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PROJECT REPORT 8

WHY CLONE FARM ANIMALS?

Goals, motives, assumptions, values and concerns among European scientists working with cloning of farm animals

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WHY CLONE FARM ANIMALS?

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A report from the project Cloning in Public
a specific support action within the European 6th Framework Programme, priority 5: Food quality and safety

Gitte Meyer

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A specific support action within the 6th framework programme, priority 5: Food quality and safety

Coordinator: Danish Centre for Bioethics and Risk Assessment (CeBRA)

This report is the fourth deliverable from the project "CLONING IN PUBLIC; a specific support action within the sixth framework programme, Priority 5, Food quality and safety" (Contract no. 514059).

The main objectives of CLONING IN PUBLIC are: (a) to develop recommendations on the preparation of European regulation of, and guidelines covering, research on farm animal cloning and its subsequent applications (e.g. in genetically modified animals for bio-reactors); and (b) to stimulate informed public debate across Europe on these issues involving key stakeholders, university students and members of the public. These two aims are of equal importance. They are also interrelated, because if regulations and guidelines are to serve their purpose, they must take public concerns into account. In addition, stimulating, informing and reporting public debate is part of the more general, long-term aim of improving communication between science, civil society and European authorities at different levels, and hence facilitating discussion of European public affairs connected with science and technology.

Reports on the scientific, legal and ethical aspects of farm animal cloning will be made available by CLONING IN PUBLIC. A list of deliverables and dates of their publication is available at the project website: http://www.bioethics.kvl.dk/cloninginpublic.htm.

This report has been written by Dr. Gitte Meyer from the Danish Centre of Bioethics and Risk Assessment, The Royal Veterinary and Agricultural University, Denmark. The author would like to thank the interviewed scientists for inspiring talks and their kind cooperation and Prof. Peter Sandøe, Dr. Mickey Gjerris and Centre Coordinator Geir Tveit, for assistance and valuable comments.
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1. Introduction and summary

This report is the second on the technical aspects of farm animal cloning. The first technical report concentrated on a literature review of the science behind farm animal cloning, on technological barriers and challenges, and on possible applications of the technology. The aim of the present report – which has been based on an analysis of statements obtained from a series of interviews with European scientists from the area of farm animal cloning – is twofold.

There is an aim of bringing more nuances to the topic of possible applications of cloning techniques: Which goals do the scientists have in mind? What are they trying to do? What do they consider to be realistic? Questions like these belong to the technical sphere of scientific research, and normally scientists are only consulted about such directly technical aspects of their research. The present report, however, goes further. It also presents and discusses statements from the interviewees about meta-scientific aspects of the research: What is their motivation for doing the research? What purposes do they assume themselves to be serving? Which societal function and role do they assign to themselves as scientists? What kind of concerns do they have regarding the research and its possible applications?

The fact that the latter questions are of a non-technical nature does not render them irrelevant to scientists. On the contrary. Questions of purposes are important to scientists as scientists and as citizens.

Motives and purposes, originating in combinations of factual assumptions and ethical values, form the foundation of the development of technologies by informing the direction of specific research projects that may result in specific goals and applications. As to the use of cloning techniques on domestic animals those goals and applications concern the production and use of animals, and the treatment of diseases. Thus, the motives and purposes that underlie the scientific development of technologies are precursors of action in the sphere of public affairs. That is the reason why such questions are crucial to public and political deliberation, and to decision-making, on science and technology.

To citizens, sharing in responsibility for political choices, answers to questions of *why* are at least as important as answers to questions of *what*. That is also the reason why public and political discussions on the cloning of farm animals are hampered if the assumptions and values of scientists remain unspoken; if the very reasoning that underlies specific goals and applications is not made explicit. In so far as such reasoning *was* made explicit, on the other hand, it would be likely to bridge the present gap between scientists and other citizens which is embodied in the widespread idea of a dichotomy between scientists on the one hand and lay persons on the other. That is so because why-questions do not only carry what may be seen as the disturbing qualities of being huge, amorphous and inexact, but they also carry the linking quality of being of common concern to everybody, to scientists as well as to other citizens.

By including reasoning on these questions in discussions, scientists are provided with an opportunity to enter public and political discussions on the cloning of farm animals, rather than being excluded and alienated from the discussions in an isolated, technical sphere. This should not be expected to result in the dissolution of disagreement. It would, however, be likely to improve the climate of discussions and to stimulate habits of actually listening to arguments, rather than to dismiss them in advance because of prejudice. Other citizens would be allowed to understand that scientists are individual persons like everybody else – sometimes agreeing, and sometimes disagreeing – and that they do not constitute an alien, impersonal machinery of concerted, uncompromising and perhaps frigthening technological action. The point would be made that it is actually possible to argue with science and scientists.

The present report is intented to contribute to the initial step in that direction by explicitating some of the reasoning on purposes, that lie behind research on farm animal cloning.

Seen from the outside, scientific researchers in this field may appear as a sort of consortium, rationally working to realise a specific project: a target has been set, and now the scientific researchers are on the move to achieve it. The interviews show, however, that this is not the case. European scientists who are involved in the development and use of cloning techniques in relation to domestic animals differ on crucial questions concerning specific applications as well as purposes. Their ideas about how those techniques may be put to use do not compose a single, coherent picture that might be referred to as the truth about what the scientists really are trying to do. The interviewees seem to agree on the realism and desirability of a few specific goals and applications, concerning the production of animal models for human diseases and treatments, and the production of bioreactors as well as the cloning of valuable breeding bulls. They do not agree regarding the possible future production of cloned farm animals as part of European agriculture and husbandry. Nor do they agree upon the future of human, reproductive cloning. Moreover, while some of them focus on agricultural applications, others focus on human applications. The interviewees are not involved in a common, clearly defined, technological project. No such project has been defined in relation to farm animal cloning. That is an overall conclusion from the series of interviews upon which the report has been based.

Another conclusion of some consequence relates to an area of possible consensus among the interviewees and, possibly, among scientists on a wider scale. It concerns attitudes towards the public at large, and, in particular, assumptions about the possibility of having a reasonable public discussion on issues related to the research and its applications. There is an apparent consensus among the interviewees that the public at large is incapable of discussing questions regarding the research. The report points to this assumption as a challenge to EU-authorities, to national authorities and to European civil society.

The report has been structured to accomodate the above qualities of the material from the interviews. It opens with a section on goals and applications. It moves on to a section on motives, purposes, assumptions and values. It concludes with a section that sums up open questions for further deliberation.

2. Material and method

Qualitative interviews

Seven interviews with nine scientific researchers from five European countries form the basis of the report. The purpose of conducting the interviews has been to gain knowledge about how scientific researchers, who are actively engaged in the cloning[1] of farm animals think about their research in a societal context, not only regarding specific goals and applications, but also regarding motives, purposes and basic assumptions: Can possible areas of consensus among them be pointed to? Can areas of disagreement be identified? In order to facilitate public and political deliberation, the interviews have been intended to make room for this group of nine scientists to express themselves and to unfold their reasoning in a non-combative atmosphere on aspects of their research that they are not often asked to consider directly.

The interviewees have been selected by asking some to point to others who ought to be included in the series (modified snow-balling). Each interview lasted about an hour and a half. During the interviews comprehensive notes were taken by the interviewer.[2] 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 comments that were made by the interviewees (inter-subjective validation).

In order to secure a free and open exchange on controversial issues, the interviewees have been 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 have been provided with pseudonymes. Thus, in the present report they appear under the names of Paul Andersson, Lawrence Darren, Ian Dickson, Anthony Green, Victor Hepburn, Richard Hume, Robert Iljitch, Ronald Nilsson and Peter Simpson. It should be noted that Paul Andersson, Robert Iljitich and Peter Simpson were interviewed as a group.

As to the attachments 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.

Interpretation and limits to interpretation

Care must be taken neither to exaggerate nor to underestimate the sort of knowledge that can be obtained from qualitative interviews of the above kind. The interviews provide an opportunity to look into rationales and argumentations that are current among the interviewees, indicating that these ways of thinking and arguing are likely to be of wider importance to the way this particular field of scientific research is carried out. Thus, the interviews may be used to draw cautious conclusions about possible areas of consensus.

[1] As a rule, the terms 'clones', 'cloned' and 'cloning' are used in the present report. That terminology should not be taken to indicate assumptions about the animals being identical. Moreover, it should be acknowledged that the terminology constitutes – for a number of substantial as well as strategic reasons – a topic for discussion in its own right. Some of the interviewees pointed to some of the substantial reasons during the interviews, and they made the case that 'somatic cell nuclear transfer' and/or 'genomic copies' would be better expressions. See section 4**.2. Grey areas**, *Scientific uncertainty and control.*

[2] 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.

The strongest sort of evidence that can be derived from the interviews, however, concerns the existence of disagreement.[3] The interviews do, in a rather straight forward manner, document the existence of multiple – and to some extent conflicting – assumptions, motives, goals and concerns among researchers who are at present engaged in developing cloning techniques in relation to domestic animals.

[3] The series of interviews as a whole carries indications concerning the existence of different attitudes that are related to different national contexts among the interviewees. They are, however, only vague indications, not to be concluded upon without further enquiry.

3. Goals and applications

Knowledge and know-how on cloning are being pursued for a variety of reasons. Many, but not all of the interviewees state that they are mainly – or they have been mainly– driven by curiosity; that is, by a fundamental desire to understand how things work. As a rule, however, this curiosity is not as 'pure' as at first glance it may appear to be. It is easily translated from a scientific desire to understand how things work into action; that is, into a technological desire to *make* things work. This orientation is recognizable in most, but not all of the interviews.

Thus, as a group the interviewees are committed to the development of technology: the technological endeavour informs and forms part of the scientific one. The applications of the research, in the context of wider society, cannot be neatly separated from the research itself, and the scientists as 'knowers' cannot be separated from the scientists as 'actors'. Rather, certain applications are already present in the research process. Accordingly, most of the interviewees answered questions about the goals of their research without much hesitation, leaving the impression that their answers, although spontaneous, were based on earlier reflection. It should be remembered that the European debates on biotechnology put pressure on scientists in this field of research to legitimize their work by identifying and pointing to worthy and beneficial goals and applications. On the other hand it did not at all seem alien to (most of) the researchers to think in terms of goals and applications. They are, themselves, not simply aiming at *knowing*, but also at *doing* something. The goals formulated by each interviewee are, however, only to some extent shared by other interviewees.

From indirect use to use in production

Leaving the motive of scientific curiosity behind, and pooling the interviews, the following goals may be extracted from the interviews: There is a goal of using new knowledge in an *indirect* way, in order to understand causes of pregnancy problems and of stillbirth in domestic animals, in order to remove such causes by some mean or other, but not by cloning. In relation to humans there is an almost similar goal of understanding the mechanisms of stem cells in order to get a grip of principles that may be used in the treatment of human diseases, not by creating human embryos by way of cloning techniques, but by other means.

Other goals imply the *direct use* of cloning techniques. Prominent among these are the production of animals – combining, as a rule, transgenesis and somatic cell nuclear transfer (the latter supporting the former) – which may be used as models in the study of human diseases. Along the same lines there is a goal of using cloned animals for experiments on the possible uses of stem cells in the treatment of (human) diseases.

Several goals are related to the use of cloning techniques in *production*, without having any aims of gaining knowledge attached to them. The production of genomic copies of valuable breeding bulls is mentioned in all the interviews. So is the production, combining transgenesis and somatic cell nuclear transfer, of animals – bioreactors – that produce valuable, pharmaceutical or other substances in the milk or in the blood. Also, the production of genomic copies of cows, to be used for the testing of breeding bulls, has been pointed to.

Furthermore, the application of cloning techniques in order to produce herds of genetically identical domestic animals is mentioned as a continuation of present breeding techniques. The same goes for the production of human beings as an extension of the present techniques and services regarding assisted, human reproduction. These two latter applications are mentioned as long term rather than short term goals because of the present inefficiency of the techniques. Both of these possible applications are subjected to clear dissent among the interviewees.

Finally, the possible use of cloning techniques in order to safeguard species or breeds of animals is mentioned.

It should be emphasized that the above list, moving from indirect to direct applications of cloning techniques, has been made by pooling the interviews. Each of the possible applications has been mentioned by one, some, or all of the interviewees, but none of them has produced the list, and it should not be read as an expression of consensus among the interviewees about what they are trying to do. On the contrary, there is considerable disagreement among them. This is true in particular regarding the two possible long term applications of producing herds of genetically identical domestic animals and of producing human beings. Moreover, it is not the case that all of the interviewees are equally committed to agricultural and human applications. Rather, some of them are clearly committed to the former, while others are clearly committed to the latter applications.

Thus, although all of the interviewees are working in the field of somatic cell nuclear transfer on domestic animals they inhabit different positions and they see and express different perspectives on what they are actually trying to do.[4]

Different positions

Anthony Green may be seen as representative of the researchers who are driven, primarily, by scientific curiosity. He responds to a question of whether his research is driven by curiosity by stating: "It is. That is science." The remark is made that there may be other drives in science, and Anthony Green says: "To me 'science' and 'curiosity' are the same. Curiosity is at least a very important aspect of science." A remark is made about science as a producer of technology, that is, as aiming not only at understanding mechanisms, but also at using the understanding in the shape of technology. To this Anthony Green says: "In my case the understanding could be used for selection purposes in relation to different breeds of animals. The new knowledge could be used in classical breeding." The latter answer does, in fact, not refer to somatic cell nuclear transfer but to his knowledge about certain DNA sequences. Cloning techniques are instrumental to his gaining that kind of knowledge. Anthony Green is hard pressed for applications of cloning techniques, stating for instance: "The only application of practical relevance that I can think of is the safeguarding of germplasm of breeding bulls." He adds: "As to that application I do not see any problems – not as long as you protect the genetic variation." A bit later he returns to the aspect of genetic variation: "Actually, the preservation of genetic resources and somatic cell nuclear transfer might become two sides of the same coin in the future."

Lawrence Darren is one of the interviewees who are committed to human applications. He argues that to a researcher who is working at a very fundamental level of developing methods – as he is – all the possible applications are interconnected and that it "goes round in circles", but he hardly mentions agricultural applications on his own initiative during the interview, and asked to give a brief answer to the question of whether animal cloning techniques are likely to prove most useful in relation to problems of human health or in relation to agriculture, he points to problems of human health.

Richard Hume, on the other hand, is committed to agricultural purposes. Asked to sum up what he is trying to do, he says: "Our research is aimed at improving the quality of the embryos. Now we are moving towards cloning of cattle, horses and pigs. We try to understand how cells are re-programmed. This is necessary in order to understand why so few of those implanted are born alive. This understanding is important to the potential use of animal cloning in breeding." At a later stage of the interview Richard Hume argues in favour of the breeding of herds of genomically

[4] A similar pattern was found in the literature review that forms the basis of the first report on the technical aspects of farm animal cloning from the project CLONING IN PUBLIC.

identical farm animals: "These animals are of course not photocopies, but they would be quite similar if they were kept under the same conditions. They would be less susceptible to mastitits and other diseaeses. There would be clear advantages. But it would not replace other sorts of breeding." Does he believe in the possibility of combining cloning with transgenesis in order to breed cattle and other farm animals, he is asked. He says: "No, I don't believe in that at this moment. I believe in a combination of classical breeding, based on genomics and followed by cloning."

3.1. Possible agricultural applications

Ian Dickson is oriented towards agriculture, and he is primarily interested in the indirect use of cloning techniques to gain basic, biological knowledge that may be used to solve current problems in agriculture. He says: "The point is to gain a better understanding of the deciding factors behind the development of the zygotes. Cloning can be instrumental to the understanding of the fundamental, biological mechanisms of the fertilized egg. Probably this is the most important use we can make of cloning." He elaborates on this by explaining: "Cloning affects the zygote in a variety of ways during the first three to seven days in the laboratory. You may say that we are stressing it. Afterwards, when we observe the pregnancy and notice how, perhaps, it results in an abortion or in an abnormal embryo, this may help us to identify those early influences on the zygote that may be detrimental. We are provided with the possibility of detecting how we may have done damage to the zygote in the very first days of its existence."

Ian Dickson makes this more specific by stating: "There has been, during the last decade, a growing problem of mortality among new-born calves in stock all over the world. The extent of the problem differs from place to place. In some places it may affect five percent of the new-born calves. In other places as much as 20 percent of them is affected. We have to crack that curve. Cloning does not solve the problem, but the knowledge of pregnancy problems that can be gained from cloning can be helpful."

As to the application of cloning techniques for farm animal production purposes, Ian Dickson says: "It is not going to happen now. No farmer would be interested as long as it is so difficult to do – as long as the animals are so frequently abnormal, as long as the uncertainty is so great, and as long as cloning is surrounded by so many negative sentiments. It could only happen if a certain animal had such an enormous value that it could outweigh all those negative aspects. It could be a top breeding bull with success on a global scale."

Ian Dickson responds to a question about possible standardization of farm animals: "Variation remains to be the point of breeding. Some traits are popular right now. It would make sense to imagine the use of cloning to produce a lot of copies of an animal that carried the traits of current popularity, but changes occur regarding the popularity of traits. Thus, it would not go on forever." Ian Dickson agrees that a metaphor of changing fashions, from platform shoes to stiletto heels, is suitable: "You could imagine that 200.000 copies were made of the bull of the year, but after a few years that particular bull would no longer be interesting. Then, another bull would be in fashion. It does take some time for cattle to mature, so changes would probably only occur after some years. Regarding mice it might change from one year to another. That is the case, for instance, in tulips and potatoes."

Victor Hepburn is also, first and foremost, interested in the epigenetic knowledge that can be gained from studying the outcomes of somatic cell nuclear transfer. He says: "The point of my interest in cloning is to gain knowledge of how the offspring evolves, what the calves actually look like", he explains. As to goals and applications he says: "The vision is, I suppose, that cloned animals may be put to use in some way or other, but the point is also to get an understanding of developmental anomalies. We are confronted with anomalies which occur naturally in 1 out of

100,000 or 1 out of 80,000 animals, but which occur to an abnormal extent in connection with cloning – for instance in 1 out of 3 animals."

To a question of what the cloning of farm animals may or may not be used for, Victor Hepburn responds: "It cannot be used to mass-produce animals. A breeding centre with 50 similar cows, each of them producing the same amount of milk – I don't believe in it. Even if they were clones, I'm sure that they would produce very different amounts of milk. Moreover, such a scheme would never result in any progression. Asexual reproduction hampers progression in the population. Without sexual reproduction you get stagnation. And you do not get good animals. Cloning comes with far too many problems, as it is at present, at least."

Victor Hepburn is asked whether he assumes that there are biological barriers to cloning. He answers: "The problems are due to some fundamental, biological causes. The problems may, possibly, prove solvable in a long term perspective, but it will hardly become competitive, and without competitiveness it is unlikely to evolve into a realistic option in agriculture. It is quite another matter as regards one singular, selected bull. That is what the breeders do. Such an animal is worth around 50.000 US $."

Lawrence Darren confirms that, at the outset, his research had been driven primarily by curiosity. He adds: "At the agricultural research institution where I started my research on cloning, the prospect of agricultural applications was the major driver of research, but my own driver was curiosity. Today, I'm also very interested in the possible applications. I want to understand the process, but I also want to use it in relation to human medical problems, and to other problems." Lawrence Darren is asked to explain why he is pointing to human medical problems in particular – is it, for instance, because it paves the way for funding, or is it because he is committed to the traditional, scientific goal of improving human health, or is it for some other reason? He answers by pointing to the possible applications as being interrelated: "Understanding animal cloning and using it with other techniques provide us with insight into human diseases and how to cure them." He responds to the comment that to understand and to cure are two different things by stating: "We may be able to understand what goes wrong in human reproduction by using cloning techniques on animals. Furthermore, by combining transgenesis and cloning we will be able to produce animal models for human diseases in order to study those diseases. And we will be able to develop systems for testing new and experimental treatments of human diseases; treatments that have been based on the use of human stem cells. Thus, it goes round in circles."

3.2. Possible human applications

Ronald Nilsson concentrates on human applications. He is interested in embryo development, and he points to a goal of facilitating the de- and reprogramming of somatic cells in order to pave the way for new treatments of human diseases. He says: "My own curiosity is directed at the fundamental mechanisms, but I have also started to think in terms of applications. They are not really about cloned animals – although it could be interesting: I would like to contribute to the development of techniques to produce transgenic animals by means of cloning. I'm certain that it could be applied for good purposes in biomedicine – I'm now hinting at animal models for human diseases. But primarily I want to understand what goes on in the egg cell during the nuclear transfer. The focus of my interest is on the de-programming. We might be able to imitate the process if we understood what goes on in the egg cell – it might become possible to produce stem cells from the patient's own cells. If so, we might be able to treat, for instance, diabetes by providing the patients with insulin producing beta-cells that had been manufactured from their own de- and re-programmed cells. Thus, I would like to use the knowledge that we can obtain from egg cells in order to enable us to de-program cells and, afterwards, to look for ways to stimulate those cells to

serve other, specific functions. Cells of that origin would be fully compatible with the patient. One would get rid of those problems of rejection which, at present, occur after transplantations."

Ronald Nilsson responds to a comment that a public discussion on limits to treatment seems to be warranted. As part of the comment, reference is made to death as a fact of life, and to the sad and prolonged ending of life of many old people who are kept alive because of the treatment of some diseases, but who are otherwise falling apart, decaying and tormented by a multiplicity of other health problems. Ronald Nilsson says: "Well, the vision is that it might become possible to re-construct bodily functions by providing the body with fresh cells – that perhaps the decay could be synchronized. That might contribute to a more harmonious death, perhaps ... But I acknowledge that it is a huge challenge to our health care system. It is impossible to foresee the consequences offhand. Balancing and discussion are required."

Lawrence Darren responds to a claim that cloning experiments, rather than reducing complexity have revealed new – hitherto unknown – complexity, related to epigenetic factors: "Epigenesis was already there. We knew about that. But cloning experiments have drawn attention to the field of cell specialization by showing us that the genetic material in a cell, if placed in a certain context, is capable of controlling the development of a complete individual. To me, it raises the question of whether it would be possible to turn, for instance, a skin cell into a liver cell. Probably, such a re-specialization would be controlled by epigenetic mechanisms. By getting control over that process, we might be able to get around the present religious, ethical and political problems of using stem cells from human embryos to provide cures for human diseases." Lawrence Darren points to diseases like diabetes and Parkinson's as examples of diseases that might become treatable by way of cloning techniques and experiments.

Anthony Green dismisses the possibility that his research results might be applied in relation to humans. The only use he can think of concerns knowledge of the malign effects of certain techniques for assisted reproduction. Such knowledge might be transferred from animal science to human medicine.

The issue of human reproductive cloning is an area of open dissent among the interviewees. Lawrence Darren does not see any reason why the cloning of human beings should be impossible. But he does not see the point of doing so: "And really: what would be the point of cloning people? I can't think of anything but ridiculous reasons, like trying to provide people with copies of themselves or of another child, or ... Actually, I think that some of the assisted reproduction technologies are getting out of hand, but that's another discussion."

Ronald Nilsson also comments on the issue of human, reproductive cloning, stating: "I do not want to rule out the possibility that at some stage I would agree to the use of cloning techniques on humans, but I would only do so if it were biologically secure. That is not the case at present." He is asked to define worthy purposes for human, reproductive cloning, presupposing that the techniques had been made reliable. He answers: "We have accepted IVF as a treatment for childlessness. Cloning techniques might make the processes more interesting. It might become possible, perhaps, to produce two artificial gametes which could be used to produce a pseudo-fertilized individual. Thus, if both parents were sterile, one could use cells from both of them in order to provide them with a common offspring." Ronald Nilsson is asked to elaborate on the expression 'we have accepted'. He responds: "I'm willing to accept that there can be a great need for treating childlessness. I can also see, however, that society may be faced with an increasing number of problems, the further we move on. Will this end with us only being able to reproduce artificially? The thought is frightening. And one is justified in pondering the kind of problems that they have – the couples undergoing IVF. How much of it is really due to attitudes and cultural pressure?"

Victor Hepburn is generally sceptical towards the use of techniques for assisted, human reproduction. He says: "To produce children simply for one's own sake – that is the most offensive thing I can think of. Will they develop cancer at 30? Will they be affected by high blood pressure at 20? Our calves [produced by way of an assortment of artifical, reproductive techniques] develop diabetes. It is extremely unnatural in ruminants. It is almost impossible, under normal conditions, to provoke diabetes in ruminants ... To use cloning techniques on humans, one would have to be raving mad."

3.3. A multiplicity of missions

The various statements about goals and applications tend to dissolve any picture of scientists working to realise a common and well defined set of goals. They are not. Rather, although sharing a belief in a few particular applications, they are engaged in many different, personal projects which are related to a variety of national and other contexts. This is well suited to the unpredictability of scientific research. It is commonplace that the outcomes of scientific research cannot be foreseen, and that attempts at planning and controlling the outcomes would be detrimental to science.

At the same time, however, it is also commonplace that scientific enterprises, as all human actions, are informed by factual assumptions about how things are, and by ethical judgements about how things ought to be. Such assumptions and judgements – to be focused upon in the following section – inform scientists' decisions on which research questions to pose and which technological paths to pursue, but they do not themselves belong to the sphere of (unpredictable) science. Rather, they belong to the political sphere where questions about public affairs are discussed.

4. Motives, purposes, assumptions and values

All the interviews touched upon aspects of assumptions and values that inform the formulation of research questions, and that underlie the choice of technological goals. This section deals with answers to questions about such aspects, and it is aimed at identifying areas of possible consensus as well as of disagreement among the interviewees. Scientists are rarely exposed to questioning about these aspects, and it should be emphasized that the answers are spontaneuous reactions to questions that are rarely discussed in depth in scientific contexts.

4.1. Areas of possible consensus

Economic growth and efficient production

There seems to be consensus among the interviewees that the societal function and role of science is a technological one of supporting and stimulating efficient production and economic growth. This is not necessarily stated directly. Rather, it appears – from a multitude of references to the market-place, to consumers and to the needs and demands of farmers and breeders – to be assumed to be part of the natural order of things.

Anthony Green comments on the possible use of cloned breeding bulls: "The actual use would depend on the costs." To the question of whether regulation would be needed, he says: "In the end the farmers would have to decide." He elaborates on this a little later: "In general I would say that in order for new techniques to be used there should be clear benefits. They should be tested and shown to result in superior genotypes for the breeders. Thus, you would have to calculate, whether there were any benefits from having clones on the production side." Still a little later Anthony Green is asked to explain his frequent references to the market-place. He says: "This is first of all about the consumers. They ask for a certain product, and it is produced. Farmers do not produce things, if nobody would buy them."

Richard Hume also comments on the possible use of cloned breeding bulls: "I find that we are ready to enter the market. The technology is very expensive, but it is justified because of the value of the animals. I'm talking about valuable bulls. The profit from selling the semen of such bulls could easily repay a low efficiency system of producing the bulls in the first place. And there is a need for this. You wouldn't want to reproduce all valuable bulls, but I would guess that at the present cost of nuclear transfer this might happen with respect to 10 percent of valuable bulls – because of accidents happening to them, for instance." Should this be taken to mean that farmers would be willing to buy, because it would pay off for them, Richard Hume is asked. He responds: "Not farmers, but breeding companies." A question is asked about the structure of the breeding industry with respect to cattle: is it, like in the breeding of poultry, concentrated in very few, very large companies? Richard Hume says: "The companies are smaller." He mentions numbers of companies, known to him, from different European countries, and he concludes: "The breeding industry with respect to cattle is still quite fragmented, but it will probably begin to change." Why does he expect a change, Richard Hume is asked. He says: "I think it will follow once cloning becomes more common. Until now we have bred conventionally, but the use of cloning techniques is likely to result in a split: a few companies will do selection and breeding, and the commercial farmers will get their stock from these few companies. There is a drive towards more efficient ways of breeding. Whether it is good, socially, for the farmers, I don't know. But it is efficient for the companies." Richard Hume is asked about his own opinion on the structural development he expects in the breeding industry: he is in contact with farmers as well as with companies. What kind of development would he want to see? And doesn't he think that it would be possible to make use of the technology, but conserve the present, fragmented structure of the industry? He responds: "The

system must make commercial sense. Having the technology, but not the system? I don't believe in it."

A question is posed to the group of Paul Anderson, Robert Iljitch and Peter Simpson about the aims of future agricultural research on animals, including animal cloning: Should it still be directed at making animals that can produce more and more, faster and faster – more meat, more milk, more eggs and so on? The question is posed in a way that implies that we have actually had enough of that.

Robert Iljitch says: "Research might be directed at producing animals that are resistant to prions, and at obtaining more resistance to disease in general. In that way the animals would need less medical treatment."

Peter Simpson says: "There might be aims of producing meat that contained less fat. Or there might be aims of producing animals without horns. From case to case we would have to consider different questions in order to decide whether it would be worthwhile."

Robert Iljitch says: "But I think it would be wrong just to discard the aim of producing more. Recently I heard some economists predicting that in ten years time we would be in lack of meat in Europe because of a decline in meat production."

A central dogma: Growth without conflict

As a rule, the assumption and ideal of science as a promotor of economic growth seems to be linked to another assumption: that efficient production and economic growth go hand in hand with improved animal health and welfare. The combination of these two assumptions – both of them at the same time factual and ethical – appears as what might be termed the central dogma of the inteviewees and, perhaps, of animal scientists in a wider sense.

Lawrence Darren is asked how his work might be beneficial to animals. He responds: "The usefulness to animals may be debated, but I think it will be useful to animals in so far as we will be able to understand and combat animal diseases ... Perhaps we could use the example of BSE or Foot and Mouth ... " To the comment that Foot and Mouth Disease does not seem to be very detrimental to animals in the first place, but has been targeted with rather drastic measures primarily for economic reasons, Lawrence Darrens says: "I agree. Foot and Mouth is first and foremost an economic disease. It is not a good example. Let's try another one, then. The example of dairy cows and mastitis is probably better. In the USA this problem has been approached by researchers trying to produce transgenic dairy cows that are less prone to develop mastitis. That would be beneficial to the cows, and to the farmers, and to the general population as well because milk of low quality – from cows with mastitis – wouldn't enter the market. Furthermore, it would contribute to decreasing the amount of antibiotics used in the production of dairy products. Thus, it would lower the risk of inducing the evolution of bacteria with resistance to antibiotics. It is a good example. Other animal diseases would probably provide a similiar mix of benefits to animals, farmers and the general population ... take the example of worms that are crawling underneath the skin of cattle, causing pain and making holes in what is going to become a coat ... Anyway, I'm not much of an animal specialist. I'm into developing the methods. Vets and other animal specialists come along and tell me that 'this is a very serious disease, and we must do something about it', and I'm happy to help them." Asked whether he is aware, from case to case, whether the diseases are serious to the welfare of the animals or to the purses of the producers, Lawrence Darren says: "These things go together. It's like when you vaccinate people so that they may escape influenza. It serves many purposes at the same time. People do not get ill. They won't have to stay away from work. The state won't have to pay people for staying away from work. And so on."

As part of an exchange on application and regulation Anthony Green points to the requirements of farmers. He says: "It relates to questions of wealth and how to generate a fair

income. Many farmers in animal production have problems ... Farmers might profit from longevity in, for instance, dairy cattle, because longer living animals are likely to be more healthy... This might also be of interest to the public – if you could produce more robust animals. It could be of general interest."

Richard Hume is asked whether he thinks that cloning can become useful as part of ordinary breeding in agriculture. He responds: "It can become useful if it becomes more efficient, but not as it is now. We must have the same efficiency as we have in embryo transfer or in assisted insemination. It would be a dramatic advantage both for the farmers and for society if we succeeded in obtaining that sort of efficiency. Then we could breed very good animals, and these animals would need fewer antibiotics and other drugs than the animals of today, and they would be living under better conditions. There would be multiple benefits ..." A little later Richard Hume is asked whether he expects the further development and possible use of cloning techniques in breeding and farming to be good for the animals, because they will be healthier. He responds: "We must reproduce animals that are fit for the conditions they will be living under."

The commitment to economic growth and efficient production does not, however, imply the existence of a concerted commitment to support the increase of the profit of particular, private interests. Thus, several of the inteviewees make a distinction between the goal of growth and purposes of serving private interests.

Robert Iljitch provides an example, stating: "What we do should be important to society ... If you approach our research institute and ask us to produce, for instance, cloned, transgenic animals with more kasein in the milk, then the answer would be no. We would not be willing to put money into that, because it is not important to society, to the future. But we would take another stance to proposals about attempting to combat diseases by way of cloning and transgenesis. It should be important."

Ian Dickson goes even further in his answer to a question of what sort of agricultural development he would like to support as a scientist. He says: "I would like to support an agricultural development towards a linking of our own needs on the one hand, and respect for the animals on the other – towards a situation where different considerations and interests could be balanced, and where organic and conventional farming did not confront each other uncompromisingly. There should be room for principles and norms from both sides."

The protection of genetic diversity

The use of cloning techniques in order to protect threatened species is frequently pointed to by the interviewees. It appears as a completely uncontroversial application. The same is true regarding the related principle that genetic diversity should be protected. Probably the interviewees tend to subscribe to differing interpretations of the principle. In most cases, however, it seems to be based on the pragmatic acknowledgement that future needs cannot be foreseen.

The status of mankind

The superior status and value of mankind, as opposed to experimental and domestic animals, also appears – implicitly as well as explicitly – to be an area of consensus among the interviewees.

Anthony Green provides an example when touching upon the issue of using cloning techniques on human beings: "That would of course be quite another matter, and it certainly would have to be regulated. But as to animals: human beings have always used and altered animals. Look at dogs. If somebody came here from Mars they wouldn't be able to guess that all those very different dogs actually belong to the same species." This corresponds to the statement made by Ian

Dickson: "There would be even more weighty reasons for careful consideration if we were working on humans."

A refinement – indicating the status of the child as the most valuable of all living beings – is hinted at by Ian Dickson when making the case that if a country is willing to use the results of research, then it ought also to be willing to take part in the research itself. He exemplifies by saying: "It could be research that exposed animals to suffering – like, for instance, many abortions – but which resulted in the development of a pharmaceutical that could remedy serious illness in children."

Attitudes towards the public and towards public discussion

The final question to most of the interviewees dealt with issues that relate to animal cloning, and that should be taken to the public sphere for discussion: Which question(s) would the interviewee choose to highlight if he were to set up the public agenda in relation to his own field of research?

As a rule, the interviewees pointed to *information* that should be taken to the public sphere, rather than to *questions* for public discussion.

Ronald Nilsson: "It should be made clear to people that there is more than one layer to the debate on cloning, and that the most basic aspects may be enormously important to our healthcare system and, in the future, to our animal husbandry. The application of completely new principles of how to treat diseases might become feasible, and that is the reason why it is so very important to gain more fundamental, biological knowledge, and to study how the genome functions. Probably this fundamental layer of knowledge will prove, in the long run, to be more important than those options of producing cloned animals which are, today, a realistic offer to society; that is, the possibility of using cloning in order to produce transgenic animals for purposes of biomedicine – not, in other words, for food production – should society want to do so."

To the comment that he has pointed to information that should be taken to the public sphere, rather than to questions for public discussion, Ronald Nilsson says: "There are two levels to this. One of them concerns whether society wants or does not want those animal models. Underlying this is the question of whether the public is willing to accept the existence of fundamental research which is difficult to understand, but which could be of huge importance to future treatment of diseases."

Robert Iljitch states: "It should be made clear that the possible longterm effects of cloning and transgenesis must be looked into." To the comment that he has pointed to a statement that should be taken to the public, rather than to questions for public discussion, Robert Iljitch says: "I would ask: Which kinds of animals do you accept for cloning? Some people would be very ready to accept that we did it to pets, to cats and dogs. I would like to know whether people would want us to make distinctions between pets and domestic farm animals."

Paul Anderson says: "I would ask to which extent people would be ready to eat and drink products that came from cloned animals – provided that it was allowed and, thus, that it was considered to be safe. I would like to know how far people are willing to go."

Lawrence Darren states: "I don't think that the public is actually in a position to discuss questions relating to animal cloning. The public is biased, because of the media hype about human cloning. Thus, I would choose instead to try to educate the public on the possible applications of animal cloning ... It is much easier to talk to people if, for instance, they have a relative with one of the diseases – CF is an example – that we are hoping to become able to do something about."

Anthony Green says: "That is certainly a difficult question ... there is a large program on preserving animal resources. There are FAO guidelines. One might present somatic cell nuclear transfer as a means of preservation, but – if I had a question it would have to be based on facts, not just on fictions."

Richard Hume states: "First there is the issue of safety. We have to prove, discuss or demonstrate whether clones can be considered safe. They are just like twins. You have to make clear to the public that they are not monsters. The next is justification. It relates to breeding purposes. We should make clear that we can learn from animal models, and that we can do it without many problems to the animals, because we will be doing most of it in-vitro. We should try to explain the techniques and the benefits and the economics. And we should make clear that it is not simply about making more money. It is quite respectable to make money, but it is not necessarily the first driver, and it is not the only goal." To the comment that he has pointed to information that should be taken to the public sphere, rather than to questions for public discussion, Richard Hume says: "The problem is that the TV and the media do not do a good job in this country. I think it is better in other countries ... What do you ask people, if they do not know what you are asking? First you must explain things, and then you can ask: Do you want to eat beef like this? Do you want an animal model for this disease? Do you want animals for xenotransplantation? Do you want to use cloning for production? Do you want us to breed fewer, but more efficient cows, leaving you with more recreational areas to go walking in? Do you want to benefit people in developing countries? Before you ask, you have to explain about the options on the table. It is hard to know which of these options will come true, but I think that all of them have a chance."

Immediately after the formal interview had been terminated, Richard Hume made a remark about the interviewer not asking questions about, and not seeming to be interested in technical aspects of animal cloning. The remark was included in the interview document because it was understood by the interviewer to be critical of the way the interview had been conducted. It is also relevant to the present report, because it seems to be exemplifying an assumption that underlies most of the answers to the question of issues that should be subjected to public discussion: the interviewees seem to be assuming that questions about technology are scientific and technical questions, rather than political ones. On that assumption, only scientists are qualified to partake in discussing them, and the contributions of other citizens should be distrusted as incompetent.

The dismissive attitude towards the public at large and towards the possibility of having a reasonable public discussion on the use of cloning techniques appears to be rather strong among the interviewees.[5] The picture is, however, not black and white. That may be exemplified by Peter Simpson making the case that there are positive aspects to societal pressure on science. He says: "[I]t is positive that we at our institute are now pushing multidisciplinary research ahead. As a research institute we have a special obligation to do these things. Sociologists and philosophers take part in the research, and that multidisciplinary work will influence the planning of future research projects in our field. It influences the way we move on as scientists. It is positive. We have had a lot of debate on cloning and transgenesis, and there is pressure on us only to use transgenesis in basic research if we are unable to do it by using other techniques. It means that we if we want to use transgenesis in relation to domestic animals, we will have to provide convincing arguments for doing so."

Peter Simpson also argues: "I think that in relation to animal cloning we need something similar to the international climate panel, not exactly similar, but building on the same principle – an independent and multidisciplinary international group, including biological and human sciences, reporting on the achievements of cloning worldwide."

[5] Similar attitudes appear in another series of 9 interviews with 9 scientists from 8 European countries, all of them from the field of biotechnology in relation to farm animals. Those interviews were conducted as part of another EU-funded project: EADGENE.

4.2. Grey areas

Over-selling science

Some of the interviewees express concerns about pressure on scientists to deliver applicable results in a hurry, and about various, possible consequences of such pressure.

Ian Dickson states: "Our research *must* be aimed at applications. That is, by the way, also to an increasing degree the case at universities. There is a problematic side to this, because sometimes results are applied too hastily. It is crucial to make sure that you have gained experience, and that you have done meticulous testing before you embark on application."

Ronald Nilsson says: "We are working under a kind of pressure that easily leads us to prioritize unconsciously. Thus, in a way you don't prioritize at all. Things just happen." According to Ronald Nilsson the pressure is due, partly, to conditions of research funding that have become increasingly competitive during the last 15 years. He says: "Equipment and reagents have become more costly. More resources are needed to keep a laboratory going." He explains: "I swapped to stem cells because I find them interesting, but I was also motivated by improved possibilities of acquiring funding." Ronald Nilsson responds to a remark about problems related to the over-selling of potential outcomes of research by stating: "We should try not to over-sell. The point is also to avoid a situation where we are presented with demands for applications about which we are far from certain."

"There is much dishonesty in biotechnology", Victor Hepburn declares. He also states: "If people were honest and said: 'we want to know more about some basic, immunological reactions. That knowledge might be of consequence to human-to-human transplantations. It might also teach us what we can and cannot do regarding the production of transgenic animals' ... This research can furnish us with knowledge of fundamental, physiological mechanisms, but that sort of aim does not take you anywhere funding-wise, considering how much money is needed to do it. You are supposed to claim that, possibly, you will be able to to achieve this and that ... Scientists are, along the road, being turned into a kind of petty liar. It happens, you know – just before the deadline for applications for grants expires, some people, who are otherwise reasonable and honest persons, will be making the most golden and lofty promises."

The claim that scientific research has become more costly is supported by Lawrence Darren: "Research has become more costly because new technologies have been developed. The companies that sell them want to get their money back. Moreover, for me to use cattle – well, the costs would be prohibitive."

Attitudes towards animals

An attitude towards farm animals as instruments is present in the interviews at large. The interviewees do not, however, subscribe to a common idea of how this view could and should be combined with other considerations relating to the animals as living beings. Different responses to an example, that has been presented to most of the interviewees, show some of the variation.

The example concerns a hypothetical case: How would the interviewee react to a proposal that he should produce blind chickens that might walk freely around in a limited space without pecking one another – thus avoiding the animals hurting each other and fulfilling, at the same time, demands that chickens should be allowed to walk freely around, and demands for efficient production?

Victor Hepburn is dismissive. He says: "Such chickens would have a poor life. Their bodies would be misproportioned. They would have diabetes, and so on." He confirms that this refusal of his is based on an assumption about some basic biological barriers. He is asked, then, to consider the purely hypothetical case that blind, but otherwise healthy chickens could actually be produced. He says: "As seen from an animal welfare perspective it might be OK, then. Seen from the position,

however, that cruelty to animals should be prevented, it would not be OK. As I see it, it would amount to a breach of law. In this country the law actually prescribes that animals should be kept and cared for according to their physiological needs. It is not sufficient simply to exist. To be able to see – that's part of it. To be blind is a serious disadvantage."

Ian Dickson says: "It is a very thought-provoking example. It is useful for reflections on one's own attitude towards the rather abstract notion of animal integrity. At first, one might be inclined to accept the sort of argumentation that is offered in the example, but I would not want to take part in the production of blind chickens. That would be to go too far. If I would have, then, as a consumer to pay a higher price for eggs, well I would readily accept it – presupposing that I knew what I was up against."

Ronald Nilsson says: "I would rather not take part in that. Not in the kind of society that we inhabit. My attitude would, however, probably be different if it was a matter of feeding people in places where the needs are huge. In our part of the world it is not only the case that we do not need it, but it would directly reduce the quality of our lives- ... I like to work in the kitchen, and to cook. I like the direct contact with the raw materials. There is an increasing distance from the basic things in life. The technological development is co-responsible for the making of that distance. It should not be allowed to evolve into a vicious cycle."

Lawrence Darren, responding to the question before it has been completed, says: "Would I do it? No, I wouldn't. I don't know much about chickens, but my father had free-range chickens, and they were all right if they had sufficient space. The scheme you are talking about is purely for profit, and it would be detrimental to the animals. I don't think the outcome would justify the detritment to the animals."

Anthony Green says: "I would not like to do it, because there are other means. Using marker assisted selection you can select against this problem of feather pecking."

Robert Iljitch says: "My father produced chickens, so I'm familiar with the problem of pecking. I remember that we discussed whether we should cut off the tip of the beak or if we should provide them with blinkers ..." The direct question is posed: Would you produce those blind chickens if you were able and asked to do it? Robert Iljitch says: "There is not only one way to solve a problem ..." Robert Iljitch concludes: "If somebody asked us to do it we would have an internal discussion at the institute. I cannot preclude the conclusion, but we would have a discussion, and it would include the ethical aspects."[6]

Paul Andersson says: "One would have to consider: what the aim of this is. Is it only to be able to produce more? In that case I would say no. I don't think animals should be modified just to get more quantities of food products. It would be different if it had some purpose that might improve human health."

Richard Hume says: "I think that I would think about the welfare of the animals first. I would emotionally feel very uncomfortable – but some people are blind, and they do not necessarily have bad lives. And nowadays we are able to know something about these things. There are scientists who actually know something about animal welfare." Should this be taken to mean that he would consult an ethologist for an evaluation, Richard Hume is asked. He confirms he would.

Scientific uncertainty and control

Ian Dickson is asked to comment on a remark that scientists might become vain regarding their own ability to foresee and control the consequences of what they are doing. He responds: "I agree that

6 During the validation process of the interview document Robert Iljitch commented that he did not find the example relevant to discussions on cloning, adding: "today I should have not answered this question."

there is a possibility of that. No one can be completely certain about possible long term consequences of cloning."

Peter Simpson also points to uncertainty: "Cloning demonstrates that epigenetics is much more important than we have thought until now. This is a discussion among scientists. There is disagreement among scientists. Geneticists tend to say that cloned animals are genetically identical, and we are confronted with the same argument in public discussions as well; but we argue that our cloned animals are actually not identical, and that epigenesis seems to be much more important than it has been assumed."

Victor Hepburn argue along similar lines: "Three years ago I was not aware of the fact that cloning techniques could provide us with such an abundance of biological and pathological knowledge. I expected cloned animals to be far less different from each other than they actually are. The first generation – those animals that are actually made by means of cloning techniques – differ a lot from each other, even though they have been made from the same material of cells, and even though they are given the same feed and similar care. Even the markings on their skin differ. Moreover, there are a lot of problems. The second generation – the offspring that the cloned animals produce in the normal way – is more normal ... There are good reasons for scepticism regarding the idea of virgin birth."

Lawrence Darren acknowledges the existence of scientific uncertainty. At the same time, however, he makes the case that aspects of uncertainty may be of little relevance to the development of technology. He says: "There is much hype about the use of human stem cells from embryos, but we might actually be able to find alternative ways ... Actually, I'm inclined to believe that we will be able to get around those problems in practice before we understand them – just like animal cloning: we did it without understanding it." He also states: "Let's use the example of Parkinson's. We would be able to do something about it if we found a way to replace the populations of cells that are affected by the disease. And we might be able to find a way to do that without knowing what causes the problem in the first place. But then, that understanding might not be necessary to provide a cure."

Later Lawrence Darren is asked to ponder whether scientists might be fooling themselves regarding what they will be able to control in the future – being more into science fiction than they would like to admit to themselves and to others. He says: "Many of the applications we are talking about these days have in fact been talked about for a very long time. I'm working on methods to realize them." After a few exchanges he returns to the question, saying: "I would like to return to the question of whether we are fooling ourselves. I think that some scientists fool themselves as regards the time limits of what they are aiming to do. Or at least some scientists do incorrect evaluations of the time they need to succeed. We are now ten years past Dolly. Very little has in fact happened since then. Probably, a lot of the likely uses of animal cloning have not been realized because of the costs related to the research that would be needed."

The terms 'cloning' and 'cloned' have been touched upon during some of the interviews. Lawrence Darren responds to a remark that perhaps it is wrong to speak about 'clones', considering that the animals are not genetically identical. He says: "That is correct. We should not use the term clones. Mitochondrial DNA in the egg cell makes a difference, and epigenetics makes a difference. We should be talking, rather, about genomic copies. On the other hand, clones from trees, resulting from asexual reproduction, are not identical either, and they are proper clones ..."

Anthony Green says: "I have been taught that a clone is a group of genetically identical individuals. The animals that people usually refer to as clones, do not fulfil these criteria. First – they do not have cytoplasmic DNA in common. Their mitochondrial DNA differs. Secondly – you can only speak about a group if there are at least three animals, but the so-called clones of today

consist, as a rule, of only one animal. Thus, we don't usually call it cloning, but somatic cell nuclear transfer. It is a better expression." A little later a clarifying question is posed: does epigenetics have effects in itself? Anthony Green answers: "The animals would not be as different as they actually are if it hadn't."

Anthony Green is, however, confident that it will be possible to solve the technical challenges of cloning: "I think we would be able to get around the problems of effects from epigenetics and from cytoplasmic genes. It would be possible, I think, with adequate experimental designs."

Richard Hume is even more confident about the possibilities of gaining control. He responds to a remark that questions the assumption that animal welfare and farmers profit go hand in hand. As part of the remark reference is made to the breeding of fast growing chickens with fragile legs. Rihard Hume says: "I don't think that it will be profitable in the long run to have chickens with fragile legs. And – conventional breeding is one thing. It is lottery, as I said. With cloning you are able to control what you do."

Are there limits?

A couple of the interviewees explicitly dismiss the possibility that there might be limits to science.

Richard Hume reacts to the cue of human, reproductive cloning. He is asked for his opinion. He says: "I do not know. Technically it would be very demanding. You might have to use animal eggs for the nuclear transfer. That would be inter-species. We have tried that. It doesn't seem to work ... When we produced one of our first cloned animals we used 800 eggs ... You would, in other words, have to have hundreds of women to deliver eggs. Some of these would result in embryos that could be implanted in women. There would be many abortions and two of the women would in the end have to suffer late abortion – all this in order for one live child to be born. So, it is not an option at present. But as a scientist you cannot say no to a possibility. As a priest or a nun you can say no, but not as a scientist. I must try to keep an open mind ... Human reproductive cloning might become possible in ten years, perhaps."

Following an exchange on the use and abuse of science and technology, Lawrence Darren refers to a TV programme on plastic surgery. In the programme a vision was presented, encompassing human clones lying in comas on isolated islands, waiting for their 'originals' to need skin or other organs for transplantation. To the sceptical comment that it seems to be very science fictional indeed, he says: "Nothing is impossible, something is improbable ... We have been able to clone mice, pigs, cows, rats, asses, water buffaloes and so on; why shouldn't it be possible to clone human beings?" A little later, returning to the statement about nothing being impossible, Lawrence Darren is asked to consider the example of human death. Doesn't he consider it to be impossible, then, to eliminate human death? He says: "It depends on the definition of death ... What people want is the elimination of problems relating to ageing. They want to age better and to last longer. They want the development of methods to combat ageing related disorders; methods that may improve the life of people without the need to be on medication. I'm talking about diseases like diabetes or Parkinson's. They cause a lot of suffering, and they are very expensive to the state. Everybody would gain from it if we could remove the need for treatment and care. That is what we are trying to do at present: we are trying to eliminate some of the symptoms of ageing." After a few more exchanges, returning to the issue of the possibility of eliminating death, Lawrence Darren is asked to elaborate on his earlier statement about how to define 'death', and he is presented with a definition of 'death' as the end of the life of an individual. He says: "But that depends on how you define life ..." He enters into a stream of associations, starting with a children's television series featuring a boy with a hat that provides him with information. Darren combines this with the recent event of an electronic device being implanted into a handicapped person, enabling this individual –

characterized by Darren as a cyborg – to control electronic equipment. Moving on, he refers to visions voiced in relation to the latter event that, some time in the future, people may be enabled to record their dreams; to turn their dreams into actual films to be shown to other people by means of devices that have been implanted into their brains. He comments: "In the long run to swap bodies could be seen as a possible way out of the death of an individual. It might become possible to move into another body – thus confronting us with a somewhat religious question about what a human being is: is it the body or the soul? In the short run I would say that we are working to expand the life of the human body, but not eternally. We are working to extend the life span and to improve the quality of that extended life span."

4.3. Areas of disagreement

Is cloning natural?

There is clear disagreement among the interviewees regarding the naturalness of cloning.

Robert Iljitch remarks: "I think that what we do by way of cloning and transgenesis is probably just accelerating a process that would also have taken place without those techniques. Probably we will end up with the same results that we would have obtained if we had proceeded by way of classical breeding. But that way it might take centuries. It can be done much faster by using the new techniques."

Richard Hume says: "I come from a breeding background. It has been my experience that to breed an animal is like a lottery. Thus, for me the main motivation is to breed better animals, to breed the animals you want. And to me cloning is another way of breeding."

Does he see any ethical reasons for rejecting the use of cloning techniques as a means of mass-fabrication of farm animals, Victor Hepburn is asked. He responds: "Cloning results in the production of animals which are not fit and healthy, and which cannot be born naturally." Later in the interview he is asked whether he would call cloning unnatural, and he says: "It is fundamentally unnatural."

Relations to the market-place

Ambivalence towards the market-place and the world of commerce is conspicuous in the interviews. An anecdote has been presented to most of the interviewees. It is 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 have been asked to comment on the anecdote.

Lawrence Darren says: "That's what people think. They think that we do this for money, and they think that we have a lot of money. But we don't. We try to get money from companies when we can, but it is not easy ... Being part of a research team is a bit like being part of a family. You have obligations, and you try to find money for members of your group ... I did work for a company at one time, but it went bust ... I will patent if I think something is applicable, but I will do it because the money will come back to the university to fund further research. In a perfect world research could be funding itself in that way." Lawrence Darren also confirms that he understands himself to be working along the lines of producing knowledge as a common good. He is asked whether this conviction of his corresponds to reactions from members of the general public: do other people – whom he has met, for instance, at public meetings – react to him as a researcher who is producing knowledge as a common good? Lawrence Darren responds: "People are scared

because of the media hype about human cloning. It's different when you succeed in explaining to them that we are not into human cloning. People become more amenable to the uses of cloning when what we are trying to do is explained."

Richard Hume is asked whether he has met with the kind of reactions that appear in the anecdote. He says: "I have, in particular in relation to GMOs – that it is only about serving the multinationals, and that scientists want to do everything without control and just for money. It has nothing to do with the science."

Victor Hepburn says: "It is a huge dilemma. Undoubtedly, the large research projects cannot be run only by means of public money. Moreover, public authorities almost send out bulls of excommunication if you do not cooperate with private companies. That sort of cooperation affects you. It influences what you are permitted and not permitted to make public. It also influences your thinking and your attitudes." Victor Hepburn is asked how it might influence the way scientists think. He responds: "You would be tarred and feathered if you attempted to apply a critical approach. You would be certain, then, not to obtain any research funding again. It is harmful to the public debate. It is just like it was in the former East Germany."

Peter Simpson expresses ambivalence towards commercial interests. He says: "It is also a mission of our institute to do research on animals as bioreactors for producing molecules of pharmaceutical interest in their milk, and it is part of the mission to support private companies in this direction. The large companies in this area are mostly based in the USA. It is important to support national – or European – companies in order to use research to further economic growth. Basic research should be applied." A question is posed concerning conflicts of interests. The question points in particular to possible conflicts between vested, commercial interests on the one hand and 'the common good' on the other hand. Peter Simpson responds: "That is a classic discussion. We must deal with it on a case-by-case basis. Our research institute is still a strong, public institution, but around Europe things are probably changing now. Research should be a public service, as I see it, but changes seem to be going on in Europe at present in relation to the issue of the status of science as a universal good. Animal genetics is becoming private all over Europe."

The cue of 'patenting' is presented to the group of Paul Andersson, Robert Iljitch and Peter Simpson. Peter Simpson says: "We have had a very hot and lively debate on the patenting of animals. We tried to organize the debate in relation to animal cloning. There is agreement that the techniques may be patented, and that cloned animals cannot be patented. We have not reached agreement on the question of whether transgenic animals should be patentable. You will get different answers to that if you ask different persons." A question is posed in order to clarify the position of the members of the group on the issue of private or public in relation to animal cloning: Is it correctly understood that researchers at the institute would be likely to oppose attempts by private, commercial companies to clone farm animals in Europe? All members of the group confirm, and Peter Simpson adds: "In our country no private company has been involved in such cloning as yet. It is all public. But we have experienced very strong pressure and lobbying from companies in relation to our work on a report about risks in relation to animal cloning ... If we don't pay attention to the issue of risks, we will be facing a block on our research. And then the Brazilians and the Americans, for instance, will end up dominating the market with their cloned animals."

Patenting and confidentiality

Richard Hume has a sceptical attitude towards patents. He states: "Huge amounts of energy and money are used in applying for patents. It is very competitive, but it doesn't really matter what you invent – it is more important to have good lawyers ... Some of it they call 'defensive patenting' ... In cloning, I don't think that anybody has invented anything since the fifties." A remark is made about

how competition for patents, and how demands that research results be kept confidential, might affect the mental atmosphere among researchers in a negative way. Richard Hume says: "Those who do it, do it because they are forced to do it ... When you go to scientific meetings these days, you don't hear anything new. And before you start talking with colleagues, they will ask you to sign a confidentiality agreement. This is common among, for instance, Americans and Australians. I think it is slowing down scientific development ... I have learned now that those who ask you to sign that kind of agreements do not actually have anything to say. But they do make me feel a bit stupid when *I* am telling them about *my* work ... We are trying to copy the Americans for the bad things rather than for the good things. You do not have to keep information confidential in the USA in order to apply for a patent."

Ian Dickson gives an account that is almost similar to that of Hume: "Sometimes at scientific congresses there are contributions from scientists who are employed by the research departments of commercial companies. There are topics that they do not talk about. Because of their attachment to a company they are barred from being open about some aspects of their research. Their contributions end up like a sort of advertising. Afterwards, the rest of us agree that from now on we are not going to invite that kind of person to the meetings. The problem is, however, that frequently they are in possession of something that we need – typically, they have access to far more material for research, to data concerning a far larger number of animals." A little later Ian Dickson adds: "One shouldn't, by the way, be blind to the reality of what is happening to our own, public institutions. They are also marked by an increasing desire to commercialize and to take out patents. And as soon as a contact with a company is on the way, there will be discussions on conditions for the publication of results. It is crucial to whether we are able to maintain the responsibility for our research. The world of commerce has some requirements regarding confidentiality. When cooperating with the world of commerce we must be careful to maintain the freedom of research and of publication. If you are too firm on this, however, you might not succeed in having your research funded."

The comment is made that it can be difficult for other members of the public to make judgements on the realism of perspectives which are presented to them by scientists, when so many interests may be involved in the research. Ian Dickson answers: "That is why we have to maintain the principle that our work should be open to the public eye; and we must tone down the commercial involvement." Ian Dickson adds that it is very complicated, though, to do so, and he concludes: "We have entered a sphere where a good deal of confidentiality is one of the rules of the game."

Ronald Nilsson is, at the time of the interview, engaged in negotiations on a confidentiality agreement. He responds to a question of how commercialization might affect his choice of research questions: "What we *do* does of course influence how we *think*. New questions originate in our observations. This implies that the questions we ask will change as time goes by ... This makes me ponder, now, how basic, personal attitudes might be affected; attitudes, for instance, regarding how open you want to be ... The older you get, the more important it becomes to maintain your personal integrity."

Industrialization and standardization

There is a marked difference of attitudes regarding the issue of industrialization and standardization – as exemplified by the two following quotations.

Richard Hume is asked to elaborate on a statement that 'better animals' might be produced by means of cloning: what does 'better' mean? He answers: "If you see a herd of cows today, you will see quite a number of sick animals. You will see cases of mastitis. You will see animals that die. You will find that in every herd. And you will also see some cows that are never sick. A lot of this

is due to the genetic make-up of the animals. We need more homogeneous herds with animals that do not become sick easily, but there is too much of a lottery in classical breeding." A remark is made about scientific uncertainty, about only knowing to some extent what one is actually doing, and about the possibility of multiplying, inadvertently, weak traits in animals – thus making animals and farmers stronger, perhaps, in some respects but more vulnerable in other respects. Richard Hume says: "These techniques should not replace conventional breeding completely. It is important to have genetic variability, and it is important to have access to new genotypes. Many technologies will be used at the same time." But wouldn't the individual farmer become more vulnerable if he was basing his farming on animals that were genetically almost identical, Richard Hume is asked. He says: "The individual farmer could have ten animals from one clone, ten from another etc. There would be less variability, but it would be kept going."

To Ian Dickson the issue of standardization appears as one that is not altogether positive, and as an issue for deliberation: "A beautiful bunch of tulips – probably it is composed of clones. Cloning and standardization are everywhere. We are surrounded by this in a way that, perhaps, we would not feel comfortable with, if we began to think about it. I don't know. In order to make up our minds about it, though, we would have to talk about the whole spectrum. All that talk about Dolly should stop. All the nuances get lost in that way."

5. Summing up: Open questions for deliberation

The interviews disclose an array of open questions for reflection and discussion. A set of these questions are of direct relevance to current European decision-making and regulation. They concern goals and applications. The interviewees point to applications in the shape of the production of animal models for human diseases and treatments, bioreactors and cloned breeding bulls. There seems to be consensus among the interviewees regarding these applications – that they are realistic, and that they are warranted from a societal and ethical point of view. The questions for public and political deliberation are: To what extent are these applications realistic in a societal and economic context? Are they warranted? What side-effects might occur?

Some of the interviewees also point to the possible applications, in a long term perspective, of cloned farm animals on a larger scale, and of human reproductive cloning. Others dismiss those options as unrealistic and/or as unwarranted. Again, the questions for public and political deliberation relate to aspects of realism, desirability and side-effects.

At a deeper level the interviews are opening questions that relate to the purposes of animal science and of husbandry and agriculture at large. These questions remain outside the sphere of formal decision-making in so far as they cannot be solved by way of formal decicions. Nevertheless, discussions on the questions are highly relevant to future societal choices and decision-making regarding the production and use of animals, and regarding the development and use of treatments for human diseases. The questions are ethical questions, but they are not purely so. How they should be answered also depends on other sorts of judgement. This is obvious in particular regarding the assumption – which may very well be widespread among animal scientists – that economic growth goes hand in hand with animal welfare.

It is a matter for deliberation to what extent, and under what conditions the latter assumption may or may not be true. Inevitably, such deliberations lead to other questions about the definition of animal welfare and about basic attitudes towards domestic animals, as instruments and as living beings. The interviewees do not agree upon the answers to these questions. Moreover, neither do they agree upon answers to questions about the proper relationship between science and the market-place, nor upon answers to questions about industrialization and standardization in husbandry.

Thus, the disagreement concerns fundamental questions about the relationship between science and the rest of society. They bring a neglected discussion to the fore.

It is however a major challenge to EU-authorities, to national authorities and to European civil society that the interviewees appear to be distinctly dismissive regarding the possibility of having a reasonable, public discussion on the cloning of farm animals. The dismissive attitude towards public discussion seems to be rooted in the assumption that questions about the research and its possible applications are technical rather than political. On that assumption, only scientists are qualified to take part in discussing them, and the contributions of other citizens should be distrusted as incompetent. This gives rise to at least two crucial questions. Firstly: is the assumption likely to produce trust the other way around; that is: is it likely to further trust in scientists? Secondly: to what extent does the assumption constitute a barrier to aims of having a principled, public and political discussion on the use of cloning techniques as well as on other technological challenges, and what kind of steps might be taken in order to create conditions more favourable to the aim of principled, public discussion?