

Genomics and the Intrinsic Value of Plants

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Abstract

In discussions on genetic engineering and plant breeding, the intrinsic value of plants and crops is used as an argument against this technology. This paper focuses on the new field of plant genomics, which, according to some, is almost the same as genetic engineering. This raises the question whether the intrinsic value of plants could also be used as an argument against plant genomics. We will discuss three reasons why plant genomics could violate the intrinsic value of plants: 1. genomics is part of biotechnology; 2. genomics equals genetic engineering; 3. plant genomics may enhance trends that lead to the instrumentalization of plants. We will conclude that in the biotic view the intrinsic value of plants is violated by plant genomics only in case of ‘the genomics equals genetic engineering scenario’.

Introduction

Intrinsic value refers to the qualities of life, freedom and health¹. During the last agricultural crisis’s involving animals in Europe, like BSE and pig diseases, many groups in society criticised the policy of the government and the EU using their own version of intrinsic value. The concept is now also applied in discussions on the genetic modification of plants, where it is invoked to criticize modern biotechnology. For example, the adherents of organic agriculture² consider the introduction of transgenic material in a plant as a violation of its intrinsic value.

In contrast to modern biotechnology, the new interdisciplinary field of genomics is not concerned with single genes but with the whole genome. Plant genomics offers tools, like marker assisted breeding, that may be used by classical breeding, organic breeding and modern biotechnology alike. Nevertheless some groups claim that plant genomics is almost identical to genetic engineering³. Does plant genomics, as the switch to the whole genome (what could be considered a holistic view on the molecular level), influence the intrinsic value of plants?

1. Intrinsic value

The concept of intrinsic value, formerly strictly reserved for humans, is only recently well established in animal ethics. The concept means that animals have an ethical status, a value of their own, independent of the instrumental value for humans. In the Netherlands the concept of intrinsic value is even incorporated in the law on the protection of animals. Without the intrinsic value of nature environmental ethics becomes a particular application of human-to- human ethics⁴. In this traditional kind of ethics the term ‘intrinsic value’ is used to refer to certain conscious experiences of humans, and is thus anthropocentric⁵. In this view there is a central difference between humans and non-humans: only humans have moral relevance. Everything else has instrumental value. It is a situation of us against them. In traditional ethics agriculture is morally sound, and thus also plant genomics. It cannot interfere with the intrinsic value of plants because they have no moral standing.

According to Bryan Norton⁶ this traditional ethic works so well that we do not need a distinct, non-anthropocentric environmental ethic. He argues that the interests of people in all the diverse services that nature provides are quite enough to support nature protection. But what happens to species which are not of any service, or that run against the interests of people? Norton offers lots of other reasons why these species have to be protected anyhow. He concludes that a non-anthropocentric environmental ethic is simply redundant. Against this position Warwick Fox⁷ argues that it makes a huge practical difference when we grant intrinsic value to nature. In that case the burden of proof would shift from the conservationists to the people who are destroying nature. People would have to go to court seeking permission, for example, to fell trees. As a consequence people would also have to seek permission to perform all kinds of agricultural activities like cutting grass or leaves or other plant material.

With the rise of environmental ethics at the end of the sixties the term intrinsic value was also applied to the so called ‘higher’ animals that also have a conscious awareness because they can experience pain. The claim that nature has intrinsic value is the cornerstone of environmental ethics. In the terminology of Henk Verhoog⁸ this second step in the development of the concept of intrinsic value is called zoo centric ethics because humans only need to show respect to sentient animals. Verhoog argues that in the zoo-centric approach concepts developed in the anthropocentric tradition are extended to those animals that are closest to humans. In the zoo-centric view traditional animal husbandry violates the intrinsic value of animals, but it is also in this view impossible for plant genomics to violate the intrinsic value of plants because plants are not sentient animals. The third step in the development of the concept of intrinsic value, the bio-centric view, is an enlargement of the domain of intrinsic value to all living beings. In the biotic view intrinsic value is an absolute value, without degrees, and not connected to subjective human experience. This means that all activities of traditional agriculture violate the intrinsic value of all living beings in those activities. Does the biotic view also mean that plant genomics violates the intrinsic value of plants?

2. Plant Genomics

In the Dutch research setting, genomics is defined as ‘research by means of large-scale characterization of genes and gene products into the elucidation of the way genes, RNA, proteins and metabolites interact in the functioning of cells, tissues, organs and the complete organism and its environment, both in an individual or in populations of species, as well as between species’⁹. The most distinguishing issue in the Dutch definition is ‘by means of large-scale characterization’. A large-scale characterization, implicitly combined with a high or reasonable speed, places the notion of ‘high-throughput technologies’ at the heart of genomics research. The large-scale approach also motivates the further development of bio-informatics as a means to store, analyze and interpret the large amounts of data generated. By this combination with information science, genomics may and will help to move biology from *in vivo* to *in silico*. The ultimate and highly ambitious goal of genomics is knowledge and use of ‘all’: the identification and structure of ‘all’ genes, ‘all’ gene products and ‘all’ molecules and ‘all’ their interactions in ‘all’ parts of ‘all’ organisms during ‘all’ life spans in ‘all’ environments¹⁰.

Genomics researchers¹¹ promise or claim to revolutionize biology and transform biological science from a largely descriptive activity into an information science¹². In a combination of genetics and information technology, genomics will explore and exploit gene functions in living systems¹³. The knowledge that stems from genomics is thought to be useful in addressing the so-called problems of our time, such as pollution, disease and food supply. This knowledge could trigger further improvements in diagnosis, prevention and agronomic practice. Agricultural genomics may reveal what genes or combinations of genes do in plants and livestock. As genomics compiles a complete list of genes and what each of them does, the predictive power of genetic constitution on performance could increase. In this way genomics promises to have a major impact on our understanding of plant performance and also on the relevance of genes for that performance. This would help to identify in plants and livestock the variations that have high value. This could make plant breeding more efficient, but will also allow breeders to evaluate biodiversity within crops, gene banks and other stocks in a better way. Genomics could make crop growing more local and effective, as well as encourage growth of plants with combinations of genes/characters that suit the needs of farmers and farming communities.

Genomics of plant pathogens may identify the causes of plant diseases and indicate new ways of fighting them. Moreover, it can suggest strategies for minimizing the likelihood that resistance develops. Since it can show how pest organisms resist existing treatments, it may suggest new targets for novel pest management and the industrial manufacturing of such compounds. Crops that have an increased disease resistance reduce environmental impact and farming costs. Genomics will prevent pollution by reducing the use of pesticides and weed-killers in agriculture, and it may stimulate the use of plants in the cleaning up of soils contaminated with heavy metals or other undesired compounds¹⁴.

From a positivistic perspective, high-throughput technology-based genomics could be considered the ultimate culmination of the reductionist approach to biology: an explanation of life solely in terms of interactions of genes and molecules¹⁵. The explanation of biological processes in molecular terms, which are in turn reducible to chemistry and physics, would be the ultimate reduction. It is therefore interesting that in the view of some, genomics will allow for a reconstitution and focus on the organism as a whole (and population and ecosystem) and bring 'holism' back into biology¹⁶.

3. Intrinsic value and plant genomics

In the biotic view, plants, as living beings, have intrinsic value. We will discuss three reasons why plant genomics could violate the intrinsic value of plants: 1. genomics is part of biotechnology; 2. genomics equals genetic engineering; 3. plant genomics may enhance trends that lead to the instrumentalization of plants.

Biotechnology can be defined as 'the science and technology aimed at understanding and using living organisms or parts thereof to improve the organism for specific human uses or to make or modify a product'¹⁷. In this setting, many human activities should be considered part of the realm of biotechnology, and, because human use is

central in these activities, they would not be in accord with the biotic view. Genomics is or will become an important component of 'modern' biotechnology. Some feel that it is particularly special and will lift biotechnology to a new level; others feel that it should perhaps not even be considered part of biotechnology. In the latter case the arguments of the biotic view against genetic engineering do not apply to plant genomics. Apparently, terminology is used highly interchangeably, which may be taken as an indication that genomics is still a relatively young field of science¹⁸.

For some people genomics is the same as genetic engineering. This 'genomics equals genetic engineering scenario' is far from hypothetical. Both genomics and genetic engineering deal with genes, genetic material and improvements of plants. The distinction is a subtle one at most, which is easily forgotten or miscommunicated. The term 'genomics' may turn out to be a poor one¹⁹. The violation of the intrinsic value of plants is often used as an important argument against genetic engineering of plants. It is argued that genetic modification leads to an instrumentalization of plants. Transgenic plants are manufactured solely for the purpose of use by humans. The consequentialist version of the biotic view does not oppose genetic engineering as such, as a morally objectionable technique, but objects to the consequences of genetic engineering²⁰. According to Visser²¹ the questions to ask about genetic engineering are: do transgenic plants have a life that unfolds according their nature? Is life devoid of human interference in the interest of plants? Transferring these questions to plant genomics, the main question is: does the use of plant genomics interfere with plant life in a measure that their fundamental rights are violated?

Many scientists will answer this question by stating that the concepts of genomics and genetic engineering are neither synonymous, nor mutually exclusive. Agricultural genomics will point to genes (and phenotypes) in crop plants that could be used in the improvement of the organism or its associated agronomy for specific human uses. This improvement can be achieved through marker-assisted selection. This is an anthropocentric outlook, something that is part of agriculture in general. The improvements could also be put into action through genetic engineering. In genomics, genetic engineering is likely to be of help in answering research questions. The function of a plant gene may be easier studied in microbes or model plants in order to understand better what it does. However, application of such knowledge does not imply by definition the use of genetic engineering in plant improvement. In addition, the availability of funds for genomics research is a motivation to pursue the approaches thought to be specific for genomics. Genomics could, or is expected to, generate knowledge of plants that would allow obtaining desired improvements without the need for genetic engineering. In that case genomics is helping to maintain the intrinsic value of plants from the perspective of the biotic view. In the public perception, however, the relationship between agricultural genomics and plant genetic engineering seems much less clear. This is one of the reasons why some research programmes in plant genomics already gave priority to applications without genetic engineering²².

Agricultural genomics will have to face all the societal concerns associated with agricultural biotechnology in general, such as (over?) regulation, corporate control, ownership, distribution of profit and benefits, and safety. An important societal concern for agricultural genomics, even when excluding genetic engineering, may be

certain aspects of regulation. The level of regulatory scrutiny currently imposed on a genetically engineered crop is high and unprecedented for any product of plant breeding. Development and costs of such regulatory requirements may have significantly negative impacts on agricultural genomics. Alternatively, when agricultural genomics ends up in the hands of a few, very large, life sciences companies, these companies could consider regulation as a protective measure for their markets and market share. In this way, companies at the forefront of genomics innovations could be tempted to use regulation as a strategy to do away with potential competitors. Such developments may have equally negative impacts on future agricultural genomics. Agricultural genomics is a costly enterprise. High throughput technologies may make a single data point relatively cheap; total costs are considerable, due to the sheer numbers involved. Private investments far outweigh public funds, supported by mergers and continuous scale-up of life science companies. This implies that a few companies may decide over genomics research targets and applications. The corporate control of biotechnology in general, and future agricultural genomics in particular, is likely to generate considerable societal concern. Despite all the promises, agenda setting in genomics seems still focused on short-term goals. These relate to conventional, high-yield industrial agriculture aimed at profit.

Societal concerns about corporate control are immediately related to issues of ownership and intellectual property (IP). Different from plant breeding, ownership in agricultural genomics is based on patenting and patent protection. Genomics research is seen as economic investment that requires return. It seems likely that the patenting frenzy of agricultural biotechnology will continue in agricultural genomics²³. This will raise concerns about the equity, accessibility and desirability of agricultural genomics and its applications, but no concerns about intrinsic value. When agricultural genomics is seen as a high-input, high-cost, high-protected enterprise, a related legitimate concern is about the benefits of such genomics for the developing world. The developing world will face most serious problems with food supply. This concern is known as 'the genomics divide'²⁴.

Genomics can be expected to contribute to a further industrialization, economization and mechanization of agricultural production. From a biotic perspective that could be regarded as undesirable because these trends enhance the instrumentalization of plants, and thus violate their intrinsic value. Particular schools in plant breeding, such as organic farming, are still debating the acceptability of molecular markers, and similar discussions can be expected on the large-scale approaches of agricultural genomics. Moreover, any impact of agricultural genomics on a further industrialization of food production may trigger uncertainties about the safety of genomics products.

Conclusions

In general, genomics, especially when presented as a 'new' technology, will encounter all the suspicions any new technology is usually confronted with. It can be considered as a next step in the process that started with the discovery of the Laws of Genetics by Mendel and the double helix structure of DNA by Watson and Crick. Because plant genomics may be used in different kinds of agriculture, plant genomics will have to face all the ethical, moral, social and technical issues associated with agriculture in

general. Overall, there seems place and need for substantial research into the mechanisms of agenda setting in agricultural genomics research, the extent of corporate control and the diversity of society's evaluation of such issues. Policy makers and genomics researchers seem aware of the need to include society and the need to deserve a 'license to produce' and 'a license to sell', rather than to exclude society and go on²⁵.

It seems likely that how genomics will develop depends on the deliverables of the first years and technological progress in high-throughput technologies. Combined with mutagenesis, genomics may succeed in relieving crossing barriers and broadening the gene pool available for plant improvement without formally using genetic engineering. In society, this is likely to revive concerns about 'playing God'. Alternatively, the increased knowledge of plants and plant performance may eventually ease society's concerns about such and other changes.

From the perspective of traditional ethics and the zoo-ethical view, plant genomics does not violate the intrinsic value of plants. In the biotic view the intrinsic value of plants is violated by plant genomics only in case of 'the genomics equals genetic engineering scenario'. In all other cases plant genomics is as good or bad as traditional agriculture or organic agriculture.

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- 16 See Nap. op. cit. note 14. This point is also elaborated in B. Wynne. 2005. Reflexing Complexity; Post-genomic Knowledge and Reductionist Returns in Public Science. In *Theory, Culture & Society*, Vol. 22(5): 67-94.
- 17 CAST (Council for Agricultural Science and Technology). 1999. Applications of biotechnology to crops: benefits and risks, Issue paper 12, Ames, CAST, 8 pp. (http://www.cast-science.org/pdf/biotc_ip.pdf).
- 18 Nap. op. cit. note 14.
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- 22 See for example the programme of the Centre for BioSystem Genomics in the Netherlands.
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