buzz word, rather ... I would say that it means to go on breeding the animals that are highly productive without going backwards in terms of welfare — or, indeed, while improving welfare. It is, in other words, not only related to production purposes, but also to concerns of animal welfare, and, in some cases, about the environment. It is about looking a little bit further."

Carl Forbes was also asked to propose a definition of the notion of 'sustainable breeding'. He answered: "The definition depends on the perspective. From the perspective of a breeding company and a farmer, sustainable means that the breeding organization or the farm will thrive and continue to make money. But that is not the definition we would use as consumers. And if we take the environment into account we would have yet another definition — that there is a net zero effect on the environment. And from a societal point of view, we also have to think about the well-being of the animals." Asked to develop on the theme of the welfare of the animals, Carl Forbes continued: "It is difficult to ask the animals. As a molecular biologist I would say that it is related to health. Currently we use the term 'robust' to signify that the animals should be able to survive in many different sorts of environment; not only in a very protected environment."

5.3. Farmers and farm animals: conflicts of interest?

Do scientific researchers automatically serve the purpose of animal welfare when they serve the economic interests of farmers and breeders? Is it a reliable assumption that the welfare of farm animals and the wealth of producers go together? Are there no conflicts of interest between production animals and producers? There was disagreement among the interviewees on this crucial complex of questions.

Ian Andersson was asked whether questions of animal welfare play a role in his present research projects? He answered: "It should, in principle, be one specific, scientific branch ... I do not face it directly, but environmental factors on the farms are, of course, related to animal welfare." Was not animal welfare a parameter in his research, he was asked, and he responded: "It is not — you cannot do all things together. But in the long term there will be some effects on animal welfare. If we succeed in improving breeding, it will in the end lead to improved welfare." A little later Ian Andersson was asked whether he would say that breeding healthier animals would at the same time improve animal welfare. He said: "Yes, by definition."

Earl Doolittle was posed a broad question about animal welfare and animal ethics. He responded: "Mastitis is frequent and expensive. It causes economic problems for the farmers. Many cases are not acute, but subclinical. They are chronic infections. How would you feel if you had a chronic infection? I wouldn't want that. Moreover, more than half of the antibiotics used are used in order to prevent disease and promote growth in farm animals, but the massive use of antibiotics stimulates the development of bacteria which are resistant to antibiotics. We simply impose that selection on bacteria, and it causes severe problems." Earl Doolittle responded to a remark that these arguments referred, first and foremost, to economic aspects and to human health, rather than to animal welfare: "It would certainly improve animal welfare if we could breed cows that were naturally protected against mastitis. The farming effects and the benefits to human health would be side-effects. I want to understand nature's solution to the problem in order to make use of it. It would be good for the cows and good for the farmers. It is two sides of the same coin. The cows are in our care and we have to take care of their diseases."

Fred Carey argued upon a similar assumption — that the economic interests of producers and the welfare of animals go together — but he argued the other way around, viewing improved animal welfare as a side-effect. He was asked how nematoid infections in sheep affect the economy of producers and about the role of such factors in research. He answered: "The economic factors come in when we start advocating selection strategies to farmers. The benefits should, of course, be greater than the costs. We assume that our advice — about grazing, chemicals, and breeding — will also improve the welfare of the animals. We see such improvement as a beneficial by-product, but not as the aim itself."

Harold Brix said: "The identification of a genetic marker for susceptibility to stress has, for instance, led to selection of pigs that are more resistant to stress. These pigs will be less easily stressed; for instance at the slaughterhouse, and they are more able to cope with everyday situations. There are economic implications to this, because stress reactions lower the quality of the meat, resulting in what we call PSE-meat which is not desired by the consumers. Thus, this selection strategy improves the economy of the farmer and animal welfare at the same time."

Other interviewees assumed the existence of a positive link between animal welfare and high quality production. On this assumption, animal welfare was linked negatively to intensive production with the conventional aim of producing as large quantities as possible as fast as possible.

This was the assumption of Greg Gladstone. He said: "Pigs in the south of the country live outside most of their life. There is a natural atmosphere. They can move around freely. The farming is extensive. I think that we have to fight to make farmers in the north switch from intensive to extensive production. Extensive production is best for the animals. Today, in the south, there is a mix of extensive and intensive production. During certain periods of their life, the pigs have a good life — in certain other periods they don't." But did it count whether the animals had a good life, Greg Gladstone was asked. He said: "I think the product will be better. The instrument will work better, from the human point of view. There is a relationship between economic aspects and animal welfare aspects."

Greg Gladstone then went on to specify the differences between the south and the north of the country regarding pig farming. He pointed to "more animal welfare and more links to traditional ways of production" in the south, while in the north "the animals are like they are in jail, and there is much more pollution from pig production". He was asked to reflect upon how this might correspond with an earlier remark of his — that veterinary students in the south do not worry about animal welfare, while students in the north do. He said: "Perhaps it is because the students in the south have less reason to worry about animal welfare." The comment was made that his choice of words — for instance his remark about jails — seemed to indicate that he was uncomfortable with the way pigs are being treated in intensive production systems. He answered: "That is correct. But 80 percent of the production of meat from pigs come from the north. Thus, we have quality in the south, but quantity in the north. If we want to have more quality, we have to change not only research, but also animal welfare." Greg Gladstone was asked whether this should be taken to mean that he saw animal research and animal welfare as being unrelated, or did it imply that we already know how to improve welfare? He responded: "Research has been used to increase and intensify production. Because of that we now also have problems with welfare, with pollution and with diversity. It has been directed by economic considerations. At present, we are looking for genes that are related to disease resistance, but I don't know whether this research is aimed at improving the welfare of the animals or at making the production even more intensive. It could be both ways."

Later, referring to his earlier statement about 'traditional ways of production' in the south, Greg Gladstone was asked to explain the meaning of that expression. He said: "They use traditional breeds. And they need a lot of people in the production. And they make traditional, high quality products." Do the pig farmers in the south try to modernize, he was asked. He answered: "They do. They mix intensive and extensive production, and some of them switch to modern breeds. In the end, it might harm the quality of the product."

Earl Doolittle made a somewhat similar point when discussing food safety, stating: "If you improve animal welfare, you also improve food safety — I'm sure of that. Stress will affect the physiology of the animals and lower the quality of the food. Just think about the tasty meat in New Zealand. They have no stables there."

Some interviewees expressed doubts about the relationship between the economic interests of producers and the welfare of the production animals, but they did so without making the above distinction — between animal welfare going hand in hand with aims of making better products and higher quality, and animal welfare being in conflict with quantitative aims of producing more and producing faster.

Benny Hamilton was presented with the issue as a dilemma of animal welfare concerns versus concerns related to effective production and economy. He responded: "Fast-growing chickens tend to get heart problems. This leads to a high mortality rate. But there is variation — some groups have those problems, while others don't. The problems have been increasing during the past twenty odd years. We might reduce the growth and thus reduce the problems, but that would not satisfy the breeders. They operate in a competitive environment ... But the problem of heart disease among fast-growing chickens is, in fact, not only a welfare problem. It is also an economic problem to the breeders. On a cold night as many as 10 percent of the animals — if they are kept in the open air — may die."

Carl Forbes reacted to the speculation that the researchers might find that there are limits to the possibilities of combining animal welfare on the one hand and high production and fast growth in animals on the other hand: "It is possible. That might be the kind of information we end up providing. I don't know, but our future findings might lead to the conclusion that we cannot have

huge production together with good animal welfare ... I do not know what breeders would do with such information that we might produce."

Ian Andersson made the remark that "Classical breeding of today needs knowledge from genomics in order to breed more robust animals ... Well, they have the robust animals already, but they don't use them, because they don't grow very fast." He was presented with the comment that it might be suggested, during a public debate, that the robust, but not very fast growing animals, should actually be used for breeding and production. He answered: "Well — that would be perfect in a perfect life in another place. It would affect the economy negatively. Farmers would need support from the government. And intensive breeding would still go on in other parts of the world. Thus, we would solve one problem, but create another — that of not having enough production. But yes — I would like only to breed robust animals." Did he regard the proposal as Utopian, Ian Andersson was asked. He answered: "Yes, that is the word."

5.4. The purpose of animal welfare: consensus and disagreement

It is the overall impression of the CeBRA team that it would be difficult to obtain general support from the interviewees — and probably from other members of the network — to a principle, that animal welfare should be made a purpose and an aim of research in its own right. While quite a few would probably be sympathetic to the principle, some would be likely to argue that such a principle would be superfluous because producers and production animals have a common interest in animal welfare; meaning that researchers cannot avoid serving the purpose of animal welfare when they attend to the economic interests of producers. Others would be likely to argue that the principle would be Utopian because money must rule in the world of farm animal breeding and production and, thus, the application of scientific knowledge in this field must be dominated by commercial purposes.

To adopt or reject a principle of the above kind, direct reflection and discussion in the network on the relationship between animal welfare and the economic interests of producers appear to be needed.

6. A principle of continuous reflection on responsibilities

Far from being a mere formality, the adoption of principles on how scientific researchers, working in the area of infectious diseases in farm animals, genomics and breeding, should react to ethical and societal challenges is a serious and difficult matter. Such principles are meant to inform action, including the choice of research questions and the identification of problems and of possible solutions. Moreover, they are meant to institute norms for communication between scientific researchers and society at large. Assumptions and values among the interviewees about the relationship between science and society do, however, seem to be quite vague, and the series of interviews, taken as a whole, indicates there is, at the same time, considerable disagreement *and* an absence of habits and routines regarding reflection and discussion on such assumptions and values. This is likely to constitute an obstacle to the adoption of and, in particular, to the practical use of the principles that have been proposed in the above.

The proposed principles presuppose a certain degree of clarification as to — and cannot be taken into action without — direct reflection, in general and from case to case, upon questions concerning who scientific researchers are responsible to, and what their responsibilities are.

Benny Hamilton was asked to react to the speculation that many years of close collaboration with commercial interests might influence the way scientists are thinking and might lead to identification with those interests. He responded: "It could happen. It depends on the personality of the researcher. I can see that it might happen — but ... at our department we still have our own interest very much

in mind. It might be different in other places." Asked to elaborate on 'our own interest' he continued: "I really want to understand genetics, how genes work, how they are turned on and off, how they influence each other, and how they are affected by environmental factors."

Greg Gladstone, on the other hand, expressed frustration with the divorce between science and ethics: "We are happy when we discover something. We want to publish and, thereby, to improve the chances to obtain funding in the future. But we put the consequences of the research in the hands of farmers and companies. Ethics is one thing, science is another." As part of an exchange on the role of commercial interests in today's science Greg Gladstone was asked whether he felt trapped as a scientist. He responded: "I do. I have no opportunity to do anything about it. I can talk to students about it. I can argue that animal welfare aspects should be more important. I can point to extensive production. But in order to do something about it, I would have to convince the industry, and *they* say — 'You are foolish. You are talking about my business and my way of life'. Ethics is not regarded as relevant."

Is it the sole responsibility of the scientific researcher to uncover mechanisms in nature, or are there other responsibilities? If so, which responsibilities? A principle of continuous reflection on responsibilities should be seen as a possibility to dig deeper into such questions. Moreover, it should be seen as instrumental to the use of the proposed principles of moderation, of openness and sincerity, and of turning animal welfare into a purpose and a goal of research in its own right. That is so because the general issue of responsibilities may be translated into a series of more specific discussions — concerning the questions: why moderation? why openness? why focus on animal welfare? — that include questions of responsibility, both towards fellow citizens and towards domestic farm animals.

6.1. Assumptions about society, politics and public discussion

Exact and uncontested definitions of terms like 'society', 'politics', 'citizens', 'civil society' and 'public discussion' do not exist. Scores of philosophers and social scientists all over the world are discussing these terms all the time, and there is no reason to expect them ever to reach agreement or, indeed, to aim at such agreement. Rather, the fundamental purpose of those discussions — which are preconditioned by knowledge of the multiple facets of the concepts — may be seen as one of keeping alive a discussion of the kind of concerns that should be regarded as important, or irrelevant, in a societal context. The latter discussion is relevant to all citizens, and not only to philosophers and social scientists.

It is also relevant to scientific researchers who are working in the area of infectious animal diseases, genomics and breeding, and who are presented with ethical and societal challenges. The ways such challenges are faced depend on assumptions and values regarding society and the relationship between science and society. Thus, there is a need to know about, and to be able to reflect upon, different notions of society. *The series of interviews as a whole, though, indicates the existence of an overall tendency to regard questions about society as rather straightforward, and to rely upon ideas and assumptions that might easily be contested.*

Asked to clarify his use of the term 'society' Allan Innes explained that he was hinting at "the politicians".

In a digression, the definition of 'society' entered the conversation with Carl Forbes. He was asked to explain a specific acronym. He explained that it denoted a consortium for collaboration between "government, industry and research." He responded to the comment that 'civil society' seemed to be left out by arguing: "As I see it 'civil society' is represented by 'government'. Governments are elected."

To Dan Edwards, the notion of the consumer was crucial, and he hoped that market forces would 'determine' in favour of animal welfare. A question was posed to him about consequences to production animals if the aims of research and breeding remain unchanged. A reference was made to a former interviewee who found that it would be much easier to breed healthy animals if they could be just a little less productive. Dan Edwards was asked to comment on this. He said: "This takes us back to the role of the consumer and the question of whether consumers will accept paying a little bit more for a quality product. We have fast growing chickens in our country. They eat and grow very fast, and then they are cut into pieces. They are very cheap. But we also have another kind of chicken. They are slow growing, there are rules about their minimum life span, they are allowed space to move, and so on. The meat from these latter chickens is definitely more tasty. Personally, I never buy the cheap ones, and the expensive chickens have found their place in the supermarket. They are more expensive, but they are also of a better quality, and there is a place for them. But one should, of course, acknowledge that not everybody will be able to pay the price."

To the question whether this should be taken to mean that the welfare of chickens was the private responsibility of consumers, Dan Edwards responded: "Yes, because we have seen that sufficient numbers of consumers have been willing to buy the expensive chickens and thus to support that kind of product. These consumers are actually supporting the production of those chickens." Asked about the responsibilities of the huge companies that produce broilers for the global market, Dan Edwards said: "We have been in contact with them because they are interested in getting animals that are more resistant to disease. I don't know why they are interested. It may be because they are sensitive to animal suffering. It may be because they think they will be able to use it for PR purposes — by stating that 'our animals are healthy'. All I know is that they have shown some interest. We have made it clear that it will cost money to invest in the new methods of breeding. It is not cheap. Now they will have to consider whether investments in the new techniques are likely to pay off. They have not decided yet. It is up to them. And again: communication is important. If they can argue that consumers should buy their chickens because these chicken are more healthy, then they might find the investment worthwhile."

Earl Doolittle was inclined to speak about 'the taxpayers': "We provide the farmers with better criteria for selection when we characterize genes. That is what the taxpayers are giving us money to do." Referring to the terms 'farmers' and 'breeders', Earl Doolittle was asked to consider who the actual users of research results were. As part of the question a reference was made to the production of poultry where breeding is concentrated in three or four huge companies, working on a global scale. Were there conditions of a similar kind in the cattle sector? Earl Doolittle answered: "Probably, but honestly — I simply don't know. I'm paid 100 percent by different public sources. We do basic research with a focus on application, but we are not funded by the users."

The term 'politics' was used by interviewees in ambiguous ways, and conflicting ideas about the relationship between science and politics were aired.

Earl Doolittle was asked whether he had taken part in the political discussion in Europe on the patenting of genes, animals and plants. He answered: "I have not taken part in that discussion. I have chosen to be a professor; rather than to be in politics."

Greg Gladstone on the one hand used the term 'political' to indicate that a decision could not be trusted. Thus, he commented on the declaration that an infectious animal disease had been eradicated in his country of origin: "It isn't true. It was merely a political decision." On the other hand, he also talked about politics in a positive sense, as something that scientists ought to engage in: "I have been involved in research since the 1980s, but suddenly the funding stopped, or at least it didn't grow at the same pace as the costs of doing research. Then we were told to look for money from private industry ... The older ones amongst us, like me, are more worried about the political

and social consequences than the younger researchers. They are more interested in results; they are professionally better prepared; in a way they are more capable ... I think they are more like scientists in the rest of Europe. All they think about is to publish, publish, publish."

The final question to most of the interviewees dealt with issues that relate to genomics and breeding, and that should be taken to the public sphere for discussion: Which question(s) would each of them choose to highlight if he or she were to set up the public agenda in relation to his or her own field of research? *To many of the interviewees it was difficult to imagine the public at large as a group of citizens who were not simply in need of scientific information, but might be asked to discuss complicated questions of common concern. As a whole, the series of interviews provides evidence of a rather low degree of confidence among the interviewees in public discussion as a democratic institution of deliberation. This is likely to constitute an obstacle to the practical use of principles that rely on the assumption that it is actually possible to stimulate and to feed into a reasonable public discussion.*

Allan Innes answered: "We are not trying to produce transgenic animals, but to make breeding more effective by using detailed knowledge of genetics. I would like to know what people think of ethical aspects of this endeavour as distinct from ethical aspects relating to classical breeding. I do not need to be informed of how scientists think about it. I know that already. They think that the possibility of reasonable action depends on how much more knowledge we have, the more the better — but improved effectiveness may come with negative as well as positive aspects. We can do things that are more useful, but we can also make bigger mistakes. Moreover, we will be in need of an ability to weigh different concerns against each other when, in the future, we come into possession of genetic markers concerning many different traits. We will be in need of an ability to prioritize."

Benny Hamilton answered promptly: "The role of economic concerns in breeding is the most important question. What I would like to know is: Could we go back a little? There is talk about animal welfare, but when we see what happens in the supermarkets ... I don't know." He was presented with the comment that 'consumer' and 'citizen' are different notions, and that one is likely to get different responses when appealing to people as consumers or as citizens — it was implied in the comment that there is a deplorable tendency to reduce the public to consumers. He responded: "But this is difficult, because we are not only working in a national context. The scale is global. Close to 95 percent of all broilers in the world, for instance, are bred by three or four breeding companies. Should one of those companies go down, then the others would be able to fill in the hole in about a year. These companies are really big, and they work all over the world." During the interview, Benny Hamilton also stated — referring to the possible future production of transgenic animals: "We should discuss as a country: What do we want?"

Carl Forbes pointed to the issue of making proper distinctions between "classical breeding, genetic modification and new ways of breeding. It is very important to show that in the new breeding, where we use genomics, we are doing the same things as we have been doing all the time in classical breeding. We need a clear distinction between genetic modification and genomics." To the comment that he had pointed to *information* that should be taken to the public sphere, rather than to *questions* for public discussion, Carl Forbes hesitated for a moment. Prompted by an example — would it be a question about the weight that fast growth in animals ought to be given in breeding? — he settled for the question of "how important is food safety? It is an important parameter to the consumer; more important than effective production, but how important is it?"

Dan Edwards answered: "I really wish that the public would not be afraid of genetics and genomics, and that we would be able to communicate that they can be well used in animal breeding." To the comment that he had pointed to a need for *informing* the public, rather than to

questions for public discussion, he answered: "You may see it that way, but it should be followed by questions about how we would do, and then we would have to answer, and then we might have a discussion."

Earl Doolittle stated: "That is a difficult question ... What is needed is real information about transgenesis. It should be discussed more openly." He responded to the comment that he had pointed to *information* that should be taken to the public sphere, rather than to *questions* for public discussion, he stated: "Let's take a look at the risks related to keeping chickens according to new rules, putting restrictions on the use of cages. The safety of these new rules cannot be guaranteed. Recently I had the opportunity to ask a well respected immunologist about the new rules and their consequences on safety. He turned pale. He had hoped, he said, not to be presented with political questions. Then he answered that politicians were acting against all advice from veterinarians in imposing these rules. There would be huge infection pressure on the animals from pathogens in the soil. There is also, by the way, the risk of cannibalism among the chickens when they are let out of cages. Sadly enough, though, the minister responsible for this is a very stupid person." To the comment that the rules referred to are EU-rules, not national ones, Earl Doolittle answered: "They may be. But then, this minister is making it even worse in our country, being one of the ideologists who are not listening to science. They are not listening to intellectual arguments." Asked whether this should be taken to mean that he would like a public discussion on the relationship between food safety and attempts to improve animal welfare, Earl Doolittle said: "I would like the discussion to focus on the question of what we are doing with our laws in relation to animals. It is easy to claim that 'I'm the good guy, I'm taking care of the chickens' — but it isn't so easy in practice ... Not to be taken wrongly: I don't want to be a chicken in a cage." It was concluded by the interviewer that the question pointed to was about food safety versus animal welfare.

Greg Gladstone said: "I would point to the issue of public versus private funding of research, arguing that the industry is only focused on making more money. If we want to use genomics for the purpose of preserving biodiversity, then we need public funding. I would make the case that we *do* have to know the genes, but that knowledge about genes alone is not sufficient. We should not promise the public to solve all problems. We have promised a lot of things that have been lies also in the project that has triggered this interview. But we should not promise too much."

Harold Brix answered: "I think there is a broad social acceptance of the use of the tools of genomics in order to improve human health. It is not criticized. Moreover, I think we would meet a similar, positive resonance regarding the use of the tools of genomics in relation to animal health. I'm not sure, however, that the same would be true regarding the use of the tools of genomics in relation to production-related traits. Probably it would be argued that we produce too much food already in Europe, and that it is not here, but in the third world, that there is a need to make animal production more efficient." The question was asked whether this should be taken to mean that the issue for public discussion would be the use of genomics to increase and improve the efficiency of animal production, and that the question would be whether there is a need to do it in Europe, or whether it would be more suited to the needs of third world countries, Harold Brix answered: "That is the question, but I'm not sure how useful such a discussion would be, because there is a clear, economic interest behind it — as has been the case regarding the use of pesticides, and that is just *one* example. I'm sceptical, because there is not a common interest. The conditions for public discussion are poor in cases where commercial interests are strong."

Harold Brix was asked whether he, himself, would regard it as the most rational decision to focus on needs in the third world as regards the use of genomics to increase animal production and make it more efficient. He confirmed: "I would. We produce too much food already. Moreover, we would have to face tremendous environmental problems if we increased food production even more. Thus, I think that rather than sending food to the third world, we should try to improve their food

production on site." Did he think that would gain public support, he was asked. He responded: "Industry wouldn't support it." What about the general public, he was asked. He said: "I don't know. Perhaps. Perhaps the public would support it if one argued that if we help people from the third world where they are, then they wouldn't come to our countries as immigrants. But then, it would not be a very honourable reason to do it just to avoid problems and to keep people away. I wouldn't call it altruistic ... To be honest, I do not know of any examples where public discussions have been able to solve problems of this kind."

Ian Andersson said: "I would like to have at least a common statement about citizens' views, a clear answer, an explanation of the convictions they have. I would like to understand what people think about genomics. We only have statistics on this, and statistics are about simple questions and simple answers. So we don't really know ... What scares people may be their own ignorance. And they don't really get the answers from the scientists." A clarifying question was asked: was he making the point that both parties — scientists and the public — need to learn something? If so — what do the scientists need to learn? Ian Andersson pondered briefly before saying: "There is a scepticism among people towards public institutions and politics. I think that science is seen as part of 'the system' — a system that is far from being transparent." Did this imply that the idea of a public debate on questions in relation to science and technology did not make much sense to him, he was asked. He answered: "A public debate always adds knowledge, so I do like the idea. But I don't know whether it would make things change."

Fred Carey responded to the remark that scientists appear to be left alone with current dilemmas relating to demands that research results be kept confidential: "The public in this country is not particularly interested in science — nor with a number of other topics for that matter. We would be met with a wall of silence if we tried to say: 'Hello, there is a slight problem here...'. Later, following an exchange on openness about uncertainty, Fred Carey said: "I don't think that the idea of engaging our society in debates about animal genomics would work. The public in this country is not interested. They are more worried about catastrophes and football." Should this be taken to imply, he was asked, that it wouldn't make sense to him to be asked to point to issues that relate to genomics and breeding, and that it should be taken to the public sphere for discussion? Fred Carey said: "I would find it a very difficult question to answer. In order to do it I would have to think quite deeply and to approach my subject from another perspective ... I have preconceptions or prejudices about where the idea of public debate on technical scientific issues might work, and where it might not work. I think that as a rule it would become more difficult the further south you go in Europe."

6.2. Application, commercialization and public affairs

Which issues and questions that relate to the breeding and production of farm animals should be seen and treated as public affairs? How should scientists treat those public affairs that concern scientific research and its applications? These questions are crucial to the EADGENE network's deliberation on how to face ethical and societal challenges.

The proposed principle of continuous reflection on responsibilities is based on the assumption that public affairs are characterized by being linked to responsibilities that are shared by all citizens. Accordingly, public affairs must be subjected to public discussion.

The principle does not specify which aspects of animal breeding and production should be regarded as public or private affairs. Rather, it challenges scientists, who are involved in farm animal research, to engage in the task of tentative specification. That might include pondering how to distinguish between private interests and common responsibilities, and — closer to the actual research of the network — whether the economic interests of producers should be regarded as the private affairs of producers, while care for animal welfare should be regarded as a public affair.

The above kind of reflection is a time-consuming task which presumes not only a certain amount of knowledge about and interest in society and politics, but also a willingness to engage in discussions that are conditioned by substantial disagreement — and the recognition that no exact and conclusive answers may be arrived at in the end.

Probably the most widespread assumption among the interviewees was the assumption that 'application' and 'commercialization' are two words for one and the same phenomenon. Thus, research was understood either to be fundamental and 'pure' or to be applied and commercial. Like several other interviewees, Ian Andersson explained: "I like to place the things that I do in a context." But to place something in a context, to do something practical, is not, in a straightforward manner, the same as to serve private interests.

Earl Doolittle responded to the comment that science, throughout history, has been revered as the producer of knowledge as a common good, and that a linking of science and private interests might be considered problematic: "It is good to serve private interests. In my understanding the common interest is that companies pay taxes — and in the end that is how we fund public research. We want, of course, to serve some users. It is different at the universities. They are seeking knowledge for its own sake, but at our institute we are committed to applied knowledge." The remark was made by the interviewer that he and his fellow researchers might be said, thus, to be "protected from private interests", and Earl Doolittle was asked whether he would agree to that description. He answered: "I don't like the word 'protected'. Taxpayers' money must serve some purpose. We should not be 'protected' from the purposes of application."

As food for thought, the proposition might be offered that even though application and commercialization go together more often than not — like sunshine and warm weather — they do not necessarily always go together. Research may be applied without being commercialized, and the practical, ethical challenges that relate to application are not covered by considerations of commercial interests. Against this background, the phenomena of application and commercialization, and the challenges arising from each of them, should be treated as distinct, although frequently interrelated.

Harold Brix actually provided an example of applied science which was not commercial in the first place. He said: "It is inspiring when you see that something you have discovered can also be put to use." Asked for an example he said: "We can choose the example of genetic diversity among fish. That kind of knowledge can be used for the protection of endangered species. I have done some work in that field, and today fish producers use our markers to produce appropriate stocking material and to preserve such species." A question was posed about why fish producers wanted to do that. Harold Brix answered: "We have a certain species of trout which is a strong attraction for anglers. The skin of this trout is marbled, the meat is slightly reddish, and it tends to grow a little bigger than other species of trout. It is an interesting trophy for anglers. It would be an economic loss not to have this population of trout."

6.3. Reflection on responsibilities: consensus and disagreement

It is the overall impression of the CeBRA team that there would be disagreement among the interviewees — and probably among other scientists related to the network — about the proposed principle of continuous reflection on responsibilities. Thus, different interviewees expressed very different views on the value of the present amount of time and money used to look into the ethical and societal aspects of the network's research.

Dan Edwards confirmed that he was in support of the EU having made it obligatory that ethical aspects should be looked into, because he was convinced of the importance of communication. He added: "It is also because it gives another dimension to our work. It forces us to

think about what we are doing in another way; not only in a scientific way. I have learned a lot from being a member of a committee on ethics in relation to experiments with animals. It is a committee of mixed membership. There are scientists, and there are sociologists — and the sociologists challenge us. I'm very busy, but I don't think it's a waste of time to use an afternoon in that way. It gives us a dimension other than the purely scientific one, and it gives us another feeling of responsibility for what we are doing. They pose questions about values, and they ask us: 'For whom are you doing these things? For yourself? For the institute? For the animals? Or what?' Then we have to think about it and to make judgements about why it is important to do an experiment."

Allan Innes was asked for an honest — rather than a polite — answer to the question of whether he found it to be a sound use of money to ask philosophers and social scientists to look into ethical and societal aspects of biotechnological research. He responded: "Yes, I think there is reason to do so, but it has also acquired an element of whitewashing. You should just include some ethicists, and then you are safe. Moreover, you [this was directed at the interviewer] may be involved in too many projects, and possibly that could dilute the effort and redirect attention from the most controversial and risky ones. In my view it would be proper to concentrate on those applications of gene technology where the risk of doing something irreversible is the greatest. It could, for example, be related to the spreading of transgenes from plants. I don't think that the use of transgenic animals as models for human diseases represents a corresponding risk. It would be quite easy to get rid of such animals, should it be wanted."

Earl Doolittle expressed a critical attitude towards the way money is being spent in many EU-funded research projects. He argued that too little money was being directed at actual, scientific research. Earl Doolittle was asked whether this criticism also, indirectly, was a critique of public money being used to look into ethical and societal aspects of research, and he was urged to give an honest answer, even though it might be contrary to his idea of politeness. He responded: "The proportions are not correct. That is my basic criticism — and many other scientists think the same. I don't have the money I need to do my research. Thus, currently I'm striving to find national money for actually doing the research. But some of the national research money has been sent to Brussels, meaning that it is even more difficult than before to get access to national research money. In effect, money is being redirected from research to other purposes."

7. Further reflection within the network

The interviewees — and, probably, the whole group of scientific members of the EADGENE network — constitute in many respects a heterogeneous group, bound together by educational background, by common funding and by shared responsibilities towards society at large regarding the breeding and production of farm animals; but deviating from one another regarding many basic assumptions, values and ideals that are crucial to the common task. Thus, in a way *the network mirrors the wider society: it has to act under the combined conditions of shared responsibilities and conflicting convictions — the latter complicating the identification of the former. It is a continuous challenge that must be faced along the road, and which cannot be sorted out once and for all, for example by a committee.*

As in the wider society, it is hard to see any other means of meeting these conditions than to engage in on-going, common reflection and discussion. The present report is aimed at initiating, by way of example, such reflection and discussion, pointing to areas of possible consensus as well as to areas of disagreement concerning ethical and societal aspects of the network's research efforts.

It is the overall recommendation of the CeBRA team that the network engages in deliberation on how to institute norms and routines that include ethical and political questions — along with technical and economic ones — in everyday discussions on research and communication efforts.

Appendix

EADGENE days questionnaire on ethical and societal aspects

At the EADGENE days, 18-19 May, 2005 in Brussels, a questionnaire — see below — on the ethical and societal aspects of the network's research efforts was presented to the participants. The purpose of the questionnaire was to support the formulation of a proposal for principles to guide the network when relating to the public at large. The questionnaire presented a series of statements, to agree or disagree with. These statements covered the topics discussed in the first EADGENE ethics report: openness, avoidance of confidentiality, animal welfare as an aim in itself, and public discussion.

Out of the approximately 50 network participants present at the EADGENE days in Brussels, only 20 completed and returned the questionnaire — which somewhat dilutes the power of the statements made. All of the respondents answered that they had a background in science. Two of them answered that they also had a background in industry. The low response rate *could* be interpreted as a lack of interest among network participants regarding ethical and societal issues; however we prefer to be cautious and to abstain from drawing conclusions from the response. It may serve as food for thought, though, that many of the respondents are, in effect, pointing to a discrepancy between what they consider to be practically feasible and what they personally believe to be the right principles.

Below, the main responses to the questionnaire are listed and some of the respondents' comments given.

To the first three issues, it was asked whether the respondent was *personally* in favour of supporting the principle in question (e.g. openness about scientific uncertainty), whether he or she would support the *EADGENE network explicitly committing itself* to such a principle, and finally, whether the respondent considered that the principle could be *practically feasible*.

(1) *relations to the public at large; a principle of openness about scientific uncertainty and ambiguity*. More than two-thirds of those who responded agreed with the statements: "Personally I am in favour of a principle of openness about scientific uncertainty and ambiguity" and "I would support that the Network explicitly committed itself to a principle of openness about scientific uncertainty and ambiguity"; whereas only half of the respondents thought that such a principle could be practically feasible. One respondent commented that "commercial interests of research become more important".

(2) *relations to commercial interests; a principle of avoiding confidentiality about publicly funded research results*. Roughly two-thirds responded that they agreed personally, and that personally they thought that the network should commit itself explicitly to a principle of avoiding confidentiality about publicly funded research results; whereas one-third of the respondents were opposed to the network committing itself to such a principle. Nearly half did not think such a principle would be practically feasible. Here, a comment was that "funding from industries for research is dependent of intellectual properties and patents".

(3) *animal welfare; a principle that animal welfare in its own right should be an aim of breeding-related research*. Approximately three-quarters of the respondents were personally in favour of the principle that animal welfare should be — in its own right, and not only as an assumed side-effect

— an aim of breeding-related research, and the same proportion of respondents thought that the network should commit itself to such a principle. One respondent commented that "science with public funds has to look for animal welfare and not only for profit". However, only half of the respondents thought that such a principle would be practically feasible. Here, a comment made by one of the respondents was that "a balance between welfare and economical factors has to be found".

(4) *public discussion; whether it is possible to have a reasonable discussion, and what the questions for public discussion should be.* Nearly two-thirds of respondents thought it would be possible to have a reasonable, principled, public discussion on the use of genomics in relation to animal breeding. Three-quarters of the respondents saw "purposes of research" as a question for public discussion; whereas half would put "scientific uncertainty and complexity" as well as "animal welfare" forward for discussion. Other issues volunteered by the respondents included "public health", "safety concerns", "benefits to society" — one respondent commented that "genomics may be a useful tool among other tools that must be used to improve the life of man". "Public awareness" and "public education" were also mentioned. One comment was that "public discussion is too much dependent of the media/information stream reaching the people".