New Breeding Techniques in Organic Agriculture

The Limits of Biotechnology for Organic Plant Breeding

8/27/2019

Bsc Thesis Eveline Massop
WAGENINGEN UNIVERSITY AND RESEARCH

New Breeding Techniques in Organic Agriculture

The Limits of Biotechnology for Organic Plant Breeding

Student:	Eveline Massop
Registration number:	970205547090
Study program:	International Development Studies (BIN)
Major:	Sociology
Chair group:	Rural Sociology
Supervisor:	Kees Jansen
Date:	8/27/2019

Abstract

New Breeding Techniques are able to create organisms that do not (completely) contain external genetic material and are especially interesting since they enable DNA mutations faster and more precise than ever before. With the development of the New Breeding Techniques the debate about its legislation started, since these techniques might be excluded from GMO-legislation. In 2018, the European Court of Justice decided that these New Breeding Techniques do require the GMO-legislation according to Directive 2001/18/EC. Organic Agriculture refuses gene technology and therefore it bans these New Breeding Techniques. Hence, even if the New Breeding Techniques were legislated as exemption from the GMO-Directive, they would not be allowed in organic agriculture. Organic consumers, however, seem to have a slightly different understanding of 'organic' than identified in the Principles of Organic Agriculture. The question then is for whom 'organic' actually is organic and why, what the limits of biotechnology in organic agriculture are, and how this can be explained by linking different perspectives to nature.

Table of Contents

Overview Tables and Figures

Tables

Figures

List of Acronyms

COROS	The Common Objectives and Requirements of Organic Standards
DNA	Deoxyribonucleic acid, a biochemical macromolecule functioning as the most important carrier of hereditary information in organisms.
ECO-PB	The European Consortium for Organic Plant Breeding
EOSTA	Innovative distributer in the organic fruit and vegetable supply chain on several continents.
FiBL	The worldwide research and consultancy institute of organic agriculture.
GMO	Genetic Modified Organism
IFOAM	International Federation of Organic Agriculture Movements
NBT	New or Novel (Plant) Breeding Techniques
RCOFs	Regular Consumers of Organic Foods
RNA	Ribosomal ribonucleic acid, essential for protein synthesis in all living organisms.
VIB	Flemish Institute for Biotechnology
VROM	The Dutch Ministry of Public Housing, Spatial Planning and Environmental Management, existing till 2010. Now covered in the Ministry of Economic Affairs, the Ministry Domestic Affairs and Kingdom Affairs, and the Ministry of Infrastructure and Water Management.
UPOV	International Union for the Protection of New Varieties of Plants

1. Introduction

Crispr (Clustered Regularly Interspaced Palindromic Repeats)-Cas9 (CRISPR associated genes and proteins) is an anti-virus system made of bacteria and archaea (Depuydt, 2018), able to create genetically modified organisms without foreign genes. As one of the New or Novel (Plant) Breeding Techniques (NBTs), it is able to change DNA fast, precisely and cheaply (Nijland, 2017) (Van 't Hoog, 2019). There is discussion taking place whether all these revolutionary techniques should be legislated according to the GMO-Directive (Van 't Hoog, 2019). On 26 July 2018, the European Court of Justice decided that Crispr-Cas9 has to be treated like other genetic modification techniques (Tuenter, 2018). Van den Ende (2019) claims that European guidelines for genetic modification do not fit to the current technologies and therefore regrets the Courts decision. Scholars like Van den Ende argue that the Crispr-Cas9 method is more detailed and easier to track than previous mutagenic practices (including radiation or chemical treatments) and is no threat to the environment. Therefore, the Crispr-Cas9 method should be excluded from GMO-labelling (Van 't Hoog, 2019).

The aim of this research is to identify whether Crispr-Cas9 and other New Breeding Techniques would possibly fit in organic agriculture. According to the Louis Bolk Institute, without the breeding of organic species, organic agriculture is not able to further develop in the future (Louis Bolk Instituut, n.d.). There is thus a great demand for organic bred seeds, which could be created fast and relatively cheap with the use of these NBTs. However, since organic agriculture banned the use of chemical pesticides, artificial fertilizer, genetically modified organisms and preventive antibiotics (Nature and More, n.d.), and the NBTs require GMO-legislation, they are not allowed to use in organic agriculture. How would these techniques be considered without this legislation? Often, the obtained plant could also have been created by traditional mutagenesis, but the obtained plant does not (completely) contain foreign genes. Therefore, I propose there has to take place a discussion within the Organic Movement about its limits of biotechnology. These discussions are already taking place, but there is need for a clarification what different actors are claiming and why. In order to do so, this research links these arguments to different views on nature developed by Holling/Timmerman and Zweers.

The structure of this literature research will be as follows. Chapter 3 elaborates on the gathering of information, followed by the Theoretical Framework that elaborates on the development of social groups within a society and different views on nature. Chapter 4 describes the NBTs and their legalisation. The Organic Movement will be discussed in Chapter 5: how did the movement develop, what does 'organic' mean and what is important for organic plant breeding? Chapter 6 challenges 'organic': who decides what 'organic' is, who are the consumers of organic products, what are the challenges for the Organic Movement and organic plant breeding, and why is gene technology excluded in organic agriculture? In the Discussion these arguments discussed will be linked to the different views on nature. Finally, the limits of biotechnology and its argumentation will be concluded upon.

2. Methodology

To answer the question what the limits of biotechnology are for organic agriculture, different actors and their arguments were compared in a qualitative or descriptive literature research. Search engines used are google.scholar.com and the Wageningen University Library and the starting search terms were: “biotechnology in organic agriculture”, “Crispr-Cas”, “Cisgenesis”, “plant breeding” and “organic agriculture”. After the first global research on these relatively obvious terms, the snowball method was used for further research. Names that passed by often were: Edith Lammerts van Bueren, Niels Louwaars, Paul Struik, Nick van Eekeren, Edwin Nuijten and Ernst van den Ende. Edith Lammerts van Bueren is the first scholar specialized in organic plant breeding and therefore especially relevant for this research. The Louis Bolk Instituut is referred to often in articles written by Edith Lammerts van Bueren, or articles using her quotations. Other institutions that turned out to be very interesting were the IFOAM, VIB, EOSTA and VROM. These terms, names and institutions were used for further research.

3. Theoretical Framework

Over the years, the growing number of organic farmers and their supporters used to be seen as a counterculture. Whether this is correct is debateable, it is without any doubt a countermovement that created the organic industry (Kuepper, 2010). The concept 'counterculture' or 'contraculture' is identified by John Milton Yinger (1960) as a group within a society that bases their existence on a theme of conflict with the dominant culture. Despite the fact that Pollan (2006, p. 141) claims that the radical Organic Movement ended up in the American mainstream, I would argue that today's organic agriculture might probably fit better within the term 'subculture', since organic agriculture is not well known by all in our dominant culture. A subculture can be defined as: 'a group with own characteristics within a greater group or specific culture' (VanDale, 2019). The question remains what the incentive is for the Organic Movement to occur. Is the movement based on an individual conviction or can it be explained on a more societal level?

The individual conviction can be explained by the Social Identity Theory from Tajfel and Turner (1979). According to this theory, social categorizations within a society enable the individual to undertake social actions and therefore leads to self-reference: people can decide where in society they would like to be. This theory is relevant since supporters of the Organic Movement often have a certain believe in what is sustainable and what is or is not allowed in organic agriculture. In this sense, this would imply that organic agriculture itself determines what it would like to be and therefore is. Individuals themselves determine that they favour the Organic Movement.

On a more societal level, Schwarz and Thompson (1990) identified the aggregation problem: the social choice and values an individual has do not have anything to do with an individual's autonomy, but rather with the fact that every individual is an 'institutionalized individual'. Thus, people are social beings and our opinions derive not simply from the fact that we are involved, but from the distinctive organizational forms we are participating in. What we know and consider as knowledge requires a relation with other people. Here, an exchange of norms, values, meanings, and so on, takes place. Therefore, Schwarz and Thompson (1990, p. 2) state that "knowing, in other words, presupposes culture". Consequently, their definition of culture is as follows: "..., the universal solvent through which politics, technology and social choice are all dissolved into one another" (Schwarz and Thompson, 1990, p. 2). Hence, contradicting with the Social Identity Theory, it claims there are is already a broad understanding within a society and an individual is always shaped by this when giving something a value. Schwarz and Thompson (1990) linked this theory to the concept of nature. They found three principles at the heart of perceptions on nature within our Western society, see Table 1: Attitudes at the Base of Different Views on Nature by Schwarz and Thompson (1990).:

No.	Principle
1.	Views on nature are not uncommon.
2.	Views on nature go further than science (facts) and legalization (decision-making, even when consequences are uncertain).
3.	Studies bring both natural as social scientist together which makes it more interesting.

Table 1: Attitudes at the Base of Different Views on Nature by Schwarz and Thompson (1990).

Schwarz and Thompson (1990) use the by Holling (1979, 1986) and Timmerman (1986) identified approaches towards ecosystem stability, the so called the 'myths of nature'. These are elaborated on in Table 2. The "ball" symbolizes nature in the approach column. According to Schwarz and Thompson (1990), the identification with a view leads consequently to the misunderstanding of (feeling opposite towards) the other views. Their conclusion therefore is that "society is deprived of the benefits of innovation" (Schwarz and Thompson, 1990, p. 5).

In order to explain the limits of biotechnology for organic plant breeding, it is important to identify the different views that the involved actors have.

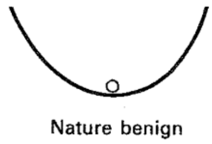
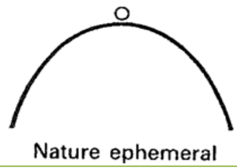
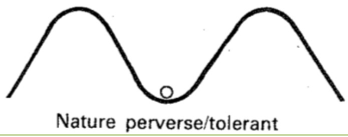
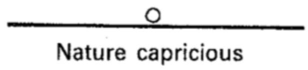
View by Holling/Timmerman	Meaning	approach
Nature benign	It does not matter what we do with nature, since it will always recover itself. *Thus, the ball will always return to the middle of the basin.*	Laissez-faire. 
Nature ephemeral	We should treat the earth with care, otherwise we damage the earth irretrievable and would collapse. *The ball is in balance but can easily get out of balance.*	Treat with care. 
Nature perverse/tolerant	Earth can recover from most events, however, earth has limit (undefined) which should not be crossed. *The ball roll back to the middle most times, however the limits should not be crossed.*	It is important there are ground rules to make sure that the limits earth has, will not be crossed. Following the ground rules, there should be space left for own interpretation. 
Nature capricious	No defined ideas about nature. It just deals with nature as it is without learning lessons from earlier events. *The ball can just roll.*	Dealing with 'erratic events'. 

Table 2: Views on Nature identified by Holling/Timmerman according to Schwarz and Thompson (1990, pp. 4-5).

De Groot (2010) describes the six perspectives towards nature identified by Wim Zweers (1989, 1995, 2000) (see Figure 1): 1) The 'Despot' stands above nature and controls it, meaning that humans can do whatever they like, without taking nature into account. 2) The 'Enlighted Despot' takes as much advantage of nature as possible, however it understands that humans are dependent of nature. According the ' Enlighted Despot', humans can help smoothening natural processes. 3) The 'Steward' regards itself above nature but is aware of the fact that it does not own it. It acknowledges it has the duty to use the earth in a sustainable manner in order for current and future generations. 4) Based on an equal relation of human and nature, 'Partnership' claims that both nature an human have an intrinsic value but have their own identity. This 'Partner' believes that the goas both nature and humans have are as important. However, it is difficult to define nature's goals. Reciprocity is an important concept, and therefore Zweers (1989) acknowledges that this approach has a more metaphorical function (it is not applicable in real life because of the fact that nature is not able to define its own goals). 5) The 'Participant' regards nature as a unity, including humans. All forms of life are as important. 6) The 'Unio Mystica' represents a feeling of connection with everything that surrounds us and in that sense can be regarded as spiritual.

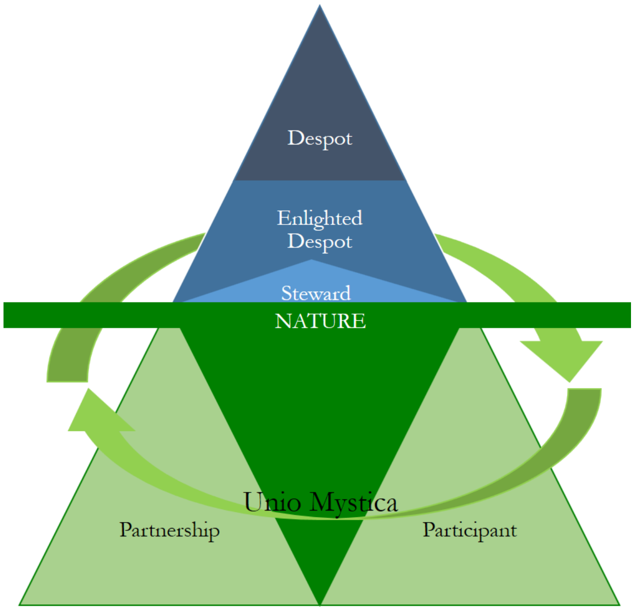


Figure 1: Perspectives Towards Nature Based on Zweers (1989) by De Groot (2010).

Why are these theories on society related to nature important? With the development of the New Plant Breeding techniques, several debates have started in the organic field. These theories suggest that technological innovation, like the Novel Breeding Techniques, should not be perceived as simply market or science driven. Jansen and Vellema (2004) used Coombs (1995) to explain that the implementation of new technologies rather is a sociological process, which makes path dependency a relevant concept: choices made in the past will influence developments in the present or future, since some possibilities became impossible. A new technology will always be institutionalized according to existing regulations. Its path can only be changed when regulations change. Thus, how should these NBTs be legislated? Several competing perceptions will be discussed in this thesis. A relevant question is how these different perceptions can be linked to views on nature. Since the New Plant Breeding Techniques are able to change DNA without the use of external genes and are able to create mutations that possibly could occur with use of classic plant breeding methods excluded from GMO-regulations and are based on natural plant reproduction, they might fit in organic agriculture. Organic agriculture does not allow the use of genetically modified organisms, but how should these new methods then be considered? Several opinions are identified and discussed in Chapter 6 and linked to the just described theories in the Discussion. In the end, the aim is to find the limits of biotechnology for organic agriculture.

4. New Biotechnological Plant Breeding Techniques

Genetic modification is "a technique to change the characteristics of a plant, animal or micro-organism, by transferring a piece of DNA from the one organism to the other" (Wageningen University and Research, n.d.-b) and is used since 1982 (VIB[1] & Schaart, 2015). Hence, A genetic modified organism is "an organism, excluding human beings, of which the genetic material is changed in such way it is not possible in natural reproduction and/or recombination" (VROM, 2006, p. 6).

There are two mechanisms to change the DNA of organisms (Stibbe & Timmermans, 2018). Through Transgenesis, genes derived from another species are implemented in the genome of the specific species. The new species consequently will show characteristics of the external organism. The other method is Mutagenesis, where no foreign DNA will be implemented and where the genome does not change. Mutagenesis can occur in nature, but is also artificially applied. (Stibbe & Timmermans, 2018). The arrival of the NBTs blurred this distinction (Farm Europe et al., 2017). Amongst NBTs are Oligonucleotides, Reverse Breeding, Agro-Infiltration, Cisgenesis, Intragenesis and Crispr-Cas9 (Farm Europe et al., 2017), Site-Directed Nucleases (SDN), RNA-dependent DNA methylation (RdDM), grafting and Synthetic Genomics (Atanassova, & Keiper, 2018). Site-Directed Nucleases is also known as Sequence-Specific Nucleases. The mutations created can also be obtained by traditional Mutagenesis, but the advantage of the new technology is that the mutation can be made specifically on the intended location (Schaars et al., 2015). It falls outside the scope of this thesis to provide technical details on RdDM and Synthetic Genomics. Grafting can be used in organic agriculture and will be referred to in the following Chapter. The other NBTs can be subdivided amongst the two genetic modification mechanisms (Figure 2). The perceived advantages of the NBTs are elaborated in Table 3.

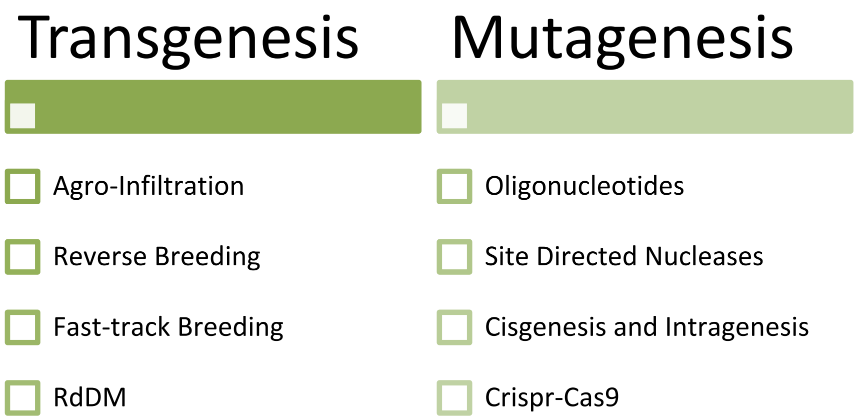


Figure 2: NBTs Divided amongst Transgenesis and Mutagenesis.
Based on Atanassova & Keiper (2018), Norkunas et al. (2018), Schaart et al. (2015), Schouten & Jacobsen (2008), VIB (n.d.) and VROM (2006).

[1] VIB is the Flemish Institute for Biotechnology.

No.	Advantage	Elaboration
1	Technical	A genetic modification technique does not necessarily lead to an offspring that also has the desired characteristics. Using NBTs can create plants of which the offspring also contains the desired characteristics. (Farm Europe et al., 2017).
2	Economic	Plant breeding goes faster than ever before. Conventional methods take up to ten years to develop a plant, which can now be reduced drastically and leads to lower production costs. (Farm Europe et al., 2017).
3	Crop	Genetic modification makes it possible to create plants or crops that are more resistant towards diseases or droughts, can produce higher yields or higher nutritional value or might be better to store. (Farm Europe et al., 2017).
4	Sustainability	"More efficient production, more food, and better use of water and other resources" (NBT Platform, 2015-b, p. 1).

Table 3: Benefits of the Use of NBTs (Farm Europe et al., 2017) (NBT Platform, 2015-b).

4.1 Methods

4.1.1 Transgenesis

Transgenesis is the implementation of genetic material from not related species. (Wageningen University and Research, n.d.-b). Amongst the NBTs there are three methods of which the final organism does not contain any or fully foreign material that are important to elaborate on shortly: Agro-Infiltration, Reverse Breeding and Fast-Track Breeding.

Agro-Infiltration uses soil bacterium 'Agrobacterium tumefaciens' (Norkunas et al., 2018). The bacterium is usually responsible for the transfer of DNA to plant cells during the development of a genetically modified plant. In the Agro-Infiltration method, the bacterium is sprayed into one or more leaves where it can spread itself further into the plant in order to produce proteins. In this way, a gene can be implemented in the DNA. The method is especially used to create resistant varieties. There is however discussion whether the whole plant should be labelled as genetic modified organism, since not all the leaves contain genetic modified organisms. (VIB, n.d., p. 26).

Reverse breeding is the opposite of creating an F1-hybrid (see the next Chapter) meaning that old parents can be redeveloped with this method. The technique itself requires genetic modification, however the final organism does not contain genetically modified organisms (VIB, n.d., p. 22). The final plant is even identical to the starting plant (VROM, 2006). See Annex 2 for further information about this method.

Fast-Track Breeding can only be used for trees and reduces the breeding period from 30 years to 5 years. The method uses reverse breeding and inoculation. This means the method is genetic modification, however the end product is not a genetically modified organism (see Figure 3). (VIB, n.d., pp. 23-25).

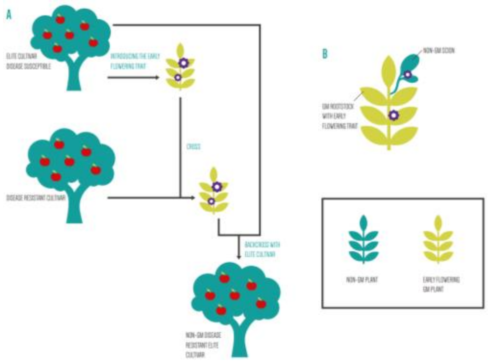


Figure 3: Fast-Track Breeding (VIB, n.d.).

4.1.2 Mutagenesis

This method requires 'mutagens' to breed and there are two different types: first, physical mutagens including radiation and temperature; and second, chemical mutagens including gasses and liquids (Alkema, 1974). Radiation can be both neutron rays or X-rays. Rays break though the cell wall to change DNA by changing or destroying chromosomes (Alkema, 1974). In chemical mutagens there are many chemicals that can be used (Alkema, 1974). A common used chemical is ethyl methane sulphate (EMS) (VIB, n.d., p.16). The plant breeder does not know in advance which part of the DNA will change, or when it will happen. Mutation breeding often leads to radical changes compared to hybrids, since it can change whole DNA fragments (VIB, n.d., p.16). Thus, mutation breeding is a matter of trial and error. Although no foreign DNA is introduced and the genome does not change, it is an artificial method to change DNA. Three methods will be elaborated upon.

Firstly, with the Oligonucleotide-Directed Mutagenesis (ODM) method it is possible to choose which part of the DNA a breeder would like to change (Atanassova & Keiper, 2018). Breeders develop a piece of DNA, the 'oligonucleotide' and introduce it mechanically in the cell. Since the oligonucleotide does not match there is no binding, but the plant does recognize the mistake and will recover the DNA by taking over the mutation of the oligonucleotide. Then the oligonucleotide will be demolished, but the mutation is stabilized in the plants' DNA. Since there are no extra genes are included, the oligonucleotide is an example for the plant how it should change its DNA. Thus, the DNA changes are very precise, but could possibly also have been created by broadly accepted classic mutation breeding. Therefore, some would like to see this method as an exception to existing GMO-regulations. (VIB, n.d.). An oligonucleotide is considered as 'recombinant', thus the method is subject to a permit (VROM, 2006). Therefore, it is not an exempt genetic modified organism.

Secondly, Cisgenesis and Intragenesis both developed as alternatives to Transgenesis (Holme et al., 2013). The similarity between Cisgenesis and Intragenesis is that both only use genetic materials derived from the species itself or from closely related species (Holme et al., 2013). It is not clear yet what the Agrobacterium strain consist of, but it is clear that it is important for both Cisgenesis and Intragenesis as a tool for the transferring of DNA (Gelvin, 2003). Schouten & Jacobsen (2008, p. 260) define a cisgenic plant as "...a crop plant that has been genetically modified with one or more genes isolated from a crossable donor plant". Thus, cisgenic plants only contain genes derived from the <u>same</u> species or from <u>sexually compatible</u> species (Schouten & Jacobsen, 2008). Schouten & Jacobsen (2008, p. 260) define intragenic plants as "...a genetically modified plant that only contains genetic elements from <u>within the sexual compatibility</u> group". The method "creates new genes with desired traits by isolating functional genetic elements such as promoters, coding parts or terminators of existing genes, rearranging them in vitro, and inserting this new 'intragenic' DNA combination back into the plant" (Schouten & Jacobsen, 2008, p. 260). In other words, genetic elements are taken out of the plant and changed outside of the plant, for example in a lab. Then this new, changed piece of DNA is inserted back into the plant. The specific differences between Cisgenesis and Intragenesis are discussed in Annex 2. The two main arguments why scholars debate their regulations are: first, the specific gene pool important for Cisgenesis or Intragenesis is the same as for conventional breeding. Since conventional breeding does not require the regulation, then why should Cisgenesis and Intragenesis need this? (Holme et al., 2013); and second, the part of DNA which is inserted using Intragenesis is better known than the DNA created with conventional breeding, which makes the method equally safe or even more safe (Schouten & Jacobsen, 2008).

Thirdly, Clustered Regularly Interspaced Short Palindromic Repeat (CRISPR)/CRISPR-associated protein 9 (Cas9) method is based on a process already existing in the immune system of bacteria. It protects the bacteria against invading 'nucleic acids' (viruses). (Bortesi & Fischer, 2015). First, a bacterium spots a virus DNA and starts producing two types of short RNA.

(McGovern Institute, 2014). RNA can be explained as the intermediary between DNA and proteins (Natuurinformatie, n.d.). One of these RNA types fits on the DNA sequence of the virus that tries to enter the bacteria, and is therefore called the 'Guide-RNA'. The RNA and the virus are connected, and form together a complex with the protein Cas9, which has an enzyme able to cut DNA. Then, the RNA finds the virus and with help of the Cas9 the virus will be cut off (McGovern Institute, 2014). This is visualized in Figure 4. The ability to change the guide RNA creates endless possibilities. Thus, in case of changing plant material, pick a piece of DNA that one desires to replace. Then match the guide-RNA and the DNA, and the Cas9 protein will cut it. Then the DNA in the cell will recover, including the piece that is chosen in place of the cut DNA. (Memo Kennislink, n.d.). Bortesi & Fischer (2015) state that the numerous publications about Crispr-cas9 in the relatively short time period since its actual development reflect the possibilities of the method. There are two main advantages when using Crispr-Cas9. First, the modifications are more precise than ever before and it takes only a few months instead of years for traditional breeding (Depuydt, 2018). Second, it is easier since it does not require protein engineering or cloning (Bortesi & Fischer, 2015).

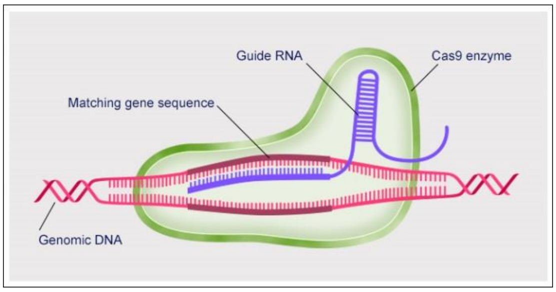


Figure 4: Crispr-Cas9 (Hobbs, 2016).

4.2 The Legislation of NBTs

4.2.1 Directive 2001/18/EC

Current EU-regulations about the use of genetic modified organisms are established in 2001 in the Directive 2001/18/EC ("EUR-Lex: Access to European Union Law," 2001). Based on the debate about the possible risks for both human and nature (VROM, 2006), the Directive 2001/18/EC defined three categories to regulate different breeding techniques (Figure 5).

The first step is testing whether the method used leads towards a genetic modified organism defined as: "an organism, excluding human beings, of which the genetic material is changed in such way it is not possible in natural reproduction and/or recombination" (VROM, 2006, p. 6). In case it does not fit the definition, Annex 1A Part II applies (Category one). Following the figure, methods like in vitro fertilisation, conjugation, transduction, transformation and polyploidy induction are not leading towards a genetic modified organism. In case the organism does fit the definition, Annex 1A Part I applies (Category two) (VROM, 2006). Some GMOs are excluded from the GMO-regulations. These fit in Annex 1B (Category three). The justification of this decision lies in the fact that these methods were already in use on large scale and have proved to be safe (VROM, 2006).

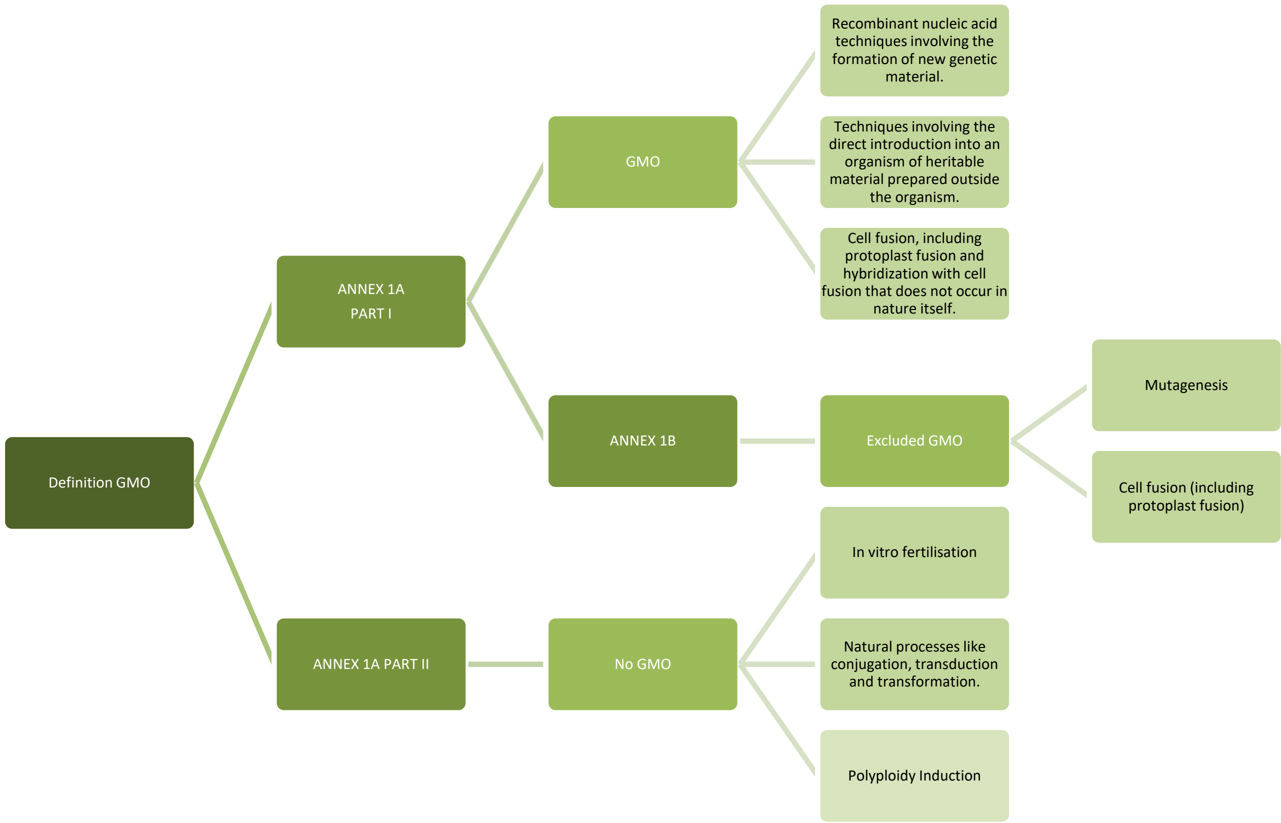


Figure 5: Classification of Plant Breeding Techniques.
Based on VROM (2006) and "EUR-Lex: Access to European Union Law" (2001).

4.2.2 The Development of New Plant Breeding Techniques and the Directive 2001/18/EC

At the time the Directive developed, techniques using genetic modification always led to an organism of which the genetic material was changed (VROM, 2006). Techniques like genome editing or RNA interference did not exist yet (Farny, 2018). However, with NBTs it becomes possible to use genetic modification without the end organism containing (changed or from another variety) genetic material, see Figure 6. Consequently, this leads to a problem: how to legislate these new methods by law? (VROM, 2006). Several arguments developed over the years pro and con the exemption of the methods within the GMO-Directive, see Table 4. Habets et al. (2019) identified five fields to categorize the arguments: safety, innovation, fair trade, ethics and societal values. On the one hand, La Via Campesina[2] (2017) wrote a complete statement why the new methods all should be included in the regulations, without any exemptions. Their arguments are visualized in green boxes in Table 4. On the other hand, the supporters of the NTBs organized themselves in a plaform: nbtplatform.org. The aim of the platform is to provide easy access to informantion about the NBTs and the products created (New Breeding Techniques Platform, 2015). Interestingly, Enza Zaden and VIB, both leading plant breeding institutions in Europe, are members of the platform (New Breeding Techniques Platform, 2015). In their 'Legal Briefing Paper' (2013) the platform concludes that the NBTs do not create genetic modified organisms. However, the judgement from the European Court of Justice was still absent at the time. Despite the fact that they do not give specific arguments for the exclusion of the NBTs in GMO-regulations, due to the solely economic advantages of the NBTs they refer to (Table 4), it becomes clear these people are in favour of the exclusion of GMO-legislation. On 25 of July 2018, the European Court of Justice judged in Case C-

[2] The largest farmers' movement on earth that striving for the rights of farmers, based on the principles of agro-ecology and food sovereignty.

528/16 that when Mutagenesis changes DNA in such way it cannot occur in nature, it is covered in the Directive 2001/18/EC due to the Precautionary Principle (Stibbe & Timmermans, 2018). The Precautionary Principle implies that decision-makers take precautionary measures in case scientific evidence about the consequences for human and environmental health are uncertain but perhaps present (Bourguignon, 2015). Nevertheless, the European Court of Justice acknowledges this is different for organisms that are already widely used and proved their safety, thus these methods are excluded for the GMO-Directive (Stibbe & Timmermans, 2018) (Habets et al., 2019).

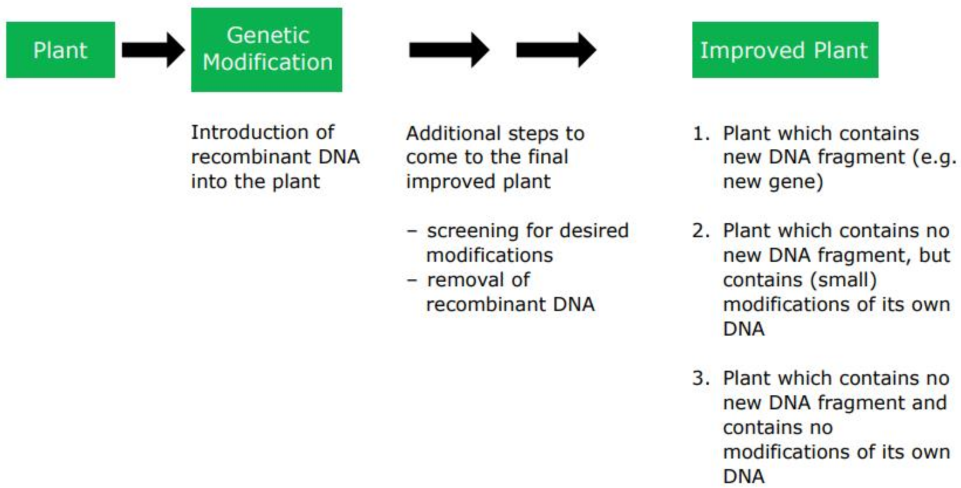


Figure 6: Characteristics in a Plant after the Use of NBTs.
(Schaart et al., 2015).

According to Habets et al., (2019), legislation now might be clear, but that does not mean the debate is closed. The debate now is focussed on the question whether the GMO-Directive should remain the way it is now, or that the law should change. Experts like Ernst van den Ende[3] and Arjen van Tuenen[4] claim that the decision is legally and politically driven, but not scientifically (Yoo, 2018). The aimed change would be a focus on the final organism instead of the focus on the method. Some scholars claim that in case the final organism does not contain foreign DNA, it should be free of the GMO-Directive. Other scholars claim the Directive should change completely, combining both opinions, by arguing that a new method requires an individual assessment on safety, characteristics, complexity and the societal value (Habets et al., 2019).

[3] Ernst van den Ende is director of the Plant Sciences Group at Wageningen University and Research.

[4] Arjen van Tuenen is director R&D Keygene for Enza Zaden en Rijk Zwaan.

No.	Field	Pro exemption	Con exemption
1	Safety	There are no risks for both human and environment, since products on the market already went through a risk assessment. Several NBTs create organisms that do not contain foreign DNA. Consequently, it will not have any different influence on the environment. "Since some but not all of the NPBTs are capable to delete or insert DNA fragments, or to modify single nucleotides of the DNA in a targeted manner at a predefined region of the genome, hazards associated with the disruption of genes/regulatory elements in the recipient genome can be minimized" (Broll et al., 2019, p. 289).	The long term effects for human and the environment are insufficiently identified. understudied. Without legislation it is possible to hide health risks for both human and the environment. Without legislation the cultivated biodiversity will further decrease.
2	Innovation	Economic development cannot be constrained. The label 'GMO' is not perceived attractive by consumers, consequently the GMO-product will hardly sell and is in that sense therefore an economic constrain.	If the products are exempt, it is not able to control anymore. Consequently, the consumers right to have free choice to decide whether they are willing to consume GMOs, cannot be guaranteed. To make sure transparency and traceability remain simple.
3	Ethics	The modifications can be made by traditional plant breeding, meaning there are not more risks involved using NBTs over traditional methods. Then why constrain them to regulations? Boersma (2017): "nothing we eat deserves the label "natural"".	The intervention in the plants' DNA is unnatural. "Human beings cannot invent in nature". "Tradition cannot be new".
4	Fair trade		"The suppression of the rights of farmers and peasants over their seeds". To prevent the disappearance of small and medium-sized seed companies. To prevent the threat from patents (Chapter 6)
5	Societal values		Without a label, consumers are not aware that genetic modification as method took place. This argument relates to the following argument: "only when consumers are informed can GMOs be rejected".

Table 4: Arguments Pro and Con the Exemption of NBTs within the GMO-Directive 2001/18/EC. Based on: VROM (2006, p. 8), "EUR-Lex: Access to European Union Law" (2001), Habets et al. (2019), Broll et al. (2019, p. 289), La Via Campesina (2017) and Boersma (2017).

Especially the Crispr-Cas9 method causes a lot of commotion. The arguments why Crispr-Cas9 should be exempt from GMO-regulation can be linked to the arguments already stated in Table 4. For example, Ernst van den Ende claims that the final organism does not differ from an organism bred under natural conditions, there is no difference between the organisms. Van Tuenen claims that it is only possible to do this in DNA that is already known by scientists and there are no external genes implanted. For this reason, Crispr-Cas9 is no genetic modification, according to Van den Ende. (Yoo, 2018). He claims that in case the end product is safe, the regulations should make it possible to bring the product on the market without the GMO-legislation. However, he acknowledges the fear people might have towards these methods, since once crossed the line for plants, the borders of for example modification in human beings comes closer and closer. He refutes this by claiming that genetic modification is already widely used in the production of medicine. Then nobody complains. (Yoo, 2018). Van den Ende bases his arguments on the perception that we need to ban world hunger and use our planet more sustainably (Yoo, 2018). This will be more elaborated upon in the following chapter. Johan Cardoen[5] however acknowledges there are possibly side effects when using Crispr-Cas9, but also refers to studies that show that mobile phones are causing brain damage, while we still use them. That is what happens when the advantages preponderate the disadvantages (Depuydt, 2018). This is a perfect example of what Lammerts van Bueren et al. (2007) call 'a consequential-utilitarian approach': a focus on the usefulness and the potential of a product, without including ethics. Broll et al. (2019) therefore call for further research, in order to limit off-target effects, but also argue that off-target mutations are smaller compared with off-target mutations acquired with classical mutagenesis.

4.2.3 Consequences of European Legislation

As explained the previous paragraph, the European Union follows a process-oriented approach to regulate genetic modified organisms. Most countries do so, however, the United States and Canada for example, follow a product-oriented approach (Broll et al., 2019). Since the European Court of Justice considers organisms obtained by using NBTs as genetic modified organisms, there are very strict rules that companies have to follow. According to Cardoen this will make it very hard for small companies in the European Union to keep their business economically viable: "[the judgement on the 25th of July 2018 is] the deathblow for plant research and agriculture in Europe" (Depuydt, 2018). He bases his claim on the following arguments: first, the legislation will slow down the implementation of the technologies and it is very expensive to acquire the required papers; second, he claims that varieties carrying the GMO-label are systematically rejected by the European Committee; and third, not enough research has been done yet in the European Union. In case this is not going to happen any soon, he does not doubt the food prices in Europe will increase enormously. Europe will then become dependent on other regions in order to meet the demand for food. (Depuydt, 2018). In this view, the Directive is not beneficial for our competitive position in the world market. It may be clear Cardoen favours a revision of the Directive/18/EC as it currently is.

[5] Johan Cardoen is director of VIB: the Flemish Institute for Biotechnology.

5. Organic Plant Breeding Regulations

5.1 History and Principles of Organic Agriculture and Organic Plant Breeding

Organic agriculture developed itself from the 1920s onwards due to the problems farmers experienced: erosion, soil depletion, decline of crop varieties, low quality food and rural poverty (Kuepper, 2010). These farmers introduced "not feeding the crops, but feeding the soil" to grow their yield (Kuepper, 2010, p. 3). Due to the fact that the humus-layer of the soil was the main focus of these farmers, they were called 'humus-farmers'. They debated about the use of artificial fertilizer and pesticides. The concept 'humus-farmer' was replaced by 'organic-farmer' in the 1940s, because 'humus' was not fashionable anymore. (Kuepper, 2010). At this time the debate about the healthiness of organic products started (Kuepper, 2010). In the 1950s organic seed production and organic breeding started to develop, however it took companies till the mid-1980s to really start business (Jongerden et al., 2002). From the early 1960s, the health issue was became an issue due to the bioaccumulation of pesticides (Kuepper, 2010). The National Organic Standard prohibited the use of genetic engineering in organic agricultural practices in the 1990s, due to possible health implications it would cause (Kuepper, 2010). These events might seem rather logic, however the Organic Movements is only since the 1970s coming more and more out of its marginalized position (Kuepper, 2010).

In this same time period (1970s), IFOAM (International Federation of Organic Agriculture Movements) developed itself as the most important guiding institution on organic agriculture, coordinating actions and to enabling scientific research (IFOAM, n.d.). The IFOAM has three main goals: first, facilitating the capacity for sustainable production; second, raising awareness for organic agriculture; and third, policy and guarantee which is the translation of the four principles of organic agriculture (see Table 5) into policies dealing with food security, climate change and biodiversity. (IFOAM Organics International, n.d.).

No.	Principle	Elaboration
1	Health	It does not mean the non-appearance of illness, it rather means "the maintenance of physical, mental, social and ecological well-being" (IFOAM-Organics International, 2017, pp. 9-10). Human health cannot be seen apart from the health of ecosystems. It is specifically organic agriculture that is responsible for the improvement of ecosystems and living beings.
2	Ecology	This principle states that production is based on ecological processes and recycling and inputs therefore should be reduced. It is important that organic companies adjust to local conditions, including culture, scale and ecology.
3	Fairness	Everybody involved in organic agriculture should have a good quality of life and should make contributions to food sovereignty and poverty reduction. Open systems of production, trade and distribution are important and both environmental and social costs should be taken into account.
4	Care	The Precautionary Principle is momentous: because of the incomplete understanding of ecosystems and agriculture, both existing and new technologies must be constantly revised.

Table 5: The Principles of Organic Agriculture by IFOAM Organics International (2017).

These four principles are dynamic and constantly revised. Consequently, several adjustments were made over the years. Bringing these four principles into practice might be challenging since the principles do not guide farmers how to practically achieve these principles. Therefore, the Common Objectives and Requirements of Organic Standards (COROS) were developed in 2008. This document is based on globally already existing standards and regulations and constructed by a collaboration of the United Nations Food and Agricultural Organization, the IFOAM- Organics International Organic Guarantee System and the Global Organic Market Access. (IFOAM-Organics International, 2017, p. 13).

Organic plant breeding has a history of its own in Europe. Although some scholars argue it started in the 1950s with Germans inspired by the ideas of Rudolf Steiner[6] (Jongerden et al., 2002), organic seed production and organic breeding started in the mid-eighties (Jongerden et al., 2002). In many European countries organic plant breeding is organized by private breeders that are member of 'Kultuursaat', which is an association for bio-dynamic breeders (Lammerts van Bueren, 2017). This is slightly different in the Netherlands. Organic farmers have been in need for organic seeds since the 1980s, but did not feel the urge to develop seeds themselves and rather collaborated with breeding experts in the hope they would be willing to produce organic. (Lammerts van Bueren, 2017). The organic sector realized it had to be more assertive when genetic modification methods emerged in the nineties. Vitalis Biologische Zaden is an important organic seed breeding company in the Netherlands since 1994 (Jongerden et al., 2002) and since 2012 full subsidiary from Enza Zaden, an international seed breeding company originating from the Netherlands (Lammerts van Bueren, 2017).

The Dutch government asked the Louis Bolk Instituut in 1997 to check all plant breeding methods on its applicability for organic agriculture. This advice was replaced in 2002 for the regulations on organic plant breeding written by the IFOAM. The discussion about organic plant breeding regulations is however ongoing with the development of NBTs. (Lammerts van Bueren, 2017).

5.2 Plant Breeding Qualifications in Organic Agriculture

The Common Objectives and Requirements of Organic Standards (COROS) document includes the regulations for organic plant breeding. It defines organic plant breeding as "[the] selection of plants or animals to reproduce and/or to further develop desired characteristics in succeeding generations" (IFOAM-Organics International, 2017, p. 20). "Organic plant breeding and variety development is sustainable, enhances genetic diversity and relies on natural reproductive ability. It aims for new varieties particularly suited for organic production systems. Organic breeding is always creative, cooperative and open for science, intuition, and new findings. Organic plant breeding is a holistic approach that respects natural crossing barriers. Organic plant breeding is based on fertile plants that can establish a viable relationship with the living soil. Organic varieties are obtained by an organic plant breeding program" (IFOAM-Organics International, 2017, p. 20). Nuijten et al. (2016, p. 5) add that "the [organic] breeding goals match the respective crop species and the needs of the complete value chain of the organic sector (producers, processers, traders and consumers". In practice this means that organic plant breeding has to follow the requirements mentioned in Table 6.

[6] Steiner developed the principles of bio-dynamic agriculture.

No.	Requirement
1	"To produce organic varieties, plant breeders shall select their varieties under **organic conditions** that comply with the requirements of this standard. All multiplication practices except meristem culture shall be under certified organic management". - The use of GMOs or their derivatives, except vaccines is forbidden in all stages of the chain. - Irradiation or ionizing radiation is forbidden. - Artificial insemination is allowed, but embryo transfer techniques and cloning are forbidden.
2	"Organic plant breeders shall develop organic varieties only on the basis of genetic material that has not been contaminated by products of genetic engineering".
3	"Organic plant breeders shall disclose the applied breeding techniques. Organic plant breeders shall make the information about the methods, which were used to develop an organic variety, available for the public latest from the beginning of marketing of the seeds".
4	"The genome is respected as an impartible entity. Technical interventions into the genome of plants are not allowed (e.g. ionizing radiation; transfer of isolated DNA, RNA, or proteins)".
5	"The cell is respected as an impartible entity. Technical interventions into an isolated cell on an artificial medium are not allowed (e.g. genetic engineering techniques; destruction of cell walls and disintegration of cell nuclei through cytoplast fusion)".
6	"The natural reproductive ability of a plant variety is respected and maintained. This excludes techniques that reduce or inhibit the germination capacities (e.g. terminator technologies)".

Table 6: Requirements for Organic Plant Breeding.
(IFOAM-Organics International, 2017, pp. 17-20).

The European Union regulation 2092/91 issued in 1991, rules that seeds used in organic farming have to be bred organically. Skal, the only institution that certifies organic in the Netherlands (see Chapter 6), published a new National Annex on their website in January 2018. Organic farmers can check whether their starting material is qualified as organic on www.biodatabase.nl. When this is not the case, farmers can check if the starting material is maybe qualified as exception in Category 2. Then an exemption can be requested. In case this exemption is not given, the starting material fits within Category 3 and therefore cannot be used. (Skal, n.d.). This indicates the difficulty of organic cultivation, see Chapter 6.2.

5.2.1. Accepted Methods

Preferably, organic plant breeding only takes place on plant level. Plant breeding on DNA-level is not allowed, and on cell/tissue-level is debatable, see Table 6. (Lammerts van Bueren & Raaijmakers, 2008).

Several techniques are allowed in organic agriculture, amongst them are: combination breeding, species crosses, bridge crossings, repeated back crossings, temperature treatment, non-irradiated mentor pollen technique (Lammerts van Bueren & Raaijmakers, 2008), polyploidy induction (FiBL, 2015), conjugation and transduction (Sima, 2012). The methods combination breeding, species crosses, bridge crossings, repeated back crossings, temperature treatment and non-irradiated mentor pollen technique, only breed new varieties with changes on plant level, thus there are no changes on cell, tissue and DNA level. Sima (2012) added conjugation and transduction to the list because the method leads not necessarily to a genetic modified organism, however, since it uses in vitro fertilisation the methods are questionable for the use in organic agriculture. In-vitro fertilization takes place on cell-level in a lab, which is not considered 'natural' (see pp. 30-31). In case the DNA is changed directly, it is not allowed in organic agriculture. (EOSTA[7], n.d.-b).

Organic farmers can also use DNA-markers to investigate which offspring has the intended qualities. An advantage is that there is no direct intervention in DNA or cells. A disadvantage is that the technique is relatively expensive. Besides, in the development of these

[7] Innovative distributer in the organic fruit and vegetable supply chain on several continents.

markers often genetically modified organisms are used. This makes the use in organic agriculture questionable (Lammerts van Bueren & Raaijmakers, 2008). Besides, Hybridization, F1-hybridization and Inoculation are allowed methods in organic agriculture. However, there is space left for discussion, which will now be elaborated upon.

Hybridization is sexual reproduction, since the pollen from the one flower will be applied to the pistil on the other flower. It means that favourable characteristics from both flowers can be combined in order to get a more demand-satisfying flower. It does remain unknown which characteristics of the new plant go to the new plant, thus it is a matter of 'trial and error'. This is explained in Annex 3.

In Annex 4 is explained how to create F1-hybrids, famous due to the 'hybrid-vigor' or 'heterosis': this hybrid proves to be better than both of its parents for one or more characteristics (VIB, n.d., p. 13). Then why are not all crops hybrids? There are several explanations. Firstly, not all inbreeding-lines are suited for hybridization. Secondly, the quality of F1-hybrids is questionable. Thirdly, the farmer is forced to buy new seeds every year to keep its productivity running. This might be good for the seed industry, but is expensive for the farmer. (VIB, n.d., p. 14). Besides, F1-hybrids are only allowed in organic agriculture when the seed is created in organic growing conditions (EOSTA, n.d.-b). Consequently, some hybrids have parents which are so old and impaired they can only give good quality seed with pesticides and are therefore not suited for organic agriculture (EOSTA, n.d.-b).

The legitimization of hybrids is questioned within organic agriculture (Jongerden et al., 2002). The first argument against the use of hybrids is on plant level: since the reproduction of hybrids does not make sense, it is unnatural (Jongerden et al., 2002). This can be linked to the second argument on business level: it is impossible to maintain a closed production circle when hybrids are used (Jongerden et al., 2002). Every year again, new seeds have to be bought. These two characteristics are contradicting with the ecology principle of organic agriculture as elaborated above. The third argument on socio-economic level states that the use of hybrids, since the new seeds have to be bought every year, creates a dependency of farmers to the market (Jongerden et al., 2002). This is contradicting with the principle of fairness, since dependent farmers are obstructed in their contributions to food sovereignty. Some breeders add the argument that the use of hybrids is unnecessary since robust seeds (see p. 27) would give the same outcome (Jongerden et al., 2002). However, there are supporters of organic agriculture that favour the use of hybrids, especially because there are often no alternatives to hybrids (Jongerden et al., 2002).

Inoculation or grafting is a technique where an upper end of a plant from the one species is planted on the bottom end of another plant from another species or variety. The practice is commonly used for the productions of fruits and roses. (VIB, n.d.). In essence, this method is allowed in organic agriculture since changes are made on plant level. However, the question is what is legitimized in case one part is genetically modified (VIB, n.d.). Since there is an exchange of water, metabolites like sugar, and molecules (including RNA which is important in cell processes), through the whole plant it is hard to measure the risk for humans and the environment (VROM, 2006). Thus in case one part of the plant is genetically modified, the European Union states the following: "since the genetic material of the plant is changed in a way not possible by natural breeding or natural recombination", the whole plant is considered as genetically modified (VROM, 2006).

5.2.2. Current Organic Plant Breeding Initiatives

Lammerts van Bueren[8] (2017) touches the projects and initiatives that have been leading for organic plant breeding in the Netherlands: Stichting Zaadgoed, Groene Veredeling, Bioimpuls, EU-Liveseed and Bioverita, visualized in Figure 7. The Figure shows that most initiatives developed from 2000 onwards as a result of the growing demand for organic products. See Annex 5 for a description of these initiatives.

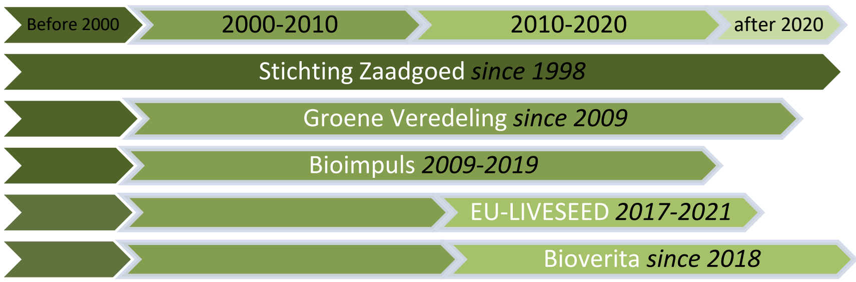


Figure 7: Overview Current Organic Plant Breeding Initiatives based on Lammerts van Bueren (2017).

[8] Edith Lammerts van Bueren has been a leading figure in the development of organic agriculture in the Netherlands and Europe for the last forty years. She worked for both Wageningen University and Research as the Louis Bolk Instituut. (V-focus, 2017).

6. Challenging “Organic”

This chapter challenges the concept “Organic”. First, it is important to define who actually decides what organic is and for who, thus to identify the important institutions and certifiers of organic in the Netherlands. Then the current challenges in organic plant breeding will be discussed, as well as the arguments against the use of gene technology. Finally, the plant-breeding orientations identified by Lammerts van Bueren (2018) will be elaborated upon.

6.1 Who Determines What Organic Agriculture/Plant Breeding Is And For Whom?

Jongerden et al. (2002) found that within the organic plant breeding sector, two different circuits exist: organic-dynamic and classic organic. A circuit is defined as “the specific way production, including the used technology, financing and the protection of seeds and new varieties are organised in their interdependence” (Jongerden et al., 2002, p. 42).

Organic-Dynamic Circuit

The first circuit is the organic-dynamic circuit, existing of diverse initiatives for organic seed production and organic plant breeding, originating from the 1980s. The circuit aims to create a range of seed-resistant varieties with its own networks and distribution hubs. The circuit remains relatively small since hybrids are not used. (Jongerden et al., 2002).

For this circuit, Demeter and EKO are the important institutions to define organic. However, what organic plant breeding means remains rather vague. This might be the case since the circuit is relatively new and therefore the range of seeds is still small. Breeding is dependent of gifts from financers, but these financers often set very limiting requirements in terms of technology use. Sometimes these requirements are even more limiting than IFOAM and EU standards. However, it might be an advantage that the financing of organic plant breeding within this circuit is not dependent from seed sales. (Jongerden et al., 2002). In terms of technology, there are two problems to define. First, it remains vague and debateable which of the plant breeding methods (see Chapter 4 & 5) fit within organic agriculture. Second, the search for new methods is limited because the solution is often sought within its own circuit. Consequently, the methods that do fit within the organic-dynamic circuit are often as follows: “existing methods minus the methods that are not allowed plus alternative new technologies” (Jongerden et al., 2002, p. 44).

Demeter is an institution that checks and certifies biodynamic companies, traders and processors of Demeter products in several countries, including the Netherlands (Demeter, 2018, p.12). The institution has its own restrictive accreditation programme: everything that is not elaborated on within the programme is forbidden, and the International Demeter Standards count globally as minimal conditions (Demeter, 2018). However, the Demeter Commission is open for debate for changes or improvements (Demeter, 2018). Important is that besides the quantitative requirements need to be met, qualitative dimensions about life in terms of emotions are taken into account as well. Therefore, it is not its aim to seek the limits of the law, but to live the organic principles in practice. (Demeter, 2018). EKO is the other institution important for this circuit, a private certification company without striving for profit. Same as Demeter, producers for EKO are required to take sustainability highly into account besides the organic standards. (EKO-keurmerk, 2017).

Classic Organic Circuit

The second circuit is the classic organic circuit, existing of former family companies involved in classic breeding methods who specialized in organic plant breeding as part of their company. Examples are Bejo and Rijk Zwaan. Companies like Enza Zaden and Vitalis

Biologische Zaden developed their seed production in collaboration with cultivators for the organic market and are part of this second circuit as well. The aim of this circuit is to build a range of hybrids and seed-resistant varieties. Companies are market driven, thus organic breeding is an extra specialization besides conventional breeding. Different from the organic-dynamic circuit, the distribution hubs are well developed worldwide. (Jongerden et al., 2002). Sometimes the crops are eligible for EKO or Demeter certificates, but regularly just receive an organic label. It is however still not economically viable to determine a company just to organic plant breeding, since the organic plant breeding often is financed by the conventional seed sales. (Jongerden et al., 2002).

So how do these companies receive their organic label? This trajectory is visualized in Figure 8 and starts with the COROS defined by the IFOAM. The IFOAM has several national and regional bodies under its supervision, for example IFOAM America Latina and IFOAM Southern African Network (IFOAM Organics International, n.d.-a). IFOAM EU group is a regional body as well, meaning the European Union is involved though this body. All organizations certifying organic in the European Union have to follow EU-regulation no. 2092/91, which is specified to labelling requirements of processed products (ECOLEX, n.d.). Besides this, most European certification companies are member of the EOCC, which is the European Organic Certifiers Council. This council debates about inspections and certification (Skal Biocontrole, 2018). The European Consortium for Organic Plant Breeding (ECO-PB) is an important institution in the sharing of knowledge about legislation about organic seed for several governance institutions within the European Union. (Lammerts van Bueren, 2017) (ECO-PB, 2019). Every European country has at least one certification organization and in the Netherlands this is Skal Biocontrole or just Skal (Stichting Skal, n.d.). This means that all parties involved in the production, processing, importation or exportation or storage, need a Skal certification (Stichting Skal, n.d.). Demeter and EKO also require Skal certification, but add the sustainability requirements. Another involved party in certifying is Bionext, aiming to connect the organic sector from farmers to consumers within the Netherlands (Bionext, 2019). Bionext is member of the IFOAM as well, it is actively in their Board and represents there the Dutch members and organizations (Bionext, 2019b). The final significant party is FiBL, the (worldwide) research and consultancy institute of organic agriculture (FiBL, n.d.).

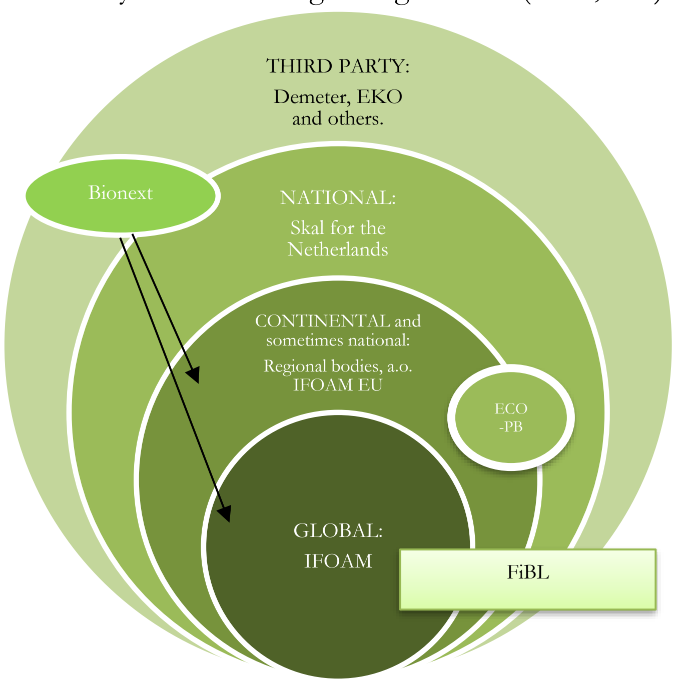


Figure 8: Organizations Determining the Concept 'Organic'.

Consumers of Organic Products

Hughner et al. (2007) argue it is important to acknowledge that consumers of organic foods are not one homogenous group. Based on several other studies, they concluded that most consumers of organic products are female with a household and children, and that especially youngsters have a more positive attitude towards organic food, but that these youngsters are not the biggest consumers. Regular Consumers of Organic Foods (RCOF's) seem to identify themselves with altruism, ecology, universalism, spirituality, self-direction, environmentalism, vegetarianism and alternative medicine. Often these people are convinced that healthy food is the best medicine to prevent illness. Table 7 lists the consumer motives to buy organic food. Hughner et al. (2007) point at two paradoxes amongst organic consumers: the health paradox and the price paradox. The health paradox states that consumers of organic food often perceive this food as more healthy than conventional food. However, this justification is never proved to be correct (Hughner et al., 2007). The price paradox states that since organic food is often more expensive than conventional food, the latter is perceived as a product of less quality. Which is not necessarily the case (Hughner et al., 2007). Maybe the most interesting finding of Hughner et al. (2007) is that even organic consumers are often not aware of what organic means.

No.	Motive
1.	Health and nutritional concern
2.	Better taste
3.	Environmental concerns
4.	Distrust conventional food industry
5.	Improved animal welfare
6.	Supporting local economies
7.	Considered to be more healthy
8.	Nostalgia
9.	Organic is a hot topic, fashion/ curiosity

Table 7: Motives for Consumers to Buy Organic Food. (Hughner et al., 2007).

Andersen et al. (2015) found that most of the Regular Consumers of Organic Foods consider environmental aspects most important in their decision to buy organic. They also found that consumers are less against genetic modification in plants than in animals. Contrastingly, according to Foodtank (2016), an American non-profit organization raising more awareness about our food, there is a misunderstanding under consumers of organic food, since approximately a quarter of the consumers think that organic food is automatically also local grown, whilst another estimated quarter of the consumers think that local grown food automatically organic is (Foodtank, 2016).

6.2 Current Challenges And Developments in Organic Plant Breeding

The debate about the limits of biotechnology for organic agriculture is related to several challenges. The challenges can be divided into several subjects: general challenges, economic challenges, technological challenges and challenges related to climate change.

- General Challenges

Seeds in organic farming have to be produced organically in the European Union since 2004 (Jongerden et al., 2002). However, this does not necessarily mean that organic produced seeds are well suited for organic farming. It is getting more and more common to use seeds bred organically, but most used seeds are originally designed for conventional agriculture (Lammerts van Bueren & Raaijmakers, 2008). This is problematic, since organic farming specifically demands for species with great resistance against plagues and diseases and require less manure and water. Varieties that suit to this description are called 'robust seeds' (Lammerts van Bueren & Raaijmakers, 2008). Conventional agriculture however does not ask for these specifications, since it is allowed to use for example (artificial) fertilizer and pesticides. There is thus a difference in focus on what crop characteristics should be. According to the Louis Bolk Institute robust varieties have a less compact ears to prevent mold and a longer stem to rise above wet leaves.

Institutionalization can be identified as another challenge in organic agriculture. Last years, institutionalization further and further increased. This led to increased efficiency, which is advantageous. However, this increased institutionalization also led to less (spontaneous) inventions. (Nuijten et al., 2016). According to Nuijten et al., (2016) it is therefore important that conventional companies are becoming more interested in more sustainable conventional farming or organic farming, so they can contribute to both the conventional as organic market.

- Economic Challenges

Despite the fact that their research was published in 2002, the research done by Jongerden et al. (2002) might still be accurate. They conclude it is hard to find investors in organic seed breeding and organic seed production, since the organic sector is still too small and diverse for the investors. The profitability and prospects were at that time not very different from conventional agriculture (Jongerden et al., 2002). Some supporters of organic agriculture believe that organic breeding does not necessarily needs to be profitable and in that sense too differs from conventional agriculture (Jongerden et al., 2002). Investments in organic plant breeding often come from funding, gifts and donations. Among investors there are people who are strongly convinced that seed free from gene technology should remain available. (Jongerden et al, 2002). Jongerden et al. (2002) also found that the demand for organic seeds will never be as relevant as the seed demand in the conventional market, since organic agriculture tries to keep cycles as closed as possible. Farmers prefer to use their 'home' seeds. The consequence is that the cost of breeding and producing organic seeds will be higher than the demand, leading towards higher prices for organic products. Most consumers are not willing to pay such high prices, despite the fact they might prefer organic products over conventional products. Thus there is need for a method to lower organic production costs. According to Andersen et al. (2015) this could be achieved by reverse breeding.

- Technological Challenges

That NBTs are at stake in today's discussions about gene technology and organic agriculture may be rather clear. However, in conventional agriculture, tissue culture techniques and protoplast fusion are common use, meaning that many modern varieties are made with help of these techniques. Scientifically seen, such methods use gene technology. It is however not mentioned in the European regulations as gene technology. Consequently, varieties bred by these methods do not require a GMO-label and are therefore not recognizable by organic farmers as genetic modified organisms. If organic agriculture would decide to ban these varieties, it would have to deal with an enormous decrease in varieties. Cabbage is an example of a vegetable that would be very hard to cultivate for organic farmers in case the protoplast fusion technique will be qualified as gene technology. (Lammerts van Bueren & Raaijmakers, 2008).

- Climate Change

As explained above, organic agriculture asks for robust seeds. Lammerts van Bueren (2017) calls this a 'mutual request for development', meaning that agricultural yield also needs to be 'climate robust'. Thus, breeders need to develop varieties that are resistant to more unpredictable and extreme weather. In order to do so, it requires sustainable intensification

(Lammerts van Bueren, 2017). Lammerts van Bueren (2017) also claims for more consciousness amongst all actors within the world food system. It is important everybody is aware of the role they play. She refers to Capra (1997), who called this 'ecoliteracy'. Organic agriculture might be helpful in terms of adaptation to climate change, however this is debateable (Muller, 2009). It is not relevant for this theses to further elaborate on this debate, what is important is that in case it is true organic agriculture is a 'better' solution for climate change adaptation than conventional agriculture, it might boost the demand for organic seed production and breeding.

- Seed Registration Challenges

First, it is important to mention that conventional bred varieties are allowed to go to the market without any safety assessment. However, it is important that a new variety meets the following three requirements before entering the market, see Figure 9.

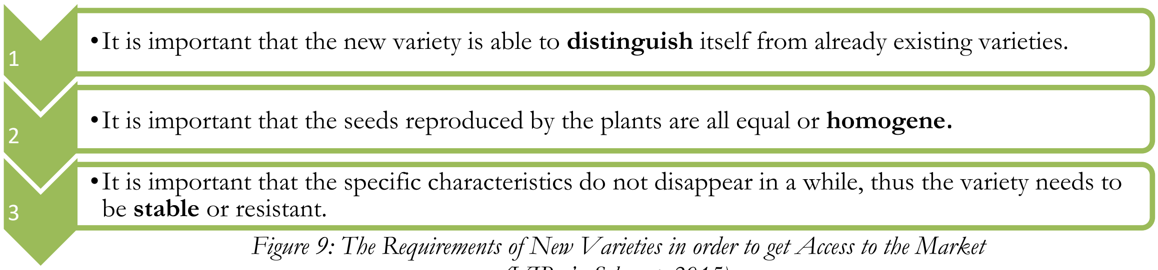


Figure 9: The Requirements of New Varieties in order to get Access to the Market (VIB & Schaart, 2015).

A seed system[9] is "the organized, formal mechanism through which farmers obtain seeds and through which seed quality can be guaranteed" (Louwaars et al., p. 7). They used to be open and informal: seeds were saved on the farm and there was an exchange on community level, which was contributing to the maintenance of agricultural diversity (Lammerts van Bueren et al., 2018) (Louwaars et al., 2011). However, over the years this changed radically. Now the seed systems can be described as more formal, closed and where legislation and registration are most important (Lammerts van Bueren et al., 2018). This is problematic since farmers are now troubled in producing their farm seeds (Lammerts van Bueren et al., 2018). According to Louwaars et al. (2011), current seed legislation is controlling the sector instead of supporting possible developments within the sector. Louwaars et al. (2011) see a decline in public sector involvement in the seed industry, which they do not consider as a positive development. The private sector will only produce when there is enough demand to make profits, which is a problem since now only the major food crops (hybrid cereals, vegetables and industrial crops like cotton) are produced for the market. Besides, it is a small amount of companies producing these crops, of which Monsanto became the largest in 2008 (Louwaars et al., 2011).

There are several rights to identify within the seed registration circuit, and the most important ones for this discussion are farmers' rights and plant breeders' rights. By farmers' rights is meant "...[the] involvement of farmers in the development of policy and givers farmers the right to save, use, exchange and sell farm-saved seeds" (Louwaars et al., 2011, p. 14). Not many countries take farmers rights into account in their seed laws, thus the use of seeds produced by the farmer is technically illegal. Plant breeders' rights are '...[the] exclusive right to the breeder of a new variety in the commercialization of that variety" (Louwaars et al., 2011).

[9] There are two systems to identify, a formal and an informal system. The formal one is focussed on the use of science, whereas the informal one is more focussed on localities Which system a farmer uses is dependent on both the policies applied to the farm and the choices the farmer makes (Louwaars et al., 2011).

The so called 'breeders' exemption' is important because it protects the breeder against competing companies while the new, specific genetic resource is available for others doing research about breeding (Louwaars et al., 2011). Louwaars et al. (2011) identified that most countries that are not member of the International Union for the Protection of New Varieties of Plants (UPOV) do not want to become member because of the UPOV acknowledges farmers' rights.

Another difficulty to identify is patents. Patents do not cover a single variety, but a new developed process to breed new plants. Louwaars et al. (2011) claim that more and more countries are giving patents, but that it remains the question whether this development is beneficial for the breeding sector.

Concluding Remarks

Lammerts van Bueren et al. (2018) expect that all actors involved in the field of agriculture work together and get support from (international) governments to achieve the best goals. However, they experience this is not happening. In the following section it will become more clear that the just elaborated challenges are approached in different ways, which makes it harder to work to a solution. Lammerts van Bueren et al. (2018) call for a holistic approach to tackle these challenges, meaning not only technological aspects should be taken into account, but socio-economic, ethical and judicial aspects too. This call is part of the systems-based approach they plead for, see page 36.

6.3 Why is Gene Technology Excluded in Organic Agriculture?

In 1994, the IFOAM decided that the use of genetic modification is not allowed in organic agriculture. This is applied by the European Union by the regulation 2092/91 in 1999 (Lammerts van Bueren, 2008). The development of NBTs as elaborated on in Chapter 4 fueled the discussion what is or should be allowed in organic agriculture in terms of the use of gene technology. This debate starts with the possible difference between genetic modification and genetic manipulation. Bovers[10] explains that the content of these words is similar but that taste is important: modification is used in a more neutral sense, where manipulation has a more negative taste. (Schröder, 2016). Following this subtle nuance, the different points of view are made visible. On the one hand, there are scholars who state that 'idealistic organizations should look beyond emotions'. Amongst them is Bert Lotz, claiming that there is a too high focus on possible dangers of new technologies and therefore cannot proof themselves to be helpful in the production of more, more sustainable and more healthy food. According to him, we should not continue evoking on the Precautionary Principle (Rector, 2018). On the other hand, there are scholars who claim that the exclusion of gene technology is an ethical choice and besides that, this exclusion is underlying the principles of organic agriculture (see Table 5). These scholars question whether the speed of NBTs to breed new varieties is sustainable. Amongst them is Edith Lammerts van Bueren, claiming that gene technology fits within an anthropocentric perception of the world (human and their survival is central), but especially for organic agriculture, the whole ecosystem should be taken into account in a world perception. (Schröder, 2016). This is a scientific debate, but the debate is going on within the whole society. Hidde Boersma[11] (2017) refers to 'The War on Science' (Otto, 2016) by explaining that according to him the gene technology debate is part of a culture war: a clash between left and right and is not about facts but about values. Despite scientific based facts, some people or groups within society belong to be against gene technology. American scientist Carl Sagan once

[10] Marjan Bovers works for the ministry of Infrastructure and Environment in the Netherlands.

[11] Hidde Boersma is promovendus moleculair biology and science journalist for Volkskrant, Elsevier and Quest (De Correspondent, n.d.).

said: "We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology" (AsapSCIENCE, 2015).

This section gives an overview of the debate whether gene technology fits in organic agriculture. First, the concept 'naturalness' will be discussed. Then scientific arguments against the use of gene technology will be given. However, as just touched upon, within society there is more going on. Therefore an elaboration on arguments by institutions within the Organic Movement will be given. To find out whether these are new arguments, they are compared in a table to the scientific arguments. A short introduction to arguments in favour of gene technology use in agriculture in general will be given, followed by an overview of arguments what gene technology could mean for organic agriculture. To conclude, the classification Lammerts van Bueren et al. (2018) created will be elaborated on.

Defining 'Naturalness'

Organic agriculture is often perceived as "more natural" compared to conventional agriculture by producers, traders and consumers of organic food, but it remains vague what this 'naturalness' contains (Lammerts van Bueren, 2002). Lammerts van Bueren uses Vijverberg (2001) define two ways 'naturalness'. On the one hand, there is natural in that sense that it can refer to 'anything in the universe'. "In this way one could argue that also genetic modification is natural, because natural processes at the molecular level are exploited, in contrast to fields as chemistry where really synthetic products are made" (Lammerts van Bueren, 2002, p. 21). On the other hand, 'natural' can mean anything 'unaffected by human interference', thus humans cannot do or produce anything natural. Lammerts van Bueren (2002) interviewed experts and consumers of organic products about their perception of naturalness. Experts in the organic field are aware that farming as such is an activity where people interfere in nature. For them it is the manner of interference that makes the difference between organic and conventional farming. Consumers of organic products were neither aware of food production practices in conventional ways, nor in organic ways. (Lammerts van Bueren, 2002). This is interesting since people are assumed to deliberately make the choice to buy organic products. Evidently, consumers regard nature as anything that lives, but with an emotional feeling added that it also is 'peaceful'. For consumers counts the rule: "the more artificial the food production and process, the less natural it is" (Lammerts van Bueren, 2002, p. 28). Consequently, gene technology is perceived as the opposite of natural. One consequently might tentatively state that at least some consumers of organic products are not as aware of, or involved in the point of view they claim to have. The second relevant finding is that both experts and consumers believe that organic food is more healthy compared to conventional food, due to its naturalness. Farmers however claim that organic agriculture needs a fundamental change in the way of thinking in terms of finding solutions for the problems they face. Thus, according to them, exclusion of methods solely and replacing them for anything that fits within the regulations is not enough. (Lammerts van Bueren, 2002). Additionally, farmers experience the inclusion or dependency of nature, which is called the 'agro-ecological' approach, beneficial compared to conventional farming where farming is independent from nature and crops are isolated from their environment. Thus, naturalness is important for the organic agriculture philosophy, but the realization of the fact that humans are participants in nature is lacking, especially amongst consumers. Lammerts van Bueren (2002) therefore adds a third explanation of naturalness, namely nature as an entity: within organic agriculture the ideal is to integrate nature and culture but without giving up one of its relative autonomies. The Louis Bolk Institute claims that organic farming interferes within nature, but with respect for its independence. This can be done in the following manners: first, the use of natural resources instead of synthetic inputs; second, the stimulation of the self-regulation of plants and animals and the agro-ecological system; and third, respect for the individuality of a plant, animal, company and landscape, without the interest for humans. (Verhoog & Louis Bolk Instituut, 2004).

Scientific Arguments Against The Use of Gene Technology in Organic Agriculture

Organic agriculture is legally forced to only use organic seeds since 2004. In this year, the Louis Bolk Institute published an article that elaborates on the reasons why organic agriculture refuses gene technology. These arguments are listed in Table 8.

No.	Argument
1	Genetic contamination is inevitable, especially if more and more genetically modified organisms will be used in the future. By regulating limits from permitted contamination, the freedom of both farmers and consumers who oppose genetic engineering in principle are not justified. *This argumentation is based on the fact that it is not possible to keep organic and conventional supply chains completely separated, which is confirmed by the European Committee in 2003 since there is no further labelling required when the unintended and inevitable (adventitious) genetic contamination of the end product remains below 0,9%. This rule is problematic since some companies are striving to keep their numbers of genetic modification below this percentage, but do not have the intention anymore to ban the genetic modified organisms based on the principles of organic agriculture. However, when a farmer knows that seeds are not gene technology free, he is not allowed to buy these seeds (Biologica, n.d). Organic agriculture is in principle against gene technology and therefore even the smallest contamination should be avoided, even though the health consequences might be questionable. (pp. 8-12). This contamination is often perceived as the irreversible 'genetic pollution' of nature (Biologica, n.d., p. 6).*
2	Gene technology is regarded as a technology that amplifies the distance between the consumer and the food-producing farmer: increase of estrangement. *Reductionism is an important concept for this argument: biotechnologists often consider nature as that which can be researched with natural sciences, but according to supporters of organic agriculture this is going further and further away from the world we experience every day. The actual fear is that with the NBTs, farmers are becoming increasingly dependent on the knowledge produced by experts in genetics and molecular biology.*
3	The current social economic embedding of gene technology does not fit within the social-ethical ideals of organic agriculture. *Organic agriculture within the market, is not more than just a niche and its principles are just details. The application of gene technology is often captured with patents of a small amount of multinationals, a monopoly. Even without gene technology, it is hard for organic agriculture to keep its ideals alive. In the market, organic is just an opportunity to earn money and it is expected to produce for a standard quality around the year for supermarkets. Consequently, there is an ongoing pressure to make organic standards and prices suited for the world market. Let it be clear, when producing for the market it is only a disadvantage when a farmer uses his own seeds, then it would be better to buy new ones every year.*
4	Another consequence of globalization is the fear that regional diversity in terms of food production will decrease continuously. This is especially the case for the diversity of cultivated plant and animal species (agro diversity). Because of the monopoly of few large companies, the seed demand will be increasingly limited. *A loss of varieties and the growth of monocultures relates to the food crisis (e.g. dumping). It is gene technology that creates monocultures, and therefore small scale technology use, like within organic farming, is a better solution than gene technology.*
5	Gene technology is a continuation of the trend towards further agricultural industrialization. This is contradicting with organic agriculture's principle attitude towards nature. *According to the principles of organic agriculture, the creation of resistant crops with gene technology is just the control of symptoms, but there is no trust in the sustainability of this solution, specifically when the resistance is built on just one gene.*
6	Gene technology does not fit within the holistic world view of organic agriculture. The stability of implemented gene constructs and the manageability of technology cannot be guaranteed. In organic agriculture, the risk of damaging the environment is therefore considered high. *Despite the fact there is (still) no evidence that genetic modified organisms are bad for humans health, there is evidence that it is a threat for the environment. In the United States, the use of gene technology did not lead to a decrease in pesticide use. Besides, with the use of most genetically modified organisms still requiring pesticides made the varieties itself resistant. Artificial constructs only seem to work efficient in a small number of cases. It is not possible to just change DNA and expect the organism to work out as imagined. DNA is more dynamic than expected and therefore its relation with the environment is so important, which is taken into account in organic farming.*
7	Genetic modified organisms are developing by the implementation of synthetic gene constructs. Organic agriculture prefers the use of organic substances over these synthetic gene constructs.

	Gene technology creates artificial constructs that do not occur in nature, and is therefore not allowed.
8	Within gene technology, it is not about natural processes, like stimulating the self-regulation of a plant or animal. Gene Technology breeding is considered as enforcement rather than provocation.
9	In gene technology, natural reproductions limits are broken though, which does not show respect for the integrity of plants and animals. Thus, gene technology is considered as damage for the integrity of plants and animals. *The intrinsic value is the opposite of the instrumental value. The intrinsic value covers the moral respect for living organisms. The integrity of an organism can be damaged without damaging its wellbeing. The instrumental value is the value of the use, the complete domination, which does not justify its intrinsic value.*

Table 8: Arguments Why Organic Agriculture does Not Allow Gene Technology.
(Verhoog & Louis Bolk Instituut, 2004, pp. 4-7).

The Louis Bolk Institute bases its arguments for the exclusion of gene technology on the following official documents: 'Position on Genetic Engineering and Genetically Modified Organisms' written by the IFOAM World Board in Canada (2002), 'Norms for Organic Production and Processing' (2002), the position paper about co-existence of the IFOAM (2003), 'Biologisch is natuurlijk, natuurlijk is gentech-vrij' by Biologica (1998), and 'Memorandum zur Koexistenz von Gentechnik-Landwirtschaft, konventionellen und ökologischen Betriebsweisen' written by Wirz et al. (2003) (Verhoog & Louis Bolk Instituut, 2004). The Louis Bolk Institute acknowledges that some arguments in their document are re-written arguments from the above discussed papers and that personal points of view are therefore significant (Verhoog & Louis Bolk Instituut, 2004). Interestingly, the 'Precautionary Principle' is not mentioned specifically, but is mentioned in many non-scientific sources about the exclusion of gene technology in organic agriculture. The Precautionary Principle "...enables decision-makers to adopt precautionary measures when scientific evidence about an environmental or human health hazard is uncertain and the stakes are high" (Bourguignon, 2015). Thus, gene technology and the NBTs cannot be accepted in organic agriculture since the consequences for both health and the environment are not scientifically justified (EOSTA, n.d.) (Lammerts van Bueren et al. 2007) and unnatural interventions in the organism were made (Lammerts van Bueren et al. 2007). "Organic agriculture [thus] requires process rather than product evaluation of novel breeding techniques" (Lammerts van Bueren et al., 2007, p. 1).

Interestingly, even in the United States where the NBTs are not regulated according a GMO-Directive, the organic sector is not allowed to put an 'organic' label on the products created with use of the NBTs (Bio Based Press & Warmflash , 2018).

Arguments Against The Use of Gene Technology in Organic Agriculture by the Organic Movement

The till now discussed arguments are on scientific level, but the Organic Movement is more than science-based. It is important to take other positions into account as well. Often, but not always, arguments are based on scientific evidence. Within the Organic Movement I would like to refer to Hivos and Greenpeace as major institutions supporting Organic Movements. Their arguments are visualized in Table 9, linked to the scientific arguments elaborated on above. Oxfam Novib is another important NGO for the Organic Movement, however their statement against the use of GMOs remains vague. Nevertheless, with the 'SD=HS-Programme'[12] in Zimbabwe, they do make a specific statement. (Oxfam Novib, n.d.). Further, it is important to refer to arguments farmers have.

[12] The SD=SH-programme has the aim to let farmers work together to breed seeds in order to yield crops that are resistant to climate change. Besides, they are not dependent on big companies that own the seeds. The seeds are simply exchanged by farmers.

No.	Argument Greenpeace	Argument Hivos	Argument Louis Bolk Institute
1	Approximately 90% of the genetic modified organisms are from Monsanto, which makes farmers very dependent.	Farmers are dependent on their supplier because of patents.	Gene technology is a continuation of the trend towards further agricultural industrialization. This is contradicting with organic agricultures principle attitude towards nature.
2	In the fields, the spread of genetic modified organisms cannot be controlled because of the self-replication of plants.		Genetic contamination is inevitable, especially when more and more genetically modified organisms will be used in the future. By regulating limits from permitted contamination, the freedom of both farmers and consumers who oppose genetic engineering in principle are not justified.
3	GMO varieties do not give higher yields.		
4	The use of GMOs is maintaining the seed industry. GMO seeds are very expensive and new seeds have to be bought every year.	Contracts with Monsanto are often a financial impediment for farmers.	Gene technology is a continuation of the trend towards further agricultural industrialization. This is contradicting with organic agriculture's principle attitude towards nature.
5	The use of gene technology reduces biodiversity: The new varieties are resistant to weeds and pests because they create a (poisoning) defence system, but that also kills other life in the ecosystem.	The use of gene technology reduces biodiversity: GMO crops are often cultivated in monocultures, which is disadvantageous for the biodiversity.	Another consequence of globalization is the fear that regional diversity in terms of food production will decrease continuously. This is especially the case for the diversity in cultivated plant and animal species (agro diversity). Because of the monopoly of few large companies, the seed demand will be increasingly limited.
6	The use of GMOs does not per se lead to deforestation, Green Peace argues there is a connection in South America.		
7	The use of GMOs leads to a soil- and groundwater pollution.		
8	The consequences for animals and humans are still not clear.		Gene technology does not fit within the holistic world perception of organic agriculture. The stability of implemented gen constructs and the manageability of technology are not able to be guaranteed. In organic agriculture, the risk of damaging the environment is therefore considered high.
9		Magic bullets do not exist. Gene technology is not the solution for hunger.	
10		Seed breeding is part of many farm systems, especially in Africa. Making farmers dependent from GMO seeds also touches their autonomy, dignity and identity.	The current social economic embedding of gene technology does not fit within the social-ethical ideals of organic agriculture.
11		Crops still need pesticides because for example bacteria that make the plant sick also change, leading to a plant that is not resistant anymore.	
12		Using gene technology leads to an ignorance of social, economic and cultural aspects.	The current social economic embedding of gene technology does not fit within the social-ethical ideals of organic agriculture.

Table 9: Arguments of Green Peace and Hivos, Representing the Organic Movement, Compared to Scientific Arguments Against the use of Gene Technology. Based on Greenpeace (2009), Hivos (2017) and Verhoog & Louis Bolk Instituut (2004, pp. 4-7).

Table 9 clarifies that both NGOs use more concrete arguments than the Louis Bolk Instituut does. Most arguments can be linked to the arguments by the Louis Bolk Instituut, however not all of them. Besides, not all arguments made by the Louis Bolk Institute are elaborated on by the NGOs.

The question remains why people support these NGOs in their arguments. This can at least partially be explained by the perception some consumers have towards GMOs, fuelled by activists like for example Mike Adams (2013). He refers to himself as "The Health Ranger" and in his catchy song (see Figure 10 and Annex 6), gene technology is framed as something scary and dangerous. It makes sense that consumers do not like scary things related to their food. Boersma (2017) argues that living these days requires a lot of trust in leading institutions and that our food chains are often too long to understand or control. Some consumers distrust 'the system' and therefore choose for organic and local food as counter-reaction. However, it must be said that it is Adams' (2013) aim to scare consumers, in order to make them aware about GMOs. The correctness of his radicalized arguments in the song can be questioned. Consequently, Boersma (2017) claims the debate is spoiled with nonsense (non-scientific arguments). I would argue it is important to acknowledge that motive 'GMOs are scary and dangerous' does not count for all the consumers of organic products and that the correctness of this debate does not lie in the radicalisation of the arguments (done by both pro and con the use of GMOs), but in the scientific arguments given by for example the just mentioned NGOs.

'Just Say No to GMO' by Mike Adams (2013)
"...Uh-Oh They don't want you to know All the poison they grow The corporate profits they show from those GMO OH Those Frankenseeds that they sow They're gonna hurt us we know It's time we told 'em to go, say GMO NO! I don't want eat poison, I don't want gene mutations at my dinner reservations it's a food abomination what they doin' to this fast food nation They take artificial gene combinations inject them in seed variations so they can grow their Frankenfood imitations while the side effects cause medical patients..."

Figure 10: Adams' Protest Song Against Gene Technology. (Amethios.com, 2011).

Arguments in Favour of Gene Technology Use in Conventional Agriculture

There are several arguments in favour of the use of gene technology in general. For this elaboration I choose to refer to Biologica (now Bionext). This might seem contrastingly, due to the fact the institution promotes the Organic Movement. However, it does indicate that these arguments are taken into consideration by the Organic Movement. First, gene technology could be helpful in the production of qualitative better food. Second, gene technology can create plants that require less (harmful) pesticides, which is advantageous for the environment. Third, gene technology can create plants with higher yields and therefore solve the world food problem. However, there are other scholars that claim there is enough food in the world and distribution is the main problem in the world food crisis. (Biologica, n.d.). That there is a need for more and qualitative better food in the world and a need for a more sustainable use of resources, is confirmed at the International Food Safety Conference in Addis Ababa on 12 and

13 February 2019, organized by the Food and Agricultural Organization, the World Health Organization and the African Union. According to these institutions, the NBTs are part of the solution to meet these needs. Interesting is that they also call for 'a greater societal engagement' in order to reduce the suspicion consumers might have towards these techniques. (McKevitt, 2019).

Monsanto (as one of the leading companies in biotechnology) campaigns that biotechnology is a natural science in order to shape the public opinion more positive towards technology with the claim their created chemicals are no different from the ones created by God and without these chemicals life would be impossible (Kleinman & Kloppenburg, 1991). Kleinman & Kloppenburg (1991, p. 428) state that Monsanto creates an image of biotechnology as inevitable development, always beneficial, "...mankind at its best, [and] in Partnership with nature". Monsanto's work is however more 'obvious and inevitable' than natural processes and therefore it excels nature (Kleinman & Kloppenburg, 1991).

Arguments in Favour of Gene Technology Use in Organic Agriculture

Taking this one step further, questioning what the acceptance of genetic modification would contribute to organic agriculture, there are 4 assumptions important to identify. These are visualized in Figure 11.

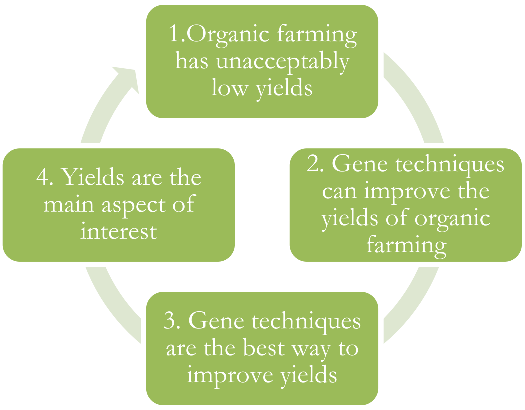


Figure 11: Assumptions when Considering Gene Technology in Organic Agriculture. (Wickson et al., 2016).

Despite the fact that checking the correctness of all arguments is not the main aim of this research, I would like to do so here, since I am convinced it contributes to the credibility of this research. To wit, this reasoning starts with the assumption that organic farming has unacceptably low yields. However, it is often not organic farmers aim to harvest outstanding high yields (Seufert et al., 2012). However, it is true there is debate about the differences in yield between organic and conventional farming. Organic yields would be little to substantially lower. Seufert et al. (2012) argue that a statement like this cannot be made as easy as it seems. Differences in yield are very context depending. Andersen et al. (2015) confirm this in their research about the "Feasibility of New Breeding Techniques for organic farming", since they claim that "ideally, the goal should be to narrow this [conventional – organic] yield gap" (Andersen et al., 2015, p. 426). Important is that according to Andersen et al. (2015) there is no shared understanding of the concept of 'naturalness' in society, which makes it possible to start the debate on the applicability of gene technology in organic farming. In order to research whether NBTs fit with organic farming, the researchers compared both characteristics. The IFOAM principles as described in Chapter 5 are tested on their applicability on the NBTs. Their findings are visualised in Table 10. Note: As explained in Chapter 4, with reverse breeding or rewilding it is possible to re-create the 'original' plant. Despite the fact that Andersen et al.

(2015) are not trying to fit the NBT perfectly in the IFOAM principles, it may become clear according to them there is space left for discussion and interpretation. Without reference to the principles written by the IFOAM, they have other arguments that are important to discuss. The first one is that Andersen et al. (2015) claim that genetic engineering is a broad term to cover several plant breeding methods. Therefore it is not correct to evaluate them all as one. Thus, according to them all methods should be evaluated separately in the organic field, instead of just rejecting them all at once. Another argument is that they claim to understand the need for robust seeds in organic agriculture, but that with conventional plant breeding methods it is too hard to accomplish. Rewilding therefore would be a good method to make this process more common. (Andersen et al., 2015).

Principle of...	Argumentation by Andersen et al. (2015)
Health	"One of the aims of rewilding is to furnish crops with lost properties of their ancestors and thereby increase their resistance to pests and diseases. By enabling crops to utilize available natural resources more effectively, the use of fertilizers and pesticides can be minimized without harvest failure. Thus, rewilding is not only compatible with the principle of health, but is also perhaps the most feasible way to promote it". (p. 429).
Ecology	"The essence of rewilding is to restore natural properties of plants that have been lost during traditional breeding. Therefore, as a tool, rewilding has a strong ecological potential, because it can effectively be used not only to sustain, but also to reinforce ecological systems". (p. 429). "As for diversity, NBTs can, of course, be used for different aims. Nonetheless, rewilding is potentially beneficial for diversity, because it may reduce the need for pesticides and fertilizers, which have an adverse effect on diversity". (p. 429).
Fairness	"This principle is open to multiple interpretations. None of the obvious ones appear to be inherently incompatible with NBT-based rewilding; however, the question of technology ownership requires attention". (pp. 429-430).
Care	"We can conclude from the principle of care that the spirit of organic agriculture has a conservative risk profile. However, it is not obvious that rejecting new technologies such as NBTs is the least-risky strategy". (pp. 429-430).

Table 10: Compatibility of NBTs with the Principles of Organic Farming by Andersen et al. (2015, pp. 429-430).

Structuring Positions by Edith Lammerts van Bueren et al. (2018)

To give these different opinions more structure, Lammerts van Bueren et al. (2018) developed an analytical framework on different orientations on plant breeding, see Figure 12.

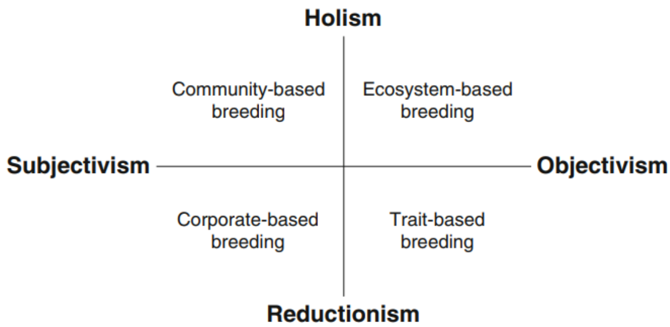


Figure 12: Diverse Orientations in Plant Breeding and the Seed Sector by Lammerts van Bueren et al. (2018).

The aim of 'community-based' breeding is to restore or renew varieties in order to support local and innovative food systems, food sovereignty and cultural diversity. It has a holistic approach, since it includes both natural and social sciences. Central is the local farmer and the support of the community. (Lammerts van Bueren, 2018). LIVESEED (see Annex 5) is mentioned as example of 'community-based breeding': it demands seeds that farmers themselves can easily improve or reproduce. The seeds therefore thus require a high genetic diversity (Lammerts van Bueren et al., 2018). 'Ecosystem-based' breeding has the aim to make sure different ecosystems have the varieties they demand. It developed itself in response to the Green Revolution, believing that the need to improve productivity should include taking care of the environment (Lammerts van Bueren et al., 2018). 'Trait-based' breeding has the aim to breed to fulfil the demand for the future. It has a very technical approach, which requires very specialized sciences. The core idea is that plants have genes that can be switched on and off, depending on what is desired. (Lammerts van Bueren et al., 2018). 'Corporate-based' breeding is breeding to meet the demands of the current market. It uses a top-down approach and is very goal driven. But, since food security and food sovereignty require seed diversity, they call for 'green policies' to include local farmers in their breeding programs. (Lammerts van Bueren et al., 2018). Lammerts van Bueren et al. (2018) acknowledge there is not just one approach to make agriculture completely sustainable. All breeding orientations have their own potential weaknesses. Therefore, they call for 'systems-based' breeding where the various paradigmatic positions are included, but not merged. It requires "a proper integration of specialist knowledge, generalist knowledge, technological choices, and socio-economic and cultural aspects" (Lammerts van Bueren et al., 2018, p. 13). The key elements and aims of this 'systems-based' breeding are stated in Figure 13. Since these are striving and lack a practical implementation, I would argue that these elements and aims only become relevant when there is a substantiation about its implementation. The further application of the discussed arguments in this Figure will be elaborated upon in the Discussion.

	Key elements	Aims
Required change in attitude	Corporate social responsibility	Including ethical and social responsibilities beyond legal and economic responsibilities
	Circular economy and true-cost accounting	Rearranging linear relationships such that value chains become value networks in which various actors work together
	Fair and green policies	Creating a frame work for optimal integration of all components of systems-based breeding
From attitude to action	Knowledge development and integration	Supporting continuous development of specialized, generalized and integrated knowledge at various levels (socio-economic, agro-ecological, etc.)
	Breeding strategies and tools	Designing a range of different appropriate technical breeding approaches
	Entrepreneurship	Developing sound entrepreneurial models suitable for various small and large value chains
From action to achievement	Food security, safety, and quality	Enhancing breeding of food that is healthy, nutritious and safe, with high and stable yield, and good shelf-life that does not require chemicals during production and storage
	Food and seed sovereignty	Allowing a pluriformity of breeding models to co-exist and for communities and markets to choose breeding models that fit best, implicitly serving cultural diversity and seeds as common good
	Social justice	Fair and just assigned rights and duties in relation to breeding activities and products, such as breeders' privilege, farmers' rights and fair prices for (farmer) contract seed producers
	Agrobiodiversity	Enhancing agro-biodiversity in farming systems; within and among crop species; improve diversity in major and small crops
	Ecosystem services	Improving breeding strategies, breeding products and crop traits that support ecosystem services
	Climate robustness	Creating climate robust and flexible breeding strategies and products that provide yield and quality stability under variable conditions

Figure 13: Systems-Based Breeding according to Lammerts van Bueren et al. (2018, p. 13).

Concluding Remarks

First, it is important to underline that the question here is why organic agriculture is against the use of gene technology and not biotechnology in general. Greenpeace proved to be against the use of gene technology, but that does not consequently lead to the rejection of biotechnology in general. Greenpeace considers Marker Assisted Selection (see Chapter 5) as a sustainable alternative for genetic modification (Greenpeace NL, 2015). This is confirmed by Lammerts van Bueren (2017) claiming she has always worked within the limits of organic agriculture (thus, amongst other things, no use of gene technology), but that innovation can be achieved by the collaboration of both organic as conventional farming. Further, it is important not to forget the opinion of farmers. They are closer to the food production than all the other parties just discussed. Claire Hall (2008) did a research on the perspectives of farmers in Scotland towards genetic modification. Since Scotland is a Western country, I assume the arguments she found can be illustrating for this research. Her main finding is that approximately a third of the farmers consider the introduction of genetic modification as a good development, since it would lower the production costs and increase the yield. Another third of the farmers considered the introduction of genetic modification as a bad development, since they expect that consumers do not want it. They also questioned the consequences for the environment. The other third of the farmers mentioned that context is very important and therefore they could not take position. Thus, even farmers, the most directly related actor to food production, do not share one clear opinion. This indicates the difficulty of the debate elaborated upon in this Chapter.

Discussion

In order to further explain the existence of the Organic Movement as it is, their arguments related to gene technology elaborated on in the previous Chapter will be linked to different views on nature by Holling/Timmerman and Zweers in Table 11, as explained in the Theoretical Framework. The actors discussed are: the scientific supporters of organic agriculture, NGOs supporting the Organic Movement, the consumers of organic products (RCOFs), biotechnological and/or plant scientists, market business related to plant breeding and farmers.

Who	Summarized opinion	Lammerts van Bueren et al. (2018)	Holling/Timmerman	Zweers
Organic scientific	Holistic world perception	Community-based	Nature ephemeral or Nature perverse/tolerant	Partnership or Participant
	Precautionary Principle			
	Intrinsic perception of nature			
NGOs supporting the Organic Movement	Against dependency and maintenance of the seed industry	Community-based	Nature ephemeral	Partnership or Participant
	Precautionary Principle			
	Holistic world perception			
	Biodiversity loss due to pollution	Ecosystem-based		
Consumers	Environmentalism Naturalness	Ecosystem-based	Nature ephemeral	Unio Mystica
	Local	Community-based		
	More healthy Fear of GMOs	Community- and Ecosystem-based	Nature ephemeral and Nature perverse/tolerant	
Biotechnological and/or plant scientists	Yields of organic farming should be increased	Trait-based and Corporate-based	Nature perverse/tolerant	Steward
Market-business	Economic (dis) advantages	Corporate-based	Nature benign	Despot
Farmers	Economic consequences	Corporate-based	Nature benign Nature ephemeral Nature perverse/tolerant and Nature capricious	Despot, Enlighted Despot and Steward

Table 11: Opinions about Gene Technology Related to Views on Nature.

Most links will be clear, however some links require further elaboration. To start, the **scientific supporters** of organic agriculture emphasize the Precautionary Principle. Therefore they can be linked to both 'nature ephemeral' and 'nature perverse/tolerant'. Due to the fact that 'nature ephemeral' states that without care the earth would collapse and this is not per se at stake in stake in scientific articles in favour of organic agriculture, the link with 'nature perverse/tolerant' view suits better, due to the ground rules on which it is based. The IFOAM principles (Chapter 5) can be considered as these ground rules. Further, it is important to note that these experts are well aware of the fact that farming as activity is interference in nature (Lammerts van Bueren, 2002), thus in terms of Zweers, agricultural practices always stand above nature. The way of practicing therefore determines the place of these scientists. On the one hand their arguments could be linked best to 'Partnership', due to the emphasis on the equal relation between human and nature and the understanding that both have an intrinsic value. On the other hand, 'Partnership' also claims that both human and nature have their own identity apart from each other, where in scientific organic agriculture there is an emphasis on closed cycles and inclusion, thus more collaboration. Therefore the 'Participant' might suit better, since it considers nature as a unity including humans.

Consumers of organic food are not a homogenous group. However, most of the consumers refer to environmentalism when explaining their motives to buy organic products (Andersen et al., 2015). Therefore, they can be linked to 'nature ephemeral' since it states we should treat the earth with care. Besides, the fear of GMOs leading to the consumption of organic products can be considered as a limit that should not be crossed. Then, the 'nature perverse/tolerant' would suit better. For consumers the rule seems to be: "the more artificial the food production and process, the less natural it is" (Lammerts van Bueren, 2002, p. 28). This 'naturalness' of organic products is often related to emotional feelings. Lammerts van Bueren (2002) found that most consumers are not aware of agricultural practices at all. Due to the (spiritual) connection consumers experience with our surroundings, including nature, they can be linked to the 'Unio Mystica' perspective.

One could argue **biotechnology or plant scientists** have a 'community-based' orientation on plant breeding because the NBTs create an organism that does not (completely) contain external genetic material and can contribute to ecological diversity of which local communities can benefit (Lammerts van Bueren et al., 2018). However, the 'trait-based' orientation suits better because NBTs are scientifically driven and there is a very top-down approach in the focus on innovation. 'Corporate-based' should be added, since scientist are the ones creating the NBTs that are interesting for the market. In this consideration, nature is less important, but since there is no specific argument that 'it does not matter' what we do with nature, it cannot be liked to 'nature benign'. Nor can it be linked to 'nature capricious', because scientist learn from previous trials in order to create the desired plant. Since scientist keep arguing that the use of the NBTs is as least as safe as Mutagenesis techniques excluded from the GMO-regulation within the European Union, safety can be identified as important issue. This can be linked to the 'nature perverse/tolerant' view towards nature. One should however keep in mind the above discussed 'corporate-based' orientation on plant breeding that these scholars have.

Since **farmers** are not a homogenous group, all views towards nature identified by Holling/Timmerman can be found within this group. Consequently, it is impossible to link farmers with one perspective towards nature identified by Zweers. The 'Despot', 'Enlighted Despot' and the 'Steward' are the perspectives that can be identified mostly amongst farmers. Hall (2018) gave an indication what farmers consider most important: yield, consumers desires, and the environment. Since the economic incentive prevails, this can be linked to a 'corporate-based' orientation.

Thus, what is now identified? For scholars the 'organic' concept seems to be clear since they have identified principles, norms and values applied in regulations. Table 6 clearly states that GMOs or their derivatives are not allowed in organic agriculture and that the genome always has to be respected as an impartible entity. This consequently excludes the possible applicability of NBTs in organic agriculture. However, there seems to be a misunderstanding between consumers and scientists, since consumers' expectations about the label 'organic' are not per se identical to what scholars identify as organic. Think especially about consumers expecting organic food to be locally grown or more healthy. Consumers preferring organic food over conventional food due to the fear for GMOs have a correct motive to do so, since organic practices exclude gene technology. On the one hand, consumers referring to environmentalism also have confirmed motive to buy organic since this is captured in the principles of organic agriculture by the IFOAM (Table 5). However, since many consumers do not seem to be aware of any agricultural practices, this motive might be questioned. Therefore, on the other hand, one could question whether environmentalism is a correct motive since according to supporters of the NBTs, these techniques are safe to use and the created crops are important for sustainable food security. The views on nature from the organic scientists, the NGOs supporting the Organic Movement and the consumers of organic products mostly have the same views on plant breeding and nature, namely 'community-based' and 'ecosystem-based' breeding. Further, these actors all have a 'nature ephemeral' or 'nature perverse/tolerant' view on nature according to Holling/Timmerman. The misunderstanding of expectations can be explained by the perceptions on nature identified by Zweers: consumers of organic products have a 'Unio Mystica' view on nature, which differs from the 'Partnership' or 'Participant' view from the organic scientists or NGOs supporting the Organic Movement. Consumers have emotions towards nature and organic agricultural practices instead of actual knowledge. Thus, the intentions of these actors are similar, but the expectations might clash.

Would then the 'systems-based' approach, called for by Lammerts van Bueren et al. (2018), be the solution? The 'systems-based' orientation on plant breeding itself can be linked to Schwarz and Thompson (1990). They identified that different views on nature are important in order to structure the world. All views on nature by Holling/Timmerman are adapting to each other and they need each other to identify their own view. Therefore Schwarz and Thompson concluded there is not one right view or one final solution. Lammerts van Bueren et al. (2018) acknowledge in their 'systems-based' orientation on plant breeding that the different orientations they identified all have their advantages and shortcomings and therefore should not merge. The orientation is thus actually the desired qualities of all the orientations created in one orientation. I would however argue that 'system-based' approach is not as revolutionary and contributing to this debate as intended by Lammerts van Bueren et al. (2018), since its aims are not so different from what the Organic Movement is already trying to achieve: climate resilience, food and seed sovereignty, social justice, fair and green policies and so on. Organic agriculture already has a holistic approach and despite the given that organic agriculture is not the solution for the world food problem or climate change solely, it acknowledges it is important to keep improving an innovating and therefore needs technology. The 'systems-based' approach is new since it states it needs some parts of all the orientations that can be identified in the plant breeding field right now, but that in order to achieve the ideal breeding climate, these orientations should not merge. I would argue that this 'systems-based' is not going to be the solution, since practicalities and its' implementation in order to achieve this development remain too vague causing a too slow development in order to tackle current challenges in both the organic as conventional sector. The extremities in all the identified orientations are needed to identify the specific orientations themselves. With only one orientation replacing the others, people might forget why the desires in this single orientation are important. Thus: "Divided we stand; united we fall" (Schwarz and Thompson, 1990, p. 13).

Since consumers' expectations are not necessarily the same as what scientists define as organic and the 'systems-based' orientation is not a (short-term) achievable solution per se, it is important that the Organic Movement is going to question itself for who it aims to be organic.

Despite the finding that at least a part of the consumers of organic products is not well familiar with the concept 'organic', I would argue it is important that the Organic Movement remains supporting scientific organic rules and practices, as explained in Table 6. Organic agriculture can indeed be identified as counterculture as defined by Schwarz and Thompson (1990), because the fear for GMOs and environmental concerns are fuelled by the exchange of knowledge and experiences via social relations within society. The niche organic agriculture has in the market and within society is important since even though some consumers might not completely understand the concept, they are aware of their consumption. This is important due to the scarcity of natural resources, climate change and so on. In the Principles of Organic Agriculture and the article by Seufert et al. (2012) it becomes clear that the aim of organic agriculture is not per se to feed the world, but to cultivate crops in a way as close as possible to natural processes and in this way contribute to a more sustainable agricultural production. In this thesis, I elaborated on the concept of 'naturalness', which is experienced differently by different actors. Since organic agriculture has a 'radically' different view towards nature than supporters of gene technology, there is a space created between conventional agriculture on the one hand and organic on the other hand. I agree with Lammerts van Bueren (2017) that this created middle is going to be able to feed the world in a sustainable way. Thus, I argue the exclusion of the NBTs in organic agriculture is a good development and should not be changed. The radical point of view from both sides creates a space for debate that is important now, but especially for the future since technologies will only further develop. Besides, scientific debates becoming public debates are important for greater consciousness amongst consumers about sustainable food production. Coming back to my argument, I would even argue that supporters of NBTs in organic agriculture have misunderstood what organic agriculture means, since the Principles of Organic Agriculture are very clear and accepted within the organic field. These supporters of NBTs have a point of view which of course be explained by their 'trait-based' or even 'corporate-based' orientation on plant breeding. Besides, these supporters place themselves above nature instead of being part of nature. Organic Agriculture is a niche in the market, of course within the market there is need for making profits. The development of new and robust varieties could be fastened with use of NBTs, but these techniques do not fit in organic agriculture since I argue it is important it remains an 'opposite' of unforeseeable technological innovations.

Conclusion

The New (Plant) Breeding Techniques are widely discussed due to their fast development and perceived advantages on technical, sustainability, economic and plant level. Besides the possibilities these techniques thus might have in terms of challenges like world hunger and climate change, the techniques are also considered as an important development for the European economy, which is however not a matter of course. This thesis discussed two debates. The first one is whether these NBTs should be legislated as GMOs following the Directive/2001/18/EC. Due to the fact that NBTs are able to create mutations faster and more specific than before, some scholars and other experts in the field claim these NBTs should be excluded from the GMO-regulation in Annex 1B. However, the European Court of Justice focussed on the method instead of the created organism when it decided that NBTs have to follow the GMO-regulation. Crops obtained with use of NBTs thus require GMO-labelling, which has several consequences: it is very expensive, time consuming and has a low success rate to get permission for the use of genetic modification within the European Union, which can lower the demand. Path dependency is a key concept in this thesis because due to the legislation that NBTs require GMO-legislation, the created crops are not allowed for use in organic farming. This is where the second debate can be identified. Since the organisms created with use of the NBTs do not (completely) contain foreign genetic material, there are scholars who argue there is space for debate to use these NBTs in organic agriculture. In the Discussion, the different actors and their opinions about the use of gene technology in organic agriculture were linked to different views on nature. The main finding is that the organic scientists, the NGOs supporting the Organic Movement and the regular consumers of organic products, share the same orientations on plant breeding identified by Lammers van Bueren et al. (2018) and the views on nature according to Holling/Timmerman, but the views on nature identified by Zweers differ. The clash between consumers' expectations of organic products and the reality can be explained by this difference, since consumers seem to have a more emotional feeling towards nature and organic agriculture, called the 'Unio Mystica', instead of scientific knowledge. The Organic Movement thus needs to reconsider for whom it aims to be organic. Should the movement aim to meet consumers' expectations in terms of environmentalism based on the argumentation that NBTs could be used to create more robust varieties, or stick to the organic principles excluding the use of these techniques? In terms of the use of gene technology, the scholars found in this research arguing that there is space left for debate, are not per se like the common supporters of the Organic Movement. Interestingly, the core of their argumentation shows a 'nature perverse/tolerant' view on nature, which can also be partly identified by the supporters of organic agriculture. The biggest difference lies in the aim of plant breeding and the fact that these scientists place themselves above nature, instead of being part of it. Therefore, I question whether these scholars truly understand what 'organic' means. Real supporters of 'organic' do not question the possible implementation of NBTs in organic agriculture due to its principles and position towards nature. Scientific debates will become public debates, which important to raise awareness amongst consumers about their consumption. "Divided we stand; united we fall" (Schwarz and Thompson, 1990, p. 13). Therefore, I argued in the Discussion that the exclusion of NBTs in organic agriculture is a good development and should not be changed. The debate between organic on the one hand and technology on other hand, like identified in this thesis, remains important in order to find the most sustainable ways of food production in the future.

Hence, the limits of plant breeding in organic agriculture are rather clear: changes in DNA can only be made on plant level, not on DNA-level, and cell or tissue level is debatable. NBTs are thus, like other gene technologies, not allowed to use. However, organic agriculture acknowledges the need for (bio)technology in order to further develop in the future, for example by Marker Assisted Selection (Chapter 5).

Literature

Adams, M. (2013, June 5). Just Say No to GMO music video www.NaturalNews.com/NoGMO :MIRROR [YouTube]. Retrieved June 21, 2019, from https://www.youtube.com/watch?v=GwhYWdp2EBc

Albert, H. (2019, April 15). Why the GMO Regulations in Europe Are 'Not Fit for Purpose. Retrieved June 24, 2019, from https://labiotech.eu/features/gmo-regulations-europe/

Alkema, H. Y. (1974). Mutatieveredeling bij bolgewassen door middel van radioactieve bestraling en andere methoden. Retrieved from https://library.wur.nl/WebQuery/wurpubs/fulltext/222637

Alrøe, H. F., & Kristensen, E. S. (2004). Why Have Basic Principles for Organic Agriculture? … And What Kind of Principles Should They Be? Ecology & Farming, 36, 27–30.

Amethios.com. (2011). Just Say No to GMO - Amethios.com. Retrieved June 21, 2019, from http://www.amethios.com/Amethios_NoGMO.html

Andersen, M. M., Landes, X., Xiang, W., Anyshchenko, A., Falhof, J., Østerberg, J. T., … Plamgren, M. G. (2015). Feasibility of new breeding techniques for organic farming. Trends in Plant Science, 20(7), 426–434.

AsapSCIENCE. (2015, October 8). The War on Science [YouTube]. Retrieved June 21, 2019, from https://www.youtube.com/watch?v=8e1XX-ngJcc

Atanassova, A., & Keiper, F. (2018). Plant breeding innovation: A global regulatory perspective. Cereal Chemistry, 95(1), 8–16.

Bio Based Press, & Warmflash , D. (2018, June 4). Why Cannot Organic Farmers Benefit from New Breeding Techniques? Retrieved July 3, 2019, from https://www.biobasedpress.eu/2018/06/why-cannot-organic-farmers-benefit-from-new-breeding-techniques/

Biologica. (n.d.). Biologische voeding is natuurlijk gentechvrij. Retrieved from https://bionext.nl/documents/20182/60540/Gentechfolder.pdf/f6c32717-f824-4476-a327-b0cd634f584d

Bionext. (2019). Onze missie. Retrieved June 11, 2019, from https://bionext.nl/onze-missie

Bionext. (2019b). Organisatiestructuur . Retrieved June 11, 2019, from https://bionext.nl/organisatiestructuur

Bioverita. (2019). Bioverita. Bio von Anfang an! Retrieved June 13, 2019, from https://bioverita.ch/en/bioverita-en/

Boersma, H. (2017, May 20). Greenpeace zit ernaast, gentech is juist geweldig. Volkskrant. Retrieved from https://www.volkskrant.nl/columns-opinie/greenpeace-zit-ernaast-gentech-is-juist-geweldig~bd99f70f/

Bortesi, L., & Fischer, R. (2015). The CRISPR/Cas9 system for plant genome editing and beyond. Biotechnology Advances, 33(1), 41–52.

Bourguignon, D. (2015, December 9). The Precautionary Principle: Definitions, Applications and Governance - Think Tank. Retrieved June 11, 2019, from https://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_IDA(2015)573876

Broll, H., Braeuning, A., & Lampen, A. (2019). European Court of Justice decision for genome editing: Consequences on food/feed risk assessment and detection. Food Control, 104, 288–291.

De Correspondent. (n.d.). Hidde Boersma. Retrieved June 28, 2019, from https://decorrespondent.nl/hiddeboersma

De Groot, M. (2010). Humans and Nature Public: Visions on Their Interrelationship. Retrieved from https://edepot.wur.nl/151135

Demeter. (2018). Demeter Voorwaarden. Retrieved from https://www.stichtingdemeter.nl/uploads/demeter-voorwaarden-versie-3-4-2018-dec.4206cd.pdf

Depuydt, P. (2018, August 3). Johan Cardoen (VIB): 'Wij zijn geen lakeien van de agrolobby".' De Tijd. Retrieved from https://www.tijd.be/ondernemen/farma-biotech/johan-cardoen-vib-wij-zijn-geen-lakeien-van-de-agrolobby/10037139.html

ECO-PB. (2019). About ECO-PB . Retrieved June 14, 2019, from https://www.eco-pb.org/about-eco-pb.html

ECOLEX. (n.d.). Council Regulation (EEC) No. 2092/91 On Organic Production of Agricultural Products and Indications Referring thereto on Agricultural Products and Foodstuffs. Retrieved July 19, 2019, from https://www.ecolex.org/details/legislation/council-regulation-eec-no-209291-on-organic-production-of-agricultural-products-and-indications-referring-thereto-on-agricultural-products-and-foodstuffs-lex-faoc002355/

EKO-keurmerk. (2017). Over EKO. Retrieved June 11, 2019, from https://www.eko-keurmerk.nl/over-eko

EOSTA. (n.d.). Waarom wijst de biologische landbouw genetische manipulatie af? . Retrieved June 11, 2019, from https://www.eosta.com/sites/www.eosta.com/files/faq/faq-nl-vraag8.pdf

EOSTA. (n.d.-a). Hoe zijn de waarden van de biologische landbouw door te vertalen naar plantwaardige veredeling? Retrieved June 26, 2019, from https://www.eosta.com/sites/www.eosta.com/files/faq/faq-nl-vraag9.pdf

EOSTA. (n.d-b.). Wat is het verschil tussen zaadvaste rassen en hybride rassen? Retrieved from https://www.eosta.com/sites/www.eosta.com/files/faq/faq-nl-vraag4_0.pdf

EUR-Lex: Access to European Union Law. (2001, April 17). Retrieved June 25, 2019, from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32001L0018

European Seed. (2016, March 1). Promising Techniques to Accelerate Innovation in Plant Breeding. European Seed, 3(1). Retrieved from https://european-seed.com/2016/03/new-breeding-techniques/

Farm Europe, Madre, Y., & Agostino, V. D. (2017, May 18). New Plant-Breeding Techniques: What Are We Talking About? Retrieved June 24, 2019, from https://www.farm-europe.eu/travaux/new-plant-breeding-techniques-what-are-we-talking-about/

Farny, N. G. (2018). A Vision for Teaching the Values of Synthetic Biology. Trends in Biotechnology, 36(11), 1097–1100.

FiBL. (n.d.). FiBL -About us. Retrieved June 11, 2019, from https://www.fibl.org/en/about-us.html

FiBL. (2015). Plant Breeding Techniques: An Assessment for Organic Farming. Retrieved from https://shop.fibl.org/CHen/mwdownloads/download/link/id/155/?ref=1

Foodtank. (2016, November 13). Organic Food Organizations and Businesses Working to Protect Consumers and the Global Environment. Retrieved June 22, 2019, from https://foodtank.com/news/2015/09/nineteen-organic-food-organizations-and-businesses-working-to-protect-cons/

García, P. R. (2006). Directive 2001/18/EC on the Deliberate Release into the Environment of GMOs: an Overview and the Main Provisions for Placing on the Market. Journal For European Environmental & Planning Law, 3(1), 1–12.

Gelvin, S. B. (2003). Agrobacterium-Mediated Plant Transformation: the Biology behind the "Gene-Jockeying" Tool. Microbiology and Molecular Biology Reviews, 67(1), 16–37.

Greenpeace NL. (2015, January 16). Slimme biotechnologie zonder gentech - Greenpeace Nederland. Retrieved June 21, 2019, from https://www.greenpeace.org/nl/natuur/5992/slimme-biotechnologie-zonder-gentech/

Greenpeace. (2009, September 11). Genetic Engineering: The World's Greatest Scam? [YouTube]. Retrieved June 20, 2019, from https://www.youtube.com/watch?v=1H9WZGKQeYg&feature=youtu.be

Habets, M., Hove, L. van en R. van Est (2019). Genoom editing bij planten en gewassen – Naar een modern biotechnologiebeleid met oog voor verschil in risico's en bredere afwegingen. Den Haag: Rathenau Instituut. https://www.rathenau.nl/sites/default/files/201902/Genome%20editing%20bij%20planten%20en%20gewassen.pdf

Hall, C. (2008). Identifying farmer attitudes towards genetically modified (GM) crops in Scotland: Are they pro- or anti-GM? Geoforum, 39(1), 204–212.

Hivos. (2017, May 30). Met gentech is honger niet zomaar de wereld uit - Hivos. Retrieved June 21, 2019, from https://www.hivos.nl/gentech-is-honger-zomaar-wereld/

Hobbs, B. (2016, April 12). CRISPR: The New Tool in The Gene Editing Revolution Explained. Retrieved June 27, 2019, from https://www.abc.net.au/news/science/2016-04-07/crispr-gene-editing-technology-explainer/7217782

Holme, I. B., Wendt, T., & Holm, P. B. (2013). Intragenesis and Cisgenesis as Alternatives to Transgenic Crop Development. Plant Biotechnology Journal, 11(4), 395–407.

Hughner, R. S., McDonagh, P., Prothero, A., Shultz, C. J., & Stanton, J. (2007). Who are Organic Food Consumers? A Compilation and Review of Why People Purchase Organic Food. Journal of Consumer Behaviour, 6(2–3), 94–110.

IFOAM Organics International. (n.d.). What We Do IFOAM. Retrieved June 11, 2019, from https://www.ifoam.bio/en/what-we-do

IFOAM Organics International. (n.d.-a). About us IFOAM. Retrieved June 11, 2019, from https://www.ifoam.bio/en/about-us

IFOAM. (n.d.). History IFOAM. Retrieved May 28, 2019, from https://www.ifoam.bio/en/about-us/history

IFOAM-Organics International. (2017). The IFOAM NORMS for Organic Production and Processing (Version 2014). Retrieved from https://www.ifoam.bio/sites/default/files/ifoam_norms_july_2014_t.pdf

Jansen, K., & Vellema, S. (2004). Agribusiness and Society: Corporate Responses to Environmentalism, Market Opportunities and Public Regulation. New York, United States: Zed Books.

Jongerden, J., Almekinders, C., & Ruivenkamp, G. (2002). Over visies en nieuwe wegen Casestudies van organisatievormen in de biologische veredeling en zaadproductie (182). Retrieved from https://library.wur.nl/WebQuery/wurpubs/fulltext/37412

Kleinman, D. L., & KIoppenburg, J. (1991). Aiming for the Discursive High Ground: Monsanto and the Biotechnology Controversy. *Sociological Forum*, *6*(3), 427–447.

Kuepper, G. (2010). A Brief Overview of the History and Philosophy of Organic Agriculture. Kerr Center for Sustainable Agriculture. Retrieved from http://www.agripress.nl/_STUDIOEMMA_UPLOADS/downloads/organic-philosophy-report.pdf.

La Via Campesina. (2017). New GMOs Should Not Be Exempt From Regulation. Retrieved June 25, 2019, from https://viacampesina.org/en/wp-content/uploads/sites/2/2017/09/2017-09-EN-ECVC-STOP-New-GMOs.pdf

Lammerts van Bueren, E., & Raaijmakers, M. (2008). Biologische veredeling vraagt om duidelijke keuzes. Ekoland, 12. Retrieved from https://library.wur.nl/WebQuery/wurpubs/fulltext/3820

Lammerts van Bueren, E. T. (2002). Organic plant breeding and propagation: concepts and strategies. Retrieved from http://www.louisbolk.org/downloads/1310.pdf

Lammerts van Bueren, E. (2008). Is co-existentie van de biologische en gangbare landbouw met genetisch gemodificeerde gewassen mogelijk? Gewasbescherming, 39(2), 75.

Lammerts van Bueren, E. T., Struik, P. C., van Eekeren, N., & Nuijten, E. (2018). Towards Resilience Through Systems-Based Plant Breeding. A review. Agronomy for Sustainable Development, 38(5).

Lammerts van Bueren, E. T., Verhoog, H., Tiemens-Hulscher, M., Struik, P. C., & Haring, M. A. (2007). Organic Agriculture Requires Process rather than Product Evaluation of Novel Breeding Techniques. NJAS - Wageningen Journal of Life Sciences, 54(4), 401–412.

Louis Bolk Instituut. (n.d.). Over ons. Retrieved June 28, 2019, from http://www.louisbolk.org/nl/over-ons

Louwaars, N., Le Coent, P., & Osborn, T. (2011). Seed Systems and Plant Genetic Resources for Food and Agriculture. Retrieved from https://library.wur.nl/WebQuery/wurpubs/fulltext/186238

McGovern Institute. (2014, November 5). Genome Editing with CRISPR-Cas9 [YouTube]. Retrieved June 27, 2019, from https://www.youtube.com/watch?v=2pp17E4E-O8

McKevitt, A. I. (2019). The First FAO/WHO/AU International Food Safety Conference Addis Ababa, 12-13 February 2019. Retrieved from http://www.fao.org/3/CA2979EN/ca2979en.pdf

Memo Kennislink. (n.d.). CRISPR-cas: knippen en plakken. Retrieved June 27, 2019, from https://biotechnologie.nl/paginas/crispr-cas9/

Milton Yinger, J. (1960). Contraculture and Subculture. American Sociological Review, 25(5), 625–635.

Moyes, C. L., & Dale , P. J. (1999). Organic Farming and Gene Transfer From Genetically Modified Crops. Retrieved from http://orgprints.org/8260/1/OF0157_2153_FRP.pdf

Muller, A. (2009). Benefits of Organic Agriculture as a Climate Change Adaptation and Mitigation Strategy for Developing Countries . Environment for Development Discussion Paper Series, 09(09).

Nature and More. (n.d.). Wat is biologisch? Retrieved May 20, 2019, from https://www.natureandmore.com/nl/all-about-organic/wat-is-biologisch

Natuurinformatie. (n.d.). RNA. Retrieved June 27, 2019, from http://www.natuurinformatie.nl/nnm.dossiers/natuurdatabase.nl/i002658.html

NBT Platform. (2013). Legal Briefing Paper: The regulatory status of plants resulting from New Breeding Technologies. Retrieved from http://www.nbtplatform.org/background-documents/legal-briefing-paper---the-regulatory-status-of-plants-resulting-from-nbts-final-.pdf

NBT Platform. (2015b). New Breeding Techniques: Seizing the Opportunity. Retrieved from http://www.nbtplatform.org/background-documents/factsheets/fact-sheet-on-nbts-in-general-2015.pdf

New Breeding Techniques Platform. (2015). New Breeding Techniques Platform. Retrieved June 27, 2019, from https://www.nbtplatform.org/about-the-nbt-platform

Nijland, R. (2017, December). Snel en simpel genen repareren . Wageningen World. Retrieved from https://wageningenworld.wur.nl/issue/december-2017/snel-en-simpel-genen-repareren/

Norkunas, K., Harding, R., Dale, J., & Dugdale, B. (2018). Improving agroinfiltration-based transient gene expression in Nicotiana benthamiana. Plant Methods, 14(1).

Nuijten, E., Messmer, M., & Lammerts van Bueren, E. (2016). Concepts and Strategies of Organic Plant Breeding in Light of Novel Breeding Techniques. Sustainability, 9(1), 18.

Organic Trade Association. (2007). Organic Trade Association 2007 Manufacturer Survey. Organic Trade Association, Greenfield, MA.

Oxfam Novib. (n.d.). Boeren sterker met eigen zaden. Retrieved June 21, 2019, from https://www.oxfamnovib.nl/armoede-verslaan/honger-en-hongersnood/boeren-verslaan-honger-met-eigen-zaden

Pollan, M. (2006). The Omnivore's Dilemma (2006th ed.). Retrieved from http://library.uniteddiversity.coop/Food/Michael_Pollan-The_Omnivores_Dilemma.pdf

Rector, R. (2018, September 6). Biotechnologie: oplossing voor klimaatverandering en voedseltekort? Retrieved June 22, 2019, from https://biotechnologie.nl/artikelen/biotechnologie-oplossing-voor-klimaatverandering-en-voedseltekort/

Schaart, J., Riemens, M., Van de Wiel, C., Lotz, B., Smulders, R., & Wageningen University and Research. (2015). Opportunities of New Plant Breeding Techniques. Retrieved from https://edepot.wur.nl/357723

Scholten, O., & Lammerts van Bueren, E. (2012). Groene Veredeling. Retrieved from https://edepot.wur.nl/196982

Scholten, O. (n.d.). Groene Veredeling Projecten. Retrieved June 12, 2019, from https://www.groeneveredeling.nl/nl/groeneveredeling/Projecten.htm

Schouten, H. J., & Jacobsen, E. (2008). Cisgenesis and Intragenesis, Sisters in Innovative Plant Breeding. Trends in Plant Science, 13(6), 260–261.

Schröder, E. (2016, August 26). Genetische modificatie en biologische landbouw. De Helling. Retrieved from https://wetenschappelijkbureaugroenlinks.nl/artikel/genetische-modificatie-en-biologische-landbouw

Schwarz, M., & Thompson, M. (1990). Divided We Stand: Re-Defining Politics, Technology and Social Choice. Philadelphia: University of Pennsylvania Press.

Seufert, V., Ramankutty, N., & Foley, J. A. (2012). Comparing the Yields of Organic and Conventional Agriculture. Nature, 485(7397), 229–232.

Sima, E. (2012). Implications of Organic Farming Upon Sustainable Rural Development. Agricultural Economics and Rural Development, IX(2), 233–244.

Skal Biocontrole . (2018). Biologische Teelt van Gewassen. Retrieved from https://www.skal.nl/assets/Infobladen/Infoblad-Biologische-teelt-van-gewassen.pdf

Skal. (n.d.). Biologisch uitgangsmateriaal. Retrieved June 16, 2019, from https://www.skal.nl/biologische-teelt-van-gewassen/voorwaarden-teelt/u-gebruikt-biologisch-uitgangsmateriaal/

Stibbe, & Timmermans, S. (2018, August 27). Gewassen door mutagenesetechnieken vallen ook onder GGO-richtlijn. Retrieved June 24, 2019, from https://www.stibbe.com/en/news/2018/august/gewassen-verkregen-door-mutagenesetechnieken-vallen-nu-ook-onder-ggo-richtlijn

Stichting Skal. (n.d.). Welkom bij Skal. Retrieved June 11, 2019, from https://www.skal.nl/

Stichting Zaadgoed. (2019). Wie wij zijn. Retrieved June 12, 2019, from https://zaadgoed.nl/wie-wij-zijn/

Tajfel, H., & Turner, J. (1979). Chapter : An Integrative Theory of Intergroup Conflict. In W. G. Austin & S. Worchel (Eds.), *The Social Psychology of Intergroup Relations* (pp. 33–47). United States: Brooks/Cole Pub. Co.

Tuenter, G. (2018, July 26). Rem op nieuwe gentech in Europa. Retrieved May 14, 2019, from https://www.nrc.nl/nieuws/2018/07/26/barriere-voor-genbewerkte-planten-a1611214

V-focus. (2017, November 28). Edith Lammerts van Bueren neemt afscheid van Louis Bolk Instituut. Retrieved June 28, 2019, from https://www.v-focus.nl/2017/11/edith-lammerts-van-bueren-neemt-afscheid-van-louis-bolk-instituut/

Van Dale. (n.d.). Subcultuur. Retrieved July 3, 2019, from https://www.vandale.nl/gratis-woordenboek/nederlands/betekenis/subcultuur

Van der Heide, W., Gehner, B., & Drok, M. (2009, July). Dictaat Weefselkweek [Studiemateriaal]. Retrieved June 17, 2019, from https://edepot.wur.nl/206060

Van 't Hoog, A. (2019, March 12). "De GMO richtlijn moet worden aangepast" . Wageningen World. Retrieved from https://issuu.com/wageningenur/docs/ww2019_01_nl/28

Verhoog, H., & Louis Bolk Instituut. (2004). Waarom de biologische landbouw tegen gentechnologie is. Retrieved from http://www.louisbolk.org/downloads/1340.pdf

VIB. (n.d.). Van Plant tot Gewas : Het verleden, heden en de toekomst van plantenveredeling. Retrieved from http://www.vib.be/nl/educatie/Documents/vib_facts_series_vanplanttotgewas.pdf

VIB, & Schaart, J. (2015). De veiligheid van genetisch gewijzigde gewassen. Retrieved June 25, 2019, from http://www.vib.be/nl/educatie/Documents/VIB_De_Veiligheid_van_genetische_gewassen.pdf

VROM. (2006). Verantwoord veredelen met genetische modificatie. Retrieved June 5, 2019, from file:///C:/Users/masso012/Downloads/kst-27428-94-b1.pdf

Wageningen University and Research. (n.d.). BioImpuls, Phytophthora-resistente aardappelrassen. Retrieved June 12, 2019, from https://www.wur.nl/nl/Onderzoek-Resultaten/Onderzoeksprojecten-LNV/Expertisegebieden/kennisonline/BioImpuls-Phytophthora-resistente-aardappelrassen.htm

Wageningen University and Research. (n.d.-b). Genetische modificatie. Retrieved June 24, 2019, from https://www.wur.nl/nl/Dossiers/dossier/Genetische-modificatie-1.htm

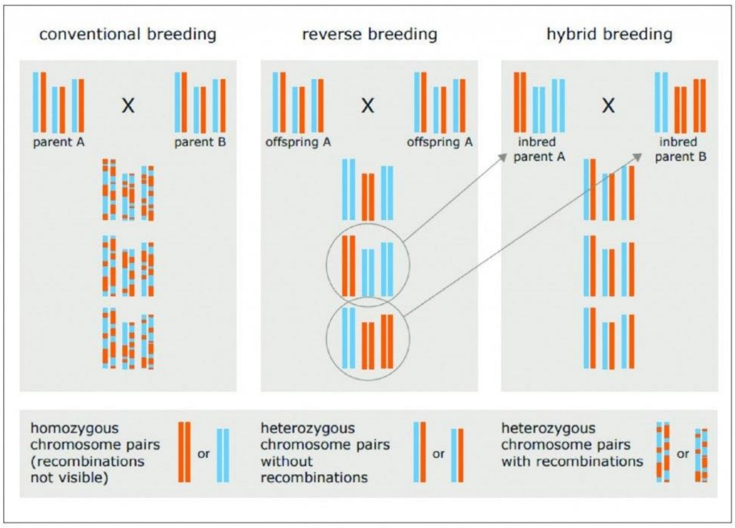
Wakasa, Y., Kawakatsu, T., Harada, T., & Takaiwa, F. (2018). Transgene-independent heredity of RdDM-mediated transcriptional gene silencing of endogenous genes in rice. Plant Biotechnology Journal, 16(12), 2007–2015.

Wickson, F., Binimelis, R., & Herrero, A. (2016). Should Organic Agriculture Maintain Its Opposition to GM? New Techniques Writing the Same Old Story. Sustainability, 8(1105).

Yoo, S. A. (2018, November 29). Met Crispr-Cas kunnen we honger oplossen. Maar 't gebruiken mag niet. VNO-NCW. Retrieved from https://www.vno-ncw.nl/forum/met-crispr-cas-kunnen-we-honger-oplossen-maar-t-gebruiken-mag-niet

Annex 1: Reverse Breeding

Hybrids are heterozygous, thus they contain DNA in which most genes are present in different forms. As explained by hybrids, their favorable qualities will disappear in further breeding. Therefore, in case a farmer really likes the crop, he only can choose to make cuttings to keep the plant. Unfortunately, this is very expensive. Therefore, reverse breeding was developed. The basics idea is that every sex cell has half of its chromosomes, and after pollination the chromosomes from both parents come together. Then a plant with the usual amount of chromosomes can grow. The sex cells are designed in such a way that the chromosomes do not exchange DNA anymore. Consequently, all chromosomes will be in their original state in the sex cells. These sex cells will eventually become an qualitatively extraordinary good plant. (VIB, n.d., p. 22).



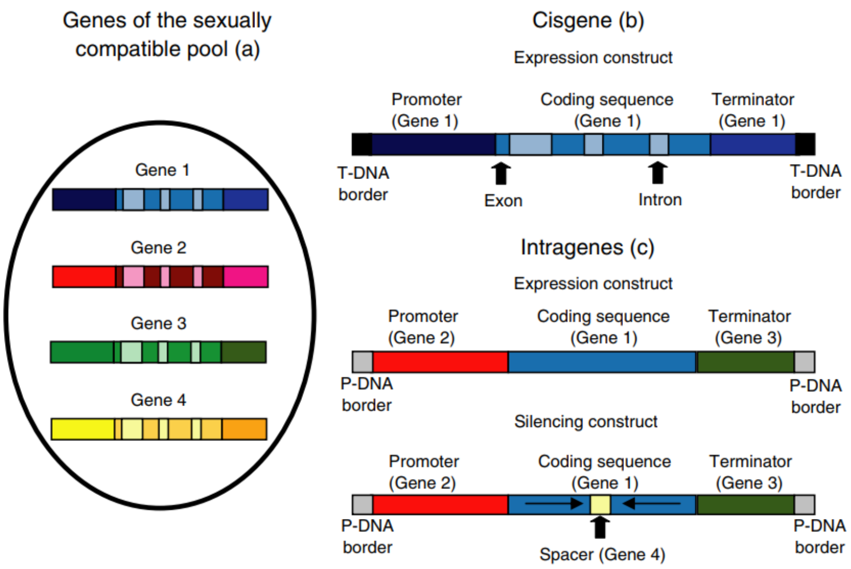
Visualization of different breeding methods (European Seed, 2016).

Annex 2: The Differences between Cisgenesis and Intragenesis

According to Schouten & Jacobsen there are two differences between Cisgenesis and Intragenesis, which are cited in the Table below. To make this more understandable, also see the Figure below. Within Cisgenesis there is only blue, so within gene 1 there are some alterations made. Then for Intragenesis there are three genes, red, blue and green. Then a piece of gene 4, the yellow one, is inserted. Due to the fact that for Cisgenesis only traditional gene pools are used, it would in that sense also occur in nature. This differs from Intragenesis where the yellow part would not occur in nature from itself and is especially created to add the specific characteristic to the plant (Schouten & Jacobsen, 2008).

Difference	Cisgenesis	Intragenesis
1	"...the gene has its native promotor, introns and terminator", which means it has a complete copy of a piece of DNA" (pp. 260-261).	"New compositions of coding sequences and promotors are made" (p. 261).
2	"[there] are no specific requirements regarding the T-DNA borders or other transferred non-coding DNA" (p. 261).	"All genetic elements should be derived from the sexually compatible group" (p. 261).

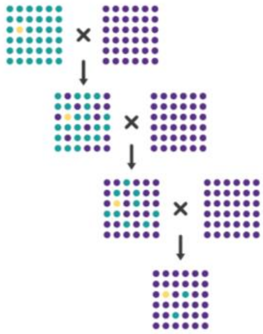
The differences between Cisgenesis and Intragenesis, by Schouten & Jacobsen (2008).



Visualization differences between Cisgenesis and Intragenesis by Holme et al. (2013, p. 396).

Annex 3: Hybridization

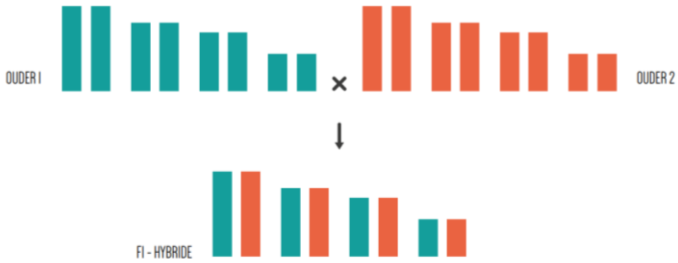
For example, plant A is favoured because of its high yield, plant B is favoured because of its appearance. However, it is important to note that results are not achieved as easy as it is explained above. The unique DNA of plant A goes for 50% in the new plant, as the unique DNA of plant B that goes for 50% in the new plant too, see the Figure below. However, it is unknown which 50% of the DNA goes to the new plant. The combination of the both unique DNA stand will therefore have unintended characteristics as well. Since the breeder does not know which specific information of DNA will be passed to the new plant or hybrid, hybridization can be describes as a process of 'trial and error'. Good qualities might disappear and bad qualities might occur. Consequently, reselection and hybridization are necessary to get the wanted result. It takes approximately ten years to get the hybrid ready for the use on large scale, however there are also examples that took forty years. (VIB, n.d.).



Visible example of hybridization (VIB, n.d., p. 12).

Annex 4: F1-hybridization

In F1-hybrids, the first inbreeding takes place before the actual breeding. This means that plant A first breeds itself, meaning its own pollen on its own pistils. The same goes for plant B, see the Figure below. Characteristics of the plant are now called 'mozygote' (VIB, n.d.). Inbreeding families are created and are now able to cross.



The creation of an F1-hybrid.
(VIB, n.d., p.13).

Annex 5: Organic Plant Breeding Projects in the Netherlands

- ## Stichting Zaadgoed

Lammerts van Bueren (2017) states that at the beginning of the new century there was a growing need for institutions to guide the conversion from conventional to organic seed use. Especially since the European Union decided the use of organic seeds would be mandatory in 2001. Eventually this was postponed up to 2004. It did however lead to the development of Stichting Zaadgoed in 1998 (Lammerts van Bueren, 2017) with the intention to support organic agriculture in the Netherlands and Belgium and an increase in agro biodiversity (Stichting Zaadgoed, 2019). Their core activities are listed in the Table below.

No.	Core activity
1	The stimulation and support of breeding activities for professional organic breeding, my means of organic farmers, breeders and scientists.
2	Building awareness among consumers with projects like 'Toekomstzaaien', 'Reclaim the Seeds' and 'de Rassentoets'.
3	Stimulation of knowledge development by offering seminars and the development of instruction documents about seed breeding for farmers.
4	Giving attention and publicity to organic plant breeding and the importance of agro-diversity on their website, publications and seminars.
5	Fundraising to stimulate organic plant breeding.

Core Activities Stichting Zaadgoed (Stichting Zaadgoed, 2019).

- ## Groene Veredeling

This research programme is set up by the Ministry of Economic Affairs, Agriculture and Innovation and its first activity was to publish guides with available organic seeds (Lammerts van Bueren, 2017). Over the years the foundation specialised itself in research about varieties that require less manure and water, and resistant varieties for illness and plagues (Scholten & Lammerts van Bueren, 2012), for the following crops: potatoes, spinach, tomatoes and leek (Scholten, n.d.). The final research presented on the website ends in 2020 (Scholten, n.d.). It remains unclear whether new projects will start from 2019 onwards.

- ## Bioimpuls

The incentive for this project was the terrible potato-year in 2007 due to Phytophthora (Lammerts van Bueren, 2017). Phytophthora is a mold which can cause fatal plant disease. Bioimpulse is a project supported by the government, in collaboration with the Louis Bolk Instituut, breeding companies and Wageningen University and Research (Wageningen University and Research, n.d.). Its aim is to find potato varieties which are Phytophthora-resistant in order to make the potato cultivation less vulnerable, first for organic farming but for conventional farming as well Wageningen University and Research, n.d.). The project started in 2009 and will end in the end of 2019 (Lammerts van Bueren, 2017).

- ## EU-LIVESEED

Globally, the production of organic seed increased. Consequently, it led to development of organic plant breeding. However, still organic farmers use conventional seeds. Therefore the European Union started the LIVESEED-project. It is a collaboration of 35 partners and 18 countries, with the main aim to boost the production of organic seeds and organic plant breeding. The project started in 2017 and will end in 2021. (Lammerts van Bueren, 2017).

- ## Bioverita labelling

Bioverita is a platform with the most important organic plant breeders, product processors and traders in Europe. The aim of the label is to increase awareness of organic farming and breeding. (Bioverita, 2019). Organic breeders asked for a label to distinguish their seeds in the market. Since February 2018 this request is fulfilled by the Bioverita-label. (Lammerts van Bueren, 2017).

Annex 6: Lyrics 'Just Say No to GMO' – Mike Adams (2011)

I'm lookin at the food that's in the grocery store
They say it's safe, everybody eat more.
On second thought, I don't really know if it's made with those GMOs

So I'm lookin for the non-GMO label 'fore I bring it home and put it on my table
I wanna know it's verified so I don't
Harm myself with genetically modified

Uh-Oh
They don't want you to know
All the poison they grow
The corporate profits they show from those GMO OH

Those Frankenseeds that they sow
They're gonna hurt us we know
It's time we told 'em to go, say GMO NO!

I don't want eat poison, I don't want gene mutations at my dinner reservations
it's a food abomination what they doin' to this fast food nation
They take artificial gene combinations
inject them in seed variations
so they can grow their Frankenfood imitations
while the side effects cause medical patients

Keep their profits alive while they
spraying all the food with name brand herbicides
and all the while they're spreadin' their lies
Monsanto destroyin' farmers lives
and the FDA keeps it all going
saying it's safe even though they all know it's just
poison stealing away your life, and that's what you eat with genetically modified.

GMO safety huh that's a corporate myth
if you don't believe me listen to Jeffery Smith
He's the man with plan gonna do what he can
To help us all get those GMOs banned
But we need you to lend a hand
take a stand against this food scam
It's a mission for the health condition worldwide
We don't wanna live genetically modified

Don't eat food unless you know what's in it
Don't believe the propaganda cuz the press will spin it
Affects everybody, we all up in it
Stand up to Monsanto, tell 'em oh no you didn't

Reject Frankenfoods in the store
demand honest labels so we can be informed
We have a natural right to know
What we buyin' Just say no to GMO

Before our farms start dyin'
Just say no to GMO

Those corporate crooks are lyin'
Just say no to GMO

This time we're not complyin'
Just say no to GMO

We're just not buyin' it
Just say no to GMO