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Ethical distinctions between different kinds of plant breeding

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Abstract
The article discusses whether there are ethically significant distinctions between different forms of plant breeding. We distinguish different forms of plant breeding according to the kind of technology and degree of human intervention compared to plant reproduction occurring in nature. According to the dominant scientific view, the main concerns are issues of biosafety that are dealt with through risk assessment. Thus, the techniques are ethically equivalent and only the resulting product is of interest. In parts of the societal and philosophical discourse, however, there are attempts to distinguish ethically between these approaches, often relying on ambiguous concepts such as “naturalness”. We argue that a virtue-based approach can be used to explicate the assumptions behind such distinctions that are relevant for scientific and public discourse, and support a conclusion that there are ethical differences between plant breeding methods. The framework can contribute to an improved dialogue between the scientific community and the wider public by making the scepticism towards GM-technology more intelligible.

Keywords
Virtue ethics, naturalness, new plant breeding techniques, GM plants

Introduction
Modern biotechnology has changed the art of plant breeding, albeit accompanied by controversy. The debate is split: The scientific community has discussed genetic modification as a method for improving the traits of food plants, focussing on biosafety, holding that if these risks are equivalent to conventionally bred counterparts, non-contained use of the GM plant is acceptable. A significant group within the European public has taken a wider normative approach to the ethics of plant biotechnology, holding that the acceptance of risk for GM depends on what benefits to expect (Gaskell et al. 2004). In addition, many have objected to the technology based on intrinsic normative assessments, such as “naturalness”, generally not part of the scientific discourse (Gaskell et al. 2011). Only seldom have any of these discourses dealt with the differentiation and refinement of plant biotechnology in different techniques as having normative significance. For the dominant scientific view the difference in methods are arguably irrelevant, as the matter is one of evaluating the product rather than the technology. For the public, the details in technical distinctions are not known or heeded. However, public surveys that take into account technological differences, find that significant proportions of the public judge them to be of moral relevance (Gaskell et al. 2011); the most important criterion for acceptance being the perceived naturalness of different kinds of breeding techniques (Mielby

et al. 2013). Most scientists would not recognize the idea of naturalness as a relevant concept in this debate – especially not when the concept also gains a normative status.

In the following, we will describe different technological possibilities of intentional changes in the traits of plants and discuss to what extent these technologies differ ethically significantly. We will suggest a virtue-based approach that takes into account both the scientific risk assessment approach and a modified concept of naturalness as a way to make a more nuanced and integrated approach to the ethical evaluation of different kinds of plant breeding. Due to limited space, we will not discuss the politics and regulation of different techniques although the ethical evaluation clearly may be relevant for regulation or for guiding consumer choices. For the same reason, we will only briefly discuss important ecological and socio-economic issues related to new plant varieties.

Different breeding techniques

We distinguish different forms of plant breeding according to the kind of technology and degree of human intervention compared to plant reproduction occurring in nature: 1: Conventional breeding by means of crossings and selection, based on phenotypic selection only. 2: DNA marker assisted selection 3: Undirected mutation breeding using irradiation or chemical treatment; 4: Directed mutation breeding, using novel genome editing techniques; 5: Using transgenic plants as intermediates, but the resulting cultivar does not have genetic alterations compared to conventional breeding (so-called null-segregants); 6: Cisgenesis, which refers to introducing natural genes from crossable relatives that can be used in conventional breeding too. However in case of cisgenesis this is performed in a targeted way, by only introducing the desired gene(s) only, using genetic modification techniques, rather then random mixing and recombination of genes (alleles) among whole genomes, as occurs in crossings; 7: Intragenesis. Similar as cisgenesis, but now new combinations of genetic elements, such as coding region and promoter form the crossable plants, are made and introduced in a plant, possibly leading to new expression patterns of the gene. In case of cisgenesis, the gene has always its native promoter and native terminator (Schouten et al., 2006); 8: Transgenesis, which refers to introduction of foreign genes, using genetic modification techniques (Lusser et al. 2012).

Narrow scientific and broad ethical assessments

According to the dominant scientific view, these methods are at the outset ethically equivalent as it is the end result, the GM-plant that is relevant. However, they differ in degree of interventions, speed of alterations, and whether the changes could have occurred without human intervention. This can be reflected in a biosafety-based differentiation as we see in the EFSA (2012) evaluation, where the biosafety of cisgenic plants for food, feed and environment is considered similar to that of conventionally bred plants, whereas intragenic plants can lead to additional risks. It is typical for this approach that the evaluation of risks is based on an implicit utilitarian approach, decoupled from two kinds of question: the first concerns the relation these possible risks have to potential benefits and the second the evaluation of the broader impacts of the technology use has on farming and society. One can argue that these questions are not parts of the scientific biosafety assessment but concern the broader assessment, which is a political task. But a full ethical assessment should include all relevant aspects of the implementation of the technology in modern society, and a narrow scientific risk assessment will therefore leave us with an incomplete evaluation. It will also leave us without resources for handling the question of the perceived naturalness of the technology.

A broader ethical assessment would ideally integrate the scientific risk assessment. The problem is that key concepts in the public discourse on plant biotechnology such as 'naturalness' are difficult to handle to scientists as they are not easily definable or measurable and apparently based on scientific illiteracy. A successful integration could perhaps be achieved if these concepts could be shown to contain more than just scientific misunderstandings and allegedly unfounded metaphysical assumptions. But that presupposes that the implicit narrow utilitarian framework for scientific assessment is adjusted and that 'naturalness' can be shown to carry meaningful content within such a broadened framework. We suggest a virtue ethical approach, based on Hursthouse (1991) and Sandler (2007), which is consequentialist in nature but avoids an instrumental conception of value, where objects or acts are merely evaluated according to how they affect happiness. A virtue theory is, from our perspective, well suited for framing the contested concepts and making the assumptions behind them relevant for scientific and public discourse.

Virtue ethics and plant breeding

The core idea of virtue ethics is that the rightness of actions is not expressed by rule-following or calculation of outcomes, but in the character of the acting person or group. In this sense, it is an agent-focused approach to morality (Baron et al. 1997: 177). The good acts are those as the good person of practical wisdom will choose; the person who knows and can make sense of what is good in life. Having virtue is an integral part of living a good life, a life in *eudaimonia*, which means human flourishing. As we will return to later, this can be interpreted as including nature in the sphere of entities with intrinsic value – in the ethical community so to speak. When we evaluate a field such as plant breeding from the point of view of virtue ethics, we judge different courses of action according to what vices or virtues they express, and to what extent these are integral to a life of human flourishing. This approach is holistic in the sense that the acts are valued not on external criteria, but according to how they are an integrated part of a good human life, or in the case of a particular practice such as plant breeding, part of a good practice of this sort. Thus, we need to ask what the virtues of plant breeding are, or to be more precise: and in what way different choices within plant breeding can contribute to a flourishing human life and – as an integral part of that - the respectful treatment of nature. Virtue ethics is also relational in the sense that human flourishing presupposes that we are social beings, realizing ourselves in moral communities. This social sphere is not necessarily limited to humans but can be said to include animals, plants and nature as such.

This obviously opens up a discussion of when a human life can be said to be flourishing. In that sense any theory of virtues demand a "thick" understanding of what is *worthwhile* as Rosalind Hursthouse calls it (Hursthouse 1991). This is, however, no more disqualifying for this type of ethical theory than it is for more utilitarian or deontological approaches that also need to give "thick" descriptions of *happiness* respectively *rationality* to be able to engage in substantial ethical discussions (Hursthouse 1991). In the case of a virtue ethics approach focusing on questions of plant breeding, the virtues needed would be focusing not only on human relationships, but also on the relationship between humans and nature.

In order to identify the relevant virtues we have to analyse the broader context of plant breeding. The aim of industrial-scale breeding is typically to produce better plants for farming, meaning that good breeding practices are those that lead to good farming practices and to the kind of food products that are good. Good here in all instances meaning "lead to a flourishing life". It is not sufficient that the plants are acceptable from a pure biosafety perspective. For example, not only the effect of introduction a gene on the safety of food, feed and environment should assessed, but also the possibly changed use of chemicals due to that introduced gene, and the ecological footprint of these chemicals, socio-economic consequences for farmers, etc. The virtues of a good plant breeder includes taking seriously the needs and concerns of those who are going to grow and eat or use the plants, but also the environment where the plant will become an element. As Sandler (2007) points out, key virtues in assessing agricultural practices such as the use of GM plants include environmental sustainability and environmental stewardship.

Sandler (2007) argues that the current dominant GM crops are expressive of a domination and manipulation approach to agriculture that is contrary to these virtues, when a more comprehensive approach is the adequate response. The problems we face are connected to modern lifestyle choices and "social, economic, and institutional factors that contribute to our environmental and agricultural challenges" (Sandler 2007: 136). Thus, we have no reason to accept the environmental and socio-economic consequences posed by the current commercially available GM varieties. Note that these are not arguments against using the GM technology as such, but only against the current implementation of the technology. To assess whether GM plants are ethically acceptable, we need a more comprehensive approach where the issue is to what extent they contribute to solve significant challenges: "alleviate the suffering of the impoverished, eliminate global inequalities, or reduce the negative ecological effects of modern agriculture" (Sandler 2007: 137). Sandler mentions Golden Rice as a case of a GM variety that could be acceptable within a comprehensive virtue ethical evaluation. The essential question here is not the utilitarian whether the technology results in greater aggregated happiness, but the comprehensive question whether it is integrated in agricultural practices that are sound, environmentally friendly and productive.

Although Sandler's general conclusion regarding the framing of the GM technology appears warranted, his analysis can and should be expanded, to capture the "richness and complexity of our relationship with the natural environment" (Sandler 2007: 3) which is relevant in using biotechnology in plant breeding. The characteristics of the technology itself make a difference in the wider assessment. In this context, the making sense of a concept such as "naturalness" within an environmental virtue ethics approach can provide the required sophistication to the discussion.

Naturalness

The idea that the concept of *naturalness* has a role to play in the ethical discussions related to plant breeding technologies is, to say the least, contested. This both in the sense that plants developed through GM-technologies would be more "unnatural" than e.g. plants developed through conventional breeding technologies and in the sense that "natural" should in some sense be normatively different from the "unnatural" (Reiss and Straughan 2000, Weale 2010, Leyser 2014). Nonetheless there is no doubt that in the public sphere the idea that GM-technology is to at least some extent more "unnatural" than more conventional technologies is widespread and that this plays a role for the ethical evaluation of the technology (Verhoog 2003, Gaskell et al. 2011, Mielby 2013). This is by proponents of the technology often explained as a "misconception" of the technology, as it is no more or no less unnatural than conventional plant breeding that also meddles with the genes of the plants. The belief that the controversy regarding GM-plants can be made to disappear through enhanced information of the public on the nature of the technology is today often labelled the "knowledge deficit" or "knowledge gap" model (Cook et al. 2004) and has in many instances been shown not to be true as acceptance of the technology does not seem to grow with the level of information (Lassen et al. 2006).

As Sagoff (2001) points out, already J. S. Mill's (1806-1873) thoughts on "nature" show that if we look for absolutes in our definition of "nature", we end up with either a notion of nature as the totality of what is, which makes everything, including all human activities such as agriculture and GM-technology "natural", or a notion where that which is natural is that which is untouched by humans. But as it will be very hard to find anything on the face of the planet in the anthropocene age that has not already been touched by humans, this leaves us with no nature at all (Sagoff 2001). The task from a virtue ethics perspective must be to see whether the notion of "naturalness" that plays a role in the public objections to GM-technology, but from a narrow scientific perspective do not make much sense, can be translated into certain virtues and vices pertaining to the relationship between humans and nature thus balancing between the two Millean extremes. This will enable a discussion of the values underlying the critique of GM-technology from the “naturalness” point of view between proponents and opponents of the technology that could move beyond the futile discussions based on the knowledge deficit model.

If we assume that the public views on naturalness are connected to the kind of wider ethical assessment suggested above, we can talk of degrees of naturalness. If we also accept that what the naturalness argument objects to is the lack of respect for the complexity of nature as something that we only partially can and should control (Myskja 2006), then we can say that showing such respect is a central virtue in plant breeding. Then classical breeding is the paradigm of a practice that displays humility regarding human potential for control over nature, expressing respect for the value of nature independent of human interests. If we are going to accept more radical interventions, we must first ensure that potential negative consequences are acceptable, and that they do provide benefits that are distributed in accordance with the potential burdens. This can be understood as less morally problematic than to infringe on the values expressed in the “naturalness” objection

Assessment of different breeding techniques

When assessing the different techniques according to this virtue approach, the significant point is not the technique as such, but how it affects the traits of the plant with regard to effect on the ecological system, food, feed, and agricultural practices. Conventional breeding and DNA marker assisted selection are both expressive of respect for our limited capacity for controlling the complexities of nature, and are based on crossings and uncontrolled reshuffling of DNA during the meiosis and fertilisation, followed by selection on phenotypic traits and/or DNA markers. Cisgenesis respects the natural crossing borders between plants, and cannot lead to novel phenotypic traits, as compared to conventional breeding. From this point of view cisgenesis is close to conventional breeding. Intragenesis uses DNA of the plant itself and from crossable relatives, but novel combinations can be made between genetic elements, leading to traits or gene expression patterns that can be novel or altered compared to nature or conventional breeding. Transgenesis introduces foreign DNA, and can lead to novel traits, and therewith novel biosafety issues. Transgenesis can be regarded as less natural, and leading to less natural products, compared to cross breeding and cisgenesis. Spontaneous mutations occur frequently in nature and conventional breeding. However, untargeted mutation breeding leads to a far higher mutation frequency. Directed mutation leads to very few mutations only, which also could occur spontaneously in nature. The use of transgenic intermediates leading to end products without genetic changes, does eventually not lead to novel traits. According to the principles we suggest, the end-product should be classified as similar to end-products of DNA marker assisted breeding.

Conclusions

Based on a virtue ethics framework, we argue that there are ethical differences between plant breeding methods, with implications for policy and regulatory issues. The framework can contribute to an improved dialogue between the scientific community and the wider public as it makes the scepticism towards GM-technology more intelligible.

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