Journal of Agricultural and Environmental Ethics (2006) 19:225–238
DOI 10.1007/s10806-005-6164-0

BJØRN K. MYSKJA

THE MORAL DIFFERENCE BETWEEN INTRAGENIC AND TRANSGENIC MODIFICATION OF PLANTS

(Accepted in revised form November 5, 2005)

ABSTRACT. Public policy on the development and use of genetically modified organisms (GMOs) has mainly been concerned with defining proper strategies of risk management. However, surveys and focus group interviews show that although lay people are concerned with risks, they also emphasize that genetic modification is ethically questionable in itself. Many people feel that this technology "tampers with nature" in an unacceptable manner. This is often identified as an objection to the crossing of species borders in producing transgenic organisms. Most scientists reject these opinions as based on insufficient knowledge about biotechnology, the concept of species, and nature in general. Some recent projects of genetic modification aim to accommodate the above mentioned concerns by altering the expression of endogenous genes rather than introducing genes from other species. There can be good scientific reasons for this approach, in addition to strategic reasons related to greater public acceptability. But are there also *moral* reasons for choosing intragenic rather than transgenic modification? I suggest three interrelated moral reasons for giving priority to intragenic modification. First, we should respect the opinions of lay people even when their view is contrary to scientific consensus; they express an alternative world-view, not scientific ignorance. Second, staying within species borders by strengthening endogenous traits reduces the risks and scientific uncertainty. Third, we should show respect for nature as a complex system of laws and interconnections that we cannot fully control. The main moral reason for intragenic modification, in our view, is the need to respect the "otherness" of nature.

KEY WORDS: biotechnology, ethics, intragenic, natural, species, transgenic

1. REGULATION OF GMOs – ETHICAL ARGUMENTS

1.1. *Regulation and Risk Assessment*

Regulation of the development, release, and commercial production of GMOs has mainly concerned questions of environmental and health risks. A typical example is EU Directive 2001/18/EC, which states that "[t]he protection of human health and the environment requires that due attention be given to controlling risks from the deliberate release into the environment of genetically modified organisms (GMOs)." Limited experience with GMOs and insufficient understanding of the complexity of nature has lead to a focus on the scientific uncertainty and even ignorance of hazards related to the use of these organisms. The European Commission accordingly requires the use of the precautionary principle in the implementation of the Directive. This and similar regulatory principles reflect major concerns within the GMO debate. Several scientists have participated in this debate, arguing either for precautionary approaches or for quantitative risk assessment procedures. European regulation, as expressed in the Directive, follows the first line of reasoning, whereas regulation in the USA takes the second approach. Despite disagreement regarding the basic principles of regulation, both approaches express what are generally termed extrinsic ethical concerns.

The focus of extrinsic approaches is on the preconditions and consequences of an activity. In addition to the risks to health and environment emphasized in the Directive, extrinsic concerns include all the benefits and disadvantages of the activity, such as the economic and social impacts on the different stakeholders. Neither the scientific debate nor the regulatory procedures give much regard to intrinsic concerns, i.e., concerns about the moral status of the activity itself or of the entities involved in it. Although the Directive mentions the importance of respecting "ethical principles recognized in a Member State," no example of such principles is given. This seems strange considering the fact that intrinsic concerns are often considered to deal with more profound questions than extrinsic ones (Reiss and Straughan, 1996: 49) and are regarded as especially important by lay people (Knox, 2000: 103f). Generally, these arguments are more often discussed by philosophers and theologians than by scientists and lawmakers, and have little impact on the political regulation of biotechnology. A frequently mentioned reason for the view that genetic modification is morally questionable, is that it is contrary to nature, i.e., that it is unnatural. Given that controlled breeding is regarded as acceptable, it seems that the problem is not human intervention in organisms in general, but intervention on the DNA level.

1.2. *"The Natural" and Crossing Species Borders*

Claiming that something is unnatural is notoriously ambiguous, and this argument against GM technology is easily, and frequently, ridiculed. Holland (2003: 152f) points out that the argument from nature is open to abuse (for example to justify discrimination against homosexuals) and can be invoked to support contradictory views. We can claim that living in an environment entirely shaped by humans, such as a large city, is unnatural, but reshaping nature according to our needs and desires is an expression of the essence of human nature. For humans, "the artificial is natural."

Moreover, the fact that something is unnatural obviously cannot support a claim that it is not morally good, just as human acts cannot be justified by demonstrating that similar events occur in nature. Both proponents and opponents of genetic modification commit this naturalistic fallacy (Thompson, 1997: 35f). The first group holds that genetic modification is morally acceptable because sudden changes in DNA, as well as exchange of genetic material between species, occur in nature. The other group employs the fact that these are not routine phenomena in nature to argue that it is morally unacceptable. It is easy to conclude that arguments about unnaturalness "do not appear to have much ethical significance, resting as they do upon unclear language and unsound reasoning" (Reiss and Straughan, 1996: 64). Even the moderate version of natural, understood as "normal," fails to establish any normative limits for human action. Still, these arguments remain important in the view of the public, and also continue to preoccupy ethicists within the field because there seem to be strong intuitions underlying the claims.

The "unnaturalness" argument is often specified as an objection to moving genetic material across species barriers. This is also an argument that appears to be easily refuted, particularly since the concept of species is ambiguous and depends on context. In one context, "species" refers to a group of individuals with similar looks and characteristics, whereas in another, individuals belong to the same species when they can produce fertile offspring (Reiss and Straughan, 1996: 61f). It is not always possible to determine the borders between species in the plant kingdom. Furthermore, all existing species have evolved from the same organism. Why is it wrong to combine genetic material from organisms that ultimately share the same source? Arguments referring to the so-called *telos* of an organism or a species fail to bring us any closer to a sound justification of the argument against crossing species barriers, since species have altered their characteristics throughout the history of evolution, showing that the *telos* of a species is not a static phenomenon but a dynamic one.[1]

Rolston (2002: 5–10) argues that the *telos* of a species should be related to an idea of intrinsic value as an adaptive fit in the integrated whole of an ecosystem. Artificial selection by breeding or transgenesis usually diminishes the adaptive fit of the species in the wild and thus reduces its value. In the case of transgenic organisms, this diminished adaptive fit is desirable, because the risk of environmental hazards due to transgenic spread is reduced. Rolston claims that this intrusion in the *telos* can be acceptable, but that we should recognize the value inherent in the species and perhaps

[1] For an evaluation and criticism of arguments against genetic modification based on the idea of *telos*, see Melin (2004).

maintain a balance by ensuring that "such integrity elsewhere remains in the wild on this marvelous planet" (Rolston, 2002: 10). Rolston's argument implies that genetic modification involves no morally objectionable crossing of species barriers *per se*. Thus, it cannot serve as an exposition of lay people's objections to the crossing of species borders.

Instead, we should consider the fact that lay people often talk about "crossing species borders," "playing God," and "meddling with nature" as synonymous expressions. The philosophical arguments above miss the point that is the core of public concerns. Lay people's objections are directed at illegitimate intervention in nature, neglecting the restrictions of one's own power, captured in the Greek notion of *hubris*. We should not assume that people believe every species has a particular *telos* or moral integrity that ought to be protected. It is not the alteration of the species that is unacceptable, but rather the overestimation of control that is implicit in this particular technology. Such interventions are taken to display a lack of respect for nature as a form of existence that cannot and should not be completely controlled by humans.

Recently, there have been some attempts to meet this concern regarding genetic modification by using rDNA techniques without introducing genes foreign to the species. If the public considers these products to be more acceptable than other GMOs, we can safely assume that the main problem is perceived to be the transfer of genetic material across species borders. But is genetic modification within the species morally more acceptable than modification crossing species barriers, or is this application of the technology a mere public relations tactic to accommodate sentiments that are seen by some as irrational? This is significant for policy matters: if there are sound moral reasons for preferring this application, we should make the distinction clear and support the development of GMOs based on genetic material from the same species. If this is merely a way to accommodate misguided assumptions about nature common in public opinion, this distinction should not play any role in regulation policy.

2. INTRASPECIES MODIFICATION

There are several reasons for altering plants and other organisms by genetic modification rather than through traditional breeding. The technique is more precise, at least in theory, because the genetic basis is changed only for the desired characteristic of the organism. Gene modification can be a faster way to achieve the same results. Moreover, unlike organisms that result from the application of essentially biological processes such as those used in traditional breeding, biotechnological inventions can be patented and potentially generate higher returns from the investment in creating a new variety. It is possible to introduce traits that are not present in the species. The first generation GMOs had simple, producer-oriented traits such as herbicide tolerance and insect resistance. Salt, drought, and temperature tolerance, as well as enhanced nutritional content are underway in the next generations, as exemplified in the development of a salt and drought tolerant tomato plant by the company FuturaGene (Sample, 2004). The tomato promises clear benefits and should be acceptable on extrinsic grounds after a weighing of benefits against disadvantages, if it performs as well as indicated by the producers. The FuturaGene project apparently addresses intrinsic concerns about respecting species borders as well: "Instead of putting new genes into the plants to help them survive, the scientists have found a way to make certain genes already present go into overdrive, beefing up the plants' defences to salty soils, cold weather and drought" (Sample, 2004). The article does not mention to what extent the promoter and other factors that contribute to this "beefing up" are imported from other species. Still, the fact that the active genes are modified within the species is a way to accommodate the moral objections raised by a significant portion of lay people.

We can imagine several possible reasons for this approach: (1) intra-species modification is the best approach for improving the plant's performance; (2) the company wants to make a product acceptable to the public; (3) the scientists involved in the project take public opinion seriously although they disagree; (4) the scientists share the opinion that crossing species barriers is morally wrong. Whatever reasons the scientists have, I want to discuss to what extent there are *moral* reasons for staying within the species when genetically modifying an organism. If there are such reasons, these considerations would have to be reflected in the public decision-making procedures. It would follow that the precautionary risk assessment advocated by the European Commission should be supplemented with an ethical analysis of the source of the genetic material employed in the genetic modification.

In a recently completed EU-funded interdisciplinary research project, the question of staying within species borders is explicitly addressed (Schaart, 2004).[2] This project focused on a new genetically modified strawberry. This strawberry is genetically modified to express increased resistance to the fungus gray mould (*Botrytis cinerea*) by enhancing the expression of two native PGIP (polygalacturonase inhibitor-protein) genes using different strawberry promoters. The fungus breaks down the cell wall using the

[2] The project "QLK5-CT-1999-01479 Sustainable production of transgenic strawberry plants, ethical consequences and potential effects on producers, environment and consumers" was funded by the 5th Framework Programme.

polygalacturonase (PG) enzyme, in order to enter the cell. PGIP inhibits the PG and defends the cell against the attack. A *kanamycin* resistance marker gene is removed after the transformation, ensuring that the GM strawberry contains only genetic material originating within the strawberry species. This novel approach was possible because genes coding for the PGIP-gene were already present in the strawberry. Widespread use of fungicides to combat gray mould is a source of significant loss both to farmers and retailers as well as customers. A resistant strawberry would mean both reduced loss as well as reduced application of fungicides harmful to the environment.

The biologists in this project have chosen to categorize the new strawberry as a *cisgenic* organism, to distinguish it from *transgenic* organisms where species-foreign material is used. The relevance of the distinction can be challenged. Some will say that the problem is not first and foremost the crossing of species barriers, but the recombination of gene sequences, regardless of origin. They argue that when genetic material is inserted into the genome it becomes transgenic even if the material originated in the same genome and that the results are equally unpredictable. Thus, introducing conceptual distinctions between different forms of genetic modifications does not address scientifically relevant distinctions. In this view, an illusion of scientifically and morally significant distinctions is created that serves little other purpose than to make a controversial product more acceptable to the skeptical public. A part of the price to pay for the introduction of this conceptual distinction could be that transgenic organisms crossing species barriers will be regarded as even less acceptable, since scientists lend credibility to the distinction between cisgenic and transgenic.

These objections are relevant, but beg the question. Whether there is a morally relevant distinction between intra- and inter-species modification is exactly what is at stake here. Biotechnology proponents often criticize the importance GMO opponents attach to the process rather than the product (Miller, 1997: 32–35), arguing that the phenotypic characteristics should be the basis of the assessment. The objection to drawing a distinction between different kinds of GMOs referred to above reflects a process-oriented approach. By arguing that we should analyze the ethically relevant differences between different kinds of genetic modification, the process is still considered a central element in the evaluation, but not the only relevant ethical issue. Both process- and product-based risk assessment strategies remain within the extrinsic ethical paradigm that dominates the GMO-debate. We should look beyond extrinsic process-based or product-based risk assessments to find whether there are scientifically and ethically relevant differences between genetic modifications according to the extent to which the organism and the inserted gene sequences are related.

We can start by asking what kind of distinction can be made between different forms of genetic modification. Nielsen (2003) has proposed a set of concepts to specify how closely related the sources of the genetic material are, using *intragenic* (and not *cisgenic* as the biologists suggested for the fungus resistant strawberry) as a term for intraspecies modification. Other categories are *famigenic* (modifications within the same family), *linegenic* (within the same phylogenetic lineage), *transgenic* (modification with unrelated DNA material), and *xenogenic* (where the inserted genes are laboratory constructs). In the last case, the genes are not found in any existing organism. I will not discuss the relevance of all these fine-grained distinctions, but merely examine the differences between intragenic and transgenic modifications relevant for the argument against crossing species barriers.

3. INTRAGENIC MODIFICATION AND ETHICS

There are three reasons for introducing different regulatory policies for intragenic and transgenic organisms. First, I argue that lay people's arguments against crossing species barriers should be regarded as important and relevant expressions of an alternative world-view. The only way to do this is by including this perspective in the procedures for assessing new GMOs, because the traditional arguments against it are based on a scientific world-view that is challenged in this lay perspective. Second, I follow Nielsen in arguing that the risks and scientific uncertainties involved in the production and release of intragenic organisms will probably be reduced, since the introduced trait is already present in the organism. Third, staying within species barriers expresses respect for the otherness of nature as something that we cannot and should not attempt to control completely. This is the core of the argument against crossing species barriers. Only the last argument is directly related to the idea of the "unnatural," but the first argument implies that this idea is expressive of a valid alternative world-view, and the second indicates that respecting this idea means that we should accept the limits to scientific knowledge. Thus, these arguments are inter-related by idea of the "unnatural."

3.1. *The Imperative of Public Participation*

The first reason for producing intragenic rather than transgenic organisms is that it addresses the most common intrinsic arguments against genetic modification. Both religious and non-religious groups within the general public emphasize the argument that crossing species barriers is unnatural.

Intragenic transformation respects this argument.[3] Scientists and many ethicists will object, claiming that the view displays ignorance of scientific facts and should not be taken seriously. One should rather educate people on the continuity between traditional breeding and genetic modification to make them see that one is as natural as the other. Education of the public would appear to be the correct approach if the argument about the unnaturalness of crossing species barriers would be based on a flawed conception of "the natural." However, the problem with this dismissal of the "unnaturalness" objection is that it presupposes the correctness and completeness of the scientific view. We know, however, that science is a work in progress and hardly anybody believes that the scientific view of the world provides a complete picture of reality. Perhaps the primary strength of the scientific approach is the methodological assumption of its own fallibility, making a dogmatic approach contradict its own ideological basis. Scientific facts are certainly better founded than most common-sense conceptions of the world, and there is obviously a need for better public understanding of the life sciences. Still, one-sided public education is not the solution to the disagreement between science and parts of public opinion.

The scientific community represents a relatively homogenous group, despite its typical methods of self-correction based on internal debate. Thus, it is subject to the psychological tendency of group polarization, where "members of a deliberating group predictably move towards a more extreme point in the direction indicated by the members' predeliberation tendencies" (Sunstein, 2003: 81). When the scientific community initially shares some basic values reflected in certain world-views and risk perceptions, this psychological factor can lead to a rejection of values that contradict these shared assumptions. Open public debate is necessary to counter this effect. Furthermore, the objection to "tampering with nature" is based on distrust of scientific activities, not necessarily on misconceptions of scientific facts. As Shrader-Frechette (1991) points out, public disagreement with science in matters of risk is not irrational even if the public is more risk averse than the proponents of scientific assessment, which also involves subjective, value-based aspects. Thus, the procedure of risk evaluation should be made more democratic, involving the public. Especially in areas of significant uncertainty and potential scientific ignorance, demonstrated by scientific controversy, an extended peer review community is needed to decide the course of action (Ravetz, 1999). Lay people's arguments should be listened to on an equal footing with expert opinion in cases where the stakes are high

[3] A survey done by Reidun Heggem at the Norwegian Centre for Rural Research showed that 75% of respondents completely or partially agreed to the statement: "It is more acceptable that one moves genes inside a species rather than moving them between species." Merely 10% disagreed (Myskja et al., 2004).

and the uncertainty is significant. In such situations, it is widely accepted that collectively binding decisions can only be regarded as ethically justifiable if they result from a process of public deliberation where all affected parties have had the opportunity to participate and put forward their proposals and arguments.

From this perspective, one can argue that we have a moral duty to ensure that all relevant arguments and views are taken into account. Arguments contrary to the scientific understanding of nature are also relevant in this sense. We should, therefore, present them as reasonable and coherent contributions to the debate, inasmuch as this is possible. It is insufficient to take the arguments into account strategically, i.e., in order to achieve political support for agricultural biotechnology. A procedure that only *appears* to take lay people's arguments seriously is morally unsound. The ideals of open public deliberation require that every argument be taken seriously, regardless of the status of its proponents. When people insist on the significance of crossing species borders, it is our moral duty to explore the strength of this argument. It is a duty because this is the way to ensure that all possible positions are taken into account and given a chance to influence policy decisions. But we have not taken this argument seriously if we fail to reconstruct it in the best way possible, and to scrutinize the presuppositions of both the pro- and the contra-arguments.

3.2. *Uncertainty and Scientific Ignorance*

The second argument for distinguishing between intragenic and transgenic modification concerns the phenotypic alterations involved in different kinds of genetic modification. When a completely new trait is introduced, as is the case for the first generation GMOs that are currently in commercial production, it is likely that the plant will be less similar to its conventional counterpart than in the case of a modification enhancing traits already present in the species. We can, admittedly, imagine cases where the impact of the species-foreign gene sequence is insignificant, but then the plant will not be interesting for production. The main reason for introducing foreign species in an organism is to improve its performance in a particular way, which implies that only those where the trait is properly expressed will be used. We can accordingly assume that transgenic modification generally will lead to more radical changes of the plant than intragenic modification. Nielsen (2003) argues that such radical alterations will in many cases lead to more areas of risk and to greater risks:

> Generally, the release and use of GMOs with simple nucleotide changes are likely to generate few ecological concerns beyond those faced by the organisms' traditionally bred counterparts. However, species-foreign genes, synthetic genes, and other genetic

changes have been introduced into GMOs, and some deviate substantially (...) from what classical, selection-based breeding has achieved. These organisms have genetic compositions that do not reflect evolutionary processes occurring under natural conditions. Generally, we can say that the uncertainties increase when the inserted trait has not occurred within the species or family earlier.

The assumption of reduced uncertainties may seem exaggerated when we look closer at the intragenic strawberry. PGIP is continuously expressed at high levels due to a novel combination of promoter and PGIP-encoding gene sequences. In conventional strawberries the expression level of the protein varies during the season, and this change alters the trait in a significant way. Thus, the main risks and uncertainties involved seem to be analogous to the uncertainties regarding the transgenic crops expressing the *Bacillus thuringiensis* toxin. In addition, the trait occurs in an unknown location in the genome, as it does in transgenic organisms. But the analogy does not hold, since the trait is already present in the strawberry, allowing a delimitation of the areas of uncertainty. We know the effect of the trait in the common environment of this species, and have a better basis for predicting the effects of a continuous higher expression level of the same trait in the same circumstances. The number of unknown factors is reduced. The chances that we will experience totally unexpected kinds of harm due to scientific ignorance are also reduced. Reduced risk due to the restricted novelty of the reintroduced traits justifies that we distinguish between intragenic and transgenic modifications in regulatory policy, for as far as the extent of the risks is concerned, transgenic modifications are more problematic not only from a scientific but also from a moral point of view. However, this claim seems to rest on purely extrinsic moral concerns. It demonstrates that intragenic modification is more morally acceptable in view of reduced risks and increased public legitimacy, but this line of argumentation seems irrelevant for the concerns expressed in the objection to "tampering with nature."

3.3. *Respecting Evolutionary Changes*

The final and most important reason for supporting conceptual and regulatory distinction between intragenic and transgenic modifications is based on the argument against crossing species barriers as contrary to nature. "Species" may mean different things in different contexts. Even if we agree on a particular definition, it is still a fact that species change over time. Paradoxically, this fact is the core of the argument against crossing species barriers. Although species are dynamic entities, they play particular roles in particular environments. Each organism interacts with other organisms, and the changes in one organism alter these patterns of interaction through the process of adaptation. Thus, every species is part of a larger unity that develops according to its particular complex patterns of laws. As a rule, evolutionary change is a slow process where alterations are minor and geographically restricted for a long period of time, allowing other organisms to adjust to the altered traits without catastrophic results for the equilibrium. The slow alterations and similarly gradual spread of the changes imply that the characteristics of the species are only gradually altered, even if the individual organisms acquire radically new traits due to mutations. Also in these cases, where the change in traits may cause radical changes in the local ecosystem, the spread of these traits to other ecosystems takes a long time. Therefore, the probability of changes destructive to a large number of species over large areas in a short time is very low. In modern agriculture using GM technology we introduce new varieties with radically altered traits in many different locations over a short period of time. This practice is radically different from the changes of evolution.

An ecological system is in a fragile state of continuous change – a dynamic equilibrium – changing while retaining major characteristics over time. Despite rapidly increasing biological knowledge, due to the complexity of ecosystems scientists are unable to make precise predictions about the effects even of fairly limited changes. Science lacks a sufficiently detailed understanding of the "mechanics" of biological systems, unlike systems engineered by man, where the causal patterns are known and the effects of changes to the system can be predicted in detail. In this sense, nature is not controllable, at least not given the presently available theories and models of biology. Biological systems are unpredictable because they are complex and particular. Even clones that have the same genetic make-up, as is common in domestic plants, will behave differently due to environmental differences. In this sense, the laws of biology display a kind of "otherness." When intervening in biological systems, biotechnology makes a shortcut compared to the way changes generally occur in nature. Transgenic plants have radically altered traits that are introduced over large areas simultaneously. Such intervention does not respect the unique character of these systems, and overestimates the power of the technology. This is one reasonable interpretation of objections against man "playing God" or "tampering with nature," making the products of modern biotechnology "unnatural." However, this seems to prove too much, since the implication would be a rejection of *any* form of modern biotechnology, perhaps even of all modern agriculture. Why should intragenic be more acceptable than transgenic modification, when both techniques fail to employ nature's own process of reproductive changes to the traits of an organism?

As stated above, the process of natural selection, which is the major mechanism for bringing about changes in nature, is a slow process.

Realizing that science cannot explain the details of how the elements of the system interact, we should respect the restrictions on speed and dispersal of changes in nature expressed in evolutionary change. If we respect evolution's restrictions on genetic alterations, the products of our interventions will be more predictable because we refrain from experimenting with the unknown. We are less likely to let ourselves and others become victims of our ignorance. One option would be to refrain from any form of intervention on the DNA level and to use the knowledge of the rapidly expanding field of functional genomics to speed up the breeding process. Another, less conservative, option advocated here is to limit the *degree* of changes introduced via genetic modification, while retaining the benefits of this technology. Intragenic modification can be defined as genetic modification by reproductive DNA-technology to produce an organism that could have been produced by traditional breeding. It is, admittedly, the case that also intragenic modification can result in alterations that are not possible by traditional breeding. These cases can be subject to the same objections against "unnatural" interventions as transgenic plants. We should not define these as intragenic plants, despite the fact that they are produced in a similar way. These plants are functionally similar to transgenic plants, and the ultimate reason for distinguishing between intragenic and transgenic modification is the novelty of the traits, not the origin of the genetic material.

The crux of this argument is not primarily avoidance of unpredictable harm, but respect for the "otherness" of nature. This means working with nature, rather than "going against the grain."[4] Restricted scientific knowledge of the details of the complex interactions in natural systems is an indication of the otherness of nature. The fundamental lesson of the Greek myths about *hubris* is found in this kind of respect. Man believes he can be equal to the gods, but lacks understanding of the rules set by them. He transgresses the limits set by these rules and is severely punished for his lack of respect for that which is beyond his understanding. Thus, the morally blameworthy act is disrespect for the limits of human capability, not faulty prediction of the harmful consequences. By staying within species barriers in genetic modification we speed up the process of change, but simultaneously show respect for the limits of change set by the evolutionary processes.

3.4. *Connecting the Arguments*

The three arguments for distinguishing between intragenic and transgenic modifications of organisms belong to different categories. However, they are

[4] Thompson (2003) suggests a related understanding of "the natural" connected to the knowledge of established, local farming practices.

interconnected in the sense that the argument for respecting the contribution of non-scientists implies that we develop the lay arguments as a corrective to the scientific consensus. The argument against biotechnology as unnatural is connected to objections against playing God or tampering with nature, indicating a different view of how man should relate to nature. Support for the argument from nature can be drawn from both extrinsic and intrinsic sources, where scientific uncertainty and ignorance are indications of a lack of respect for nature as being different from other systems. The lesson to be learned is that if we fail to respect the otherness of nature, we overestimate our own power. We should show respect for nature as something fundamentally different from ourselves, as is demonstrated by our inability to predict and control the effects of human interventions in nature. Intragenic modification is one way to show this kind of respect.

REFERENCES

Directive 2001/18/EC of the European Parliament and of the Council of 12 March 2001 on the deliberate release into the environment of genetically modified organisms and repealing Directive 90/220/EEC: http://europa.eu.int/eur-lex/pri/en/oj/dat/2001/l 106/l 10620010417en00010038.pdf [Date of Consultation: 03/20/2005].

Holland, S. (2003), *Bioethics: A Philosophical Introduction*, Cambridge: Polity Press.

Knox, B. (2000), "Consumer Perception and Understanding of Risk from Food" *British Medical Bulletin*, 56 (1), pp. 97–109.

Melin, A. (2004), "Genetic Engineering and the Moral Status of Non-human Species" *Journal of Agricultural and Environmental Ethics*, 17 (6), pp. 479–495.

Miller, H. (1997), *Policy Controversy in Biotechnology: An Insider's View*, Georgetown Texas: R G. Landes Company and Academic Press.

Myskja, B., J. Schaart, R. Heggem, L. Mehli, T. Kjellsen, T.-H. Iversen, and H. Schouten (2004), "Cisgenic Strawberry – Biological, Sociological, and Ethical Aspects," in J. de Tavernier and S. Aerts (eds.), *Science, Ethics & Society. 5th Congress of the European Society for Agricultural and Food Ethics*, Leuven: Katholieke Universiteit Leuven, p. 335.

Nielsen, K. (2003), "Transgenic Organisms – Time for Conceptual Diversification" *Nature*, 21 (3), pp. 227–228.

Ravetz, J. R. (1999), "What is Post-Normal Science" *Futures*, 31, pp. 647–654.

Reiss, M. J. and Straughan R. (1996), *Improving Nature? The Science and Ethics of Genetic Engineering*, Cambridge: Cambridge University Press.

Rolston, H. (2002), "What Do We Mean by Intrinsic Value and Integrity of Plants and Animals?" in D. Heaf, and J. Wirz (eds.), *Genetic Engineering and the Integrity of Animals and Plants. Proceedings of a Workshop at the Royal Botanic Garden, Edinburgh, UK*, Hafan, UK: Ifgene, pp. 5–10.

Sample, I. (2004), "Breakthrough May Bring Life to Barren Earth," *The Guardian* May 21: http://www.guardian.co.uk/gmdebate/Story/0,2763,1221597,00.html [Date of Consultation: 03/20/05]

Schaart, J. G. (2004), *Towards Consumer-Friendly Cisgenic Strawberries which are Less Susceptible to* Botrytis cinerea, PhD thesis, Wageningen: Wageningen University.

Shrader-Frechette, K. (1991), *Risk and Rationality*, Berkely: University of California Press.

Sunstein, C. (2003), "The Law of Group Polarization," in J S. Fishkin, and P. Laslett (eds.), *Debating Deliberative Democracy*, Malden, MA: Blackwell, pp. 80–101.

Thompson, P. B. (1997), *Food Biotechnology in Ethical Perspective*, London: Blackie Academic and Professional.

Thompson, P. B. (2003), "Unnatural Farming and the Debate over Genetic Manipulation," in V. V. Gehring (ed.), *Genetic Prospects. Essays on Biotechnology, Ethics, and Public Policy*, Oxford: Rowman & Littlefield, pp. 27–40.

Department of Philosophy
NTNU Trondheim
NO-7491 Trondheim
Norway
Phone: +47 73590951
Fax: +47 73596460
E-mail: bjorn.myskja@hf.ntnu.no