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ARTICLES

Transferring Moral Responsibility for Technological Hazards: The Case of GMOs in Agriculture

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Abstract The use of genetically modified organisms in agriculture makes great promises of better seeds, but also raises many controversies about ownership of seeds and about potential hazards. I suggest that owners of these seeds bear the responsibility to do no harm in using these seeds. After defining the nature of this responsibility, this paper asks, if ownership entails moral responsibility, and ownership can be transferred, then how is moral responsibility transferred? Building on the literature on use plans, I suggest five conditions for a good transfer of moral responsibility for genetically modified seeds. I also look at the Monsanto Technology Use Guide and Technology/Stewardship Agreement, as an examplar of a use plan, to explore the extent to which these conditions are present. I conclude that use plans can play a role in the distribution and transfer of moral responsibility for technologies with high benefits and potential harmful uncertainties.

Keywords Moral responsibility · GMOs · Ownership · Use plans · Technology use guide · Uncertainties

Seeds of Discontent

More and more, genetically modified organisms (GMOs) are being used in agriculture for a variety of purposes. Some seed modifications involve improvements for agricultural practices (e.g. MON 810 for decreased pesticide use), while others augment nutritional content (e.g. Golden Rice with increased vitamin A). There are many ways of speaking of these seeds; I choose to refer to them as genetically modified (GM) seeds in this paper. In the past 20 years, "the annual

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global hectarage of biotech crops [reached] 179.7 million hectares" (ISAAA 2015). During that same period, they have also raised many controversies; including a de facto ban on importing and developing them in the European Union between 1998 and 2004, as well as permanent bans in Switzerland and other countries. The two main points of controversy that GMOs raise are hazards and ownership.

Where hazards are concerned, there are human and environmental health concerns. Much of the research purporting to show that GM seeds have negative effects on human health has been discredited. For example, the famous Séralini study was originally published in *Food and Chemical Toxicology*, retracted by the editors on the grounds that the data did not support the conclusions, and controversially re-published in *Environmental Sciences Europe*. Yet, one should note that while GM seeds may not harm human health, it is likely that they may not improve and even possibly harm environmental health. For instance, there is increasing evidence to discredit the notion that they allow farmers to use fewer pesticides (Bonny 2011). Also, they might affect non-target organisms more than previously thought (Bøhn et al. 2016).

On the question of ownership, GM seeds often travel to fields where they do not belong, transferred by natural agents such as animals or the wind. The unlucky farmers who own those fields have been accused of stealing GM seeds and have had to pay royalties to the companies in question (cf. Monsanto Canada Inc. v. Schmeiser 2001). Other farmers have been prohibited from using the age-old method of seed saving since GM seeds are, like other patented seeds, protected by intellectual property laws (cf. Bowman v. Monsanto Co et al. 2013). These problems are especially acute because GM seeds are living organisms that can replicate and spread with or without human intervention once they are out in the world. Even though government regulations demand buffer zones to prevent the unauthorized spread of GM seeds, these regulations vary from country to country and do not guarantee that seeds will not spread. All in all, the use of biotechnology in seeds turns out to be problematic because the institutional mechanisms of regulation, risk management, and ownership of GM seeds are changing the face of agriculture.

These changes to agriculture over the past decades call for an urgent need for social and legal innovation in the way we deal with seeds. In this paper, I connect the above-mentioned controversial issues by arguing that one effective way to address the question of hazards is through the question of ownership and the moral responsibilities that come with it. GM seeds are owned and owners reap great benefits off of these seeds, and so they should bear responsibilities, to varying degrees (Robaey 2015, 2016). In the next sections of this paper, we will see in more detail what this statement entails. The main question in this paper is that if ownership can be transferred, and if ownership comes with responsibilities, then how is moral responsibility transferred? And how should it be transferred? We investigate the issue of transferring moral responsibility for hazards of GM seeds, by drawing from the literature on moral responsibility and the ethics of technology.

Ownership Entails Moral Responsibility

Ownership can materialize in many different ways, social, psychological, technological, anthropological, and legal. In this paper, the focus is on the legal rights that owners receive. Indeed, ownership can be conceived of as legal rights, which give owners authority and benefits. This is an instrumental way of conceiving of ownership (cf. Thompson 2010), that allows putting in question the way we organize ownership of genetically modified seeds.

Conceiving of ownership as a bundle of rights (Honoré 1961) allows conceptualizing the moral responsibilities that come with these rights. In this paper, and in previous papers, I underline the importance of speaking of the responsibilities that come with ownership rights (Robaey 2015, 2016). This means, however, that when we speak of rights, they have legal import, and when we speak of responsibilities, they have moral import and may—but need not—have legal import. On the one hand, claims about ownership refer to the legal realms, i.e. different actors have different kinds of ownership rights by law. Different scholars define these rights to different extents (see Björkman and Hansson 2006), but these are, amongst others, the right to use, the right to income, the right to transfer, the right to manage, etc. On the other hand, claims about moral responsibility belong to the moral realm and have no direct legal import. All in all, a legal right might imply legal responsibilities, or duties, but they also imply moral responsibilities. It is important to stress moral responsibilities because of the uncertain, and somewhat experimental context of agriculture. The legal realm defines what we should do about what we know, but defining moral responsibilities empowers agents to act beyond what is prescribed, with the goal of not doing harm. In this paper, I assess whether the current ways of transferring ownership allow the transfer of moral responsibility, i.e. corresponds to what would be a good transfer of moral responsibility.

Indeed, ownership entails both rights and responsibilities. Since owners derive benefits from GM seeds they own, they also bear a special forward-looking moral responsibility to avoid harm. This is a so-called active responsibility, which applies *before* something harmful happens. It is aimed at reaching a good outcome (or avoiding a bad one), and the actions that lead to this good outcome are not prescribed but instead rely on the experience and judgment of the owner, or in other words, her discretionary powers. More precisely, in this paper, responsibilities are understood through a consequentialist lens. Goodin understands duties as being the deontological pendant of responsibilities (Goodin 1986). I add to this distinction, in the context of the ethics of risks, by suggesting that duties can be allocated to deal with known risks, but responsibilities are better allocated to deal with unknown risks, or uncertainties, given that they focus on desired outcomes, and grant discretionary powers to agents (Robaey 2015). This is important because it means owners, or agents, when responsible, must continuously learn about their technology, so that they can use their discretionary powers. In other words, so that they can improvise based on experience, judgement, and newly acquired knowledge, as soon as unknown risks may materialize. These discretionary powers,

or experience and judgment of agents, or different owners are further defined as epistemic virtues. Indeed, it is not enough to have discretionary powers, but it is also about how to use them well, and for good ends.

So, while owners may have different bundles of rights on the GM seed and all of its copies, they also have the responsibility to do no harm with these seeds. This responsibility will be expressed differently for the different owners according to their capacities and rights over the seeds. In order to achieve this, they should all strive to learn more about these seeds and thereby develop their epistemic virtues. These epistemic virtues can give owners a disposition to a range of actions. This range of action would however also depend on an owner's capacities. For instance, take the case of GM crops contaminating other fields: a biotechnologist could think about how to enhance the seeds' traceability, an agro-biotech company could provide financial support for this (provided that both the scientist and the company are on the patent), and a farmer with a license to use the GM seeds could experiment with different ways of using them that would diminish contamination in specific contexts (Robaey 2016). These actions might or might not be governed by legal regulations, but could in any case be seen as part of active or forward-looking moral responsibility. In other words, each owner should do what she can do to learn more about (in this case) the behaviour of the GM seeds in the field.

Owners exercising their epistemic virtues, i.e. learning, and acting according to their capacities would allow for an equitable situation in terms of efficiently and fairly sharing moral responsibility. Indeed, giving people responsibilities for which they do not have the legal rights and/or the capacities to fulfill them, would be counter productive. The other way around, people who would have rights and/or capacities to take actions to avoid harm but would not try to avoid harm simply because it was never laid out to them as their responsibility to bear would also be counter productive.

Ownership therefore involves not only benefitting from seeds but also being responsible for them. Of course, this argument might take a different shape if we were to establish that seeds could not be owned through ownership rights. It is, however, not the object of this paper to debate whether seeds, GM or non-GM can or should be owned. Here, we take a pragmatic approach, looking at the status quo and broadening the current notion of seed ownership.

The Materialization of Ownership

In the legal realm, ownership can be established through various ways that describe which rights and under which conditions these are granted to specific agents. In agriculture, ownership comes with legal innovations that have been developing since the beginning of the twentieth century along with the formalization of agriculture. It started with the Plant Patent Act of 1930, which was a first form of intellectual property rights (IPRs) on plant varieties (Fowler 2000). Throughout the last century, IPRs for plants have expanded throughout patent institutions all over the world and are granted depending on the type of innovation and the governing IPRs institution.

These developments accompany the move of breeding, or developing varieties from the field to the lab. IPRs grant exclusivity to one agent because they are seen as a way to protect investments on the R&D for new seeds (see Timmermann 2015 for an ethical discussion of IPRs). For the attribution of IPRs, the systems differ in different countries, but the results are the same, there are IPRs on GM seeds[1] by virtue of having patents on an inventive step, or a new process in their development. Also, the patents may be on a process, or a technology, but it will apply to all copies of a seed, giving the owners of the patent the right to license the GM seed as they want. Jefferson et al. (2015) investigate the issue of patent on genetically edited (i.e. modified) plant genome sequences in the US and find that a few companies hold most of the patents.

As a counter-reaction to these legal innovations, the International Treaty on Plant and Genetic Resources for Food and Agriculture lays out Farmers Rights, which try to preserve rights that farmers are progressively loosing with the advent of breeders, seed developers and biotech companies claiming rights over these seeds. More generally speaking, scholarship on the matter debates whether the reasons for setting up IPRs in such a way make sense given that it also excludes other actors from contributing to the pool of knowledge, as Jefferson et al. (2015) underline with their empirical study, and as Timmermann (2013) argues with respect to the human right to benefit and contribute to scientific knowledge.

However, in this paper, we take a look at the status quo with regards to how patents and treaties manage the attribution of ownership rights and contracts manage the transfer of these rights. Some rights might be transferred and not others, depending on what the original owner, or the full owner may want. Also contracts explain what duties come with the transfer, often formulated as "do A", or "do not A". Earlier, we examined how duties differed from moral responsibilities in the context of potential risks. Just to remind the reader, as mentioned earlier, the goal of this paper is not to question whether and how seeds should be owned, but rather to look at the transfer of ownership and how it comes to transfer moral responsibility.

So, if ownership rights can be materialized and transferred through contracts, then how is moral responsibility transferred? Are there existing social or legal instruments to do so in the case of GM seeds? If so, do they shift moral responsibility from one owner to another in a fair and effective way? It is important to think of the transfer in terms of fairness and efficiency. Nihlén Fahlquist (2006) argues, in the case of public health, that moral responsibility ascriptions should follow these values. With regard to efficiency, the goal of responsibility ascription is to achieve a good outcome overall with the use of GM seeds. This implies that agents who cannot realistically fulfill certain responsibilities should not be overburdened. With regard to fairness, it is important to ascribe moral responsibility to those who make a deliberate choice. For instance, a company may choose to sell GM seeds and some farmers may choose to buy them, so they bear responsibility because of their freedom of choice. If the values of fairness and efficiency are essential for ascribing moral responsibility, they should also be found in the ascriptions resulting from the transfer of moral responsibility.

[1] It is important to note here that patents are also given to varieties of plants that are bred through conventional methods.

As we have seen, ownership of GM seeds is protected by IPRs, so when GM seeds are purchased, they typically come with a contract.[2] For example, the Monsanto Technology/Stewardship Agreement (MTSA) grants a license to the buyer and comes with a detailed Technology Use Guide (TUG). Both these documents lay out the details of the transfer of ownership rights in terms of the right to use the GM seeds, and in terms of how those seeds should be used. One could argue that this latter topic brings about a transfer of responsibility. Indeed, issuing instructions about the proper use of a technology presupposes that using it incorrectly would have negative consequences, but we will come back to this in more detail in the next section.

Monsanto, a prominent actor on the agro-biotech stage, provides for a perfect case study that allows us to ask whether responsibilities are indeed transferred with a contract, what these responsibilities entail, and how they are embodied in the MTSA and the TUG. In the previous section, we briefly saw what an owner's responsibilities could entail in theory. Before we evaluate how specific documents present moral responsibility, it will be useful to reflect on what a good, i.e. desirable and effective, transfer of responsibility might entail. Building on the literature in ethics of technology and design studies and more specifically, the notion of use plans, we can seek not only to transfer forward-looking moral responsibility but also to do so in a way that will help avoiding potential harms. Figure 1 depicts the relations between the different concepts presented so far. In the pages that follow, I suggest a framework for assessing current practices in dealing with agro-biotechnological innovations.

Transferring Moral Responsibility for Technology

Transferring Moral Responsibility for an Artefact

Scholarship on the ethics of technology allows us to take a step back from the legal realm and look at what contracts and instruction manuals actually do, using the concept of *use plans* (Houkes and Vermaas 2004). Artefacts can be described by their physical properties but also by the intentions that are put in their design. The latter can be understood either as the function of an artifact, or its use (as described in a use plan). While these are inextricably connected, we focus on describing use in this paper. Indeed, since the objects of our investigation are contracts and instruction manuals, and these describe rights and duties of an owner, they therefore also describe the desired use of the artefact. Moreover, one can assume that an undesired use of an artifact might lead to undesirable outcomes. In order to think in more specific terms about whether and how contracts and instruction manuals can provide a platform for transferring moral responsibility requires looking at how we can conceive of a good transfer of moral responsibility. The scholarship on the matter is not vast. Pols (2010) makes a suggestion on how to transfer moral responsibility

[2] There is a growing movement looking for alternatives to the current IPR system adapted to agriculture. For instance, the BiOS licensing system (see www.bios.net).

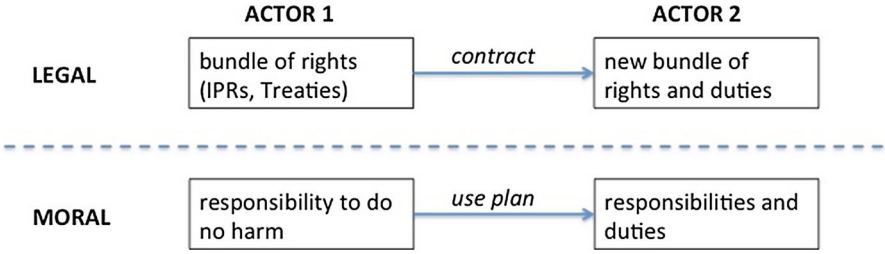

Fig. 1 Sketch of concepts. The *arrow* indicates a transfer to another agent, in the legal realm this is realized through contracts, and in the moral realm, this can be realized through use plans (that can be instruction manuals)

through use plans but before we can look into it, we need to take a closer look at what use plans actually are.

Houkes and Vermaas (2004) challenge the functional approach to artefacts and suggest an actionable account of artefacts through the idea of a *use plan*. A use plan is any rational sequence of actions with an artefact that will lead to the realization of a goal. If a use plan is appropriate, it will lead to a specific desired outcome. Use plans can vary according to the agent's skills and capacity for using the technology. Among many ways, use plans can be communicated through instruction manuals. However, these manuals provide only one possible sequence of actions that will realize one goal, whereas, in fact, several goals could be achieved with an artifact. Reversely, several use plans may achieve the same goal.

To describe this phenomenon, Houkes and Vermaas speak of a standard and non-standard use of an artifact, and the distinction between these uses is gradual. A standard use of an artifact implies a rational sequence of action that will lead each time to one specific goal following more or less the same sequence of action. A standard use is more or less obvious and repeatable. It implies that the design will lend itself to the standard use, and that the standard use can be communicated. A non-standard use of an artifact will evolve from a sequence of action and a goal that will differ to the one of the standard use. A user may come up with a non-standard use herself. An example for non standard-use are these famous life hacks suggestions on how to use a hair pin as a means to squeeze out the remnant toothpaste out of a tube instead of holding hair.

In addition, Houkes and Vermaas describe that a standard and a non-standard use can be either rational or irrational. So non-standard use by itself does not imply bad outcomes, indeed, a non-standard use might lead to a use that was not intended but that could be good, as in the example of the hair pin above. However, Houkes and Vermaas emphasize that irrational non-standard use have a higher chance of leading to no realization of any goal. One other important distinction would be an irrational but standard use. In this case, for instance, the standard use would not fit a given context, so it would be irrational.[3] Moving from a non-standard to a standard use is a

[3] This corresponds to the critique that Akrich (1992) voices through what she calls the script of a technology, i.e. how its design presupposes a certain use. She describes how inappropriate assumptions about users influence the design of a technology and thereby limit users.

dynamic and gradual process, which involves "autonomous, context-sensitive deliberation by users" (Houkes and Vermaas 2004, p. 61) and communication.

All in all, the reader might get the idea how this actionable account of artefacts underlines how narrow both a contract and an instruction manual might be in terms of communicating use.

But to return to our original problem, which was how to transfer moral responsibility, which, as we saw is connected to how we use an artifact, the idea of the use plan alone does not provide a solution. Indeed, Radder (2009) comments that the *use plan* approach does not allow for a normative assessment of use. There is an idea about achieving a goal or not achieving it and in that sense a use plan is good or bad. However, if we put it in a normative context and in the context of the ethics of risk, we can add that the outcome of the use plan should have good consequences, so be morally desirable for society. This is where the idea of defining moral responsibility for owners as a consequentialist notion re-joins the idea of the use plan. We use technologies because we want to achieve good ends, and we want to minimize unwanted negative side effects.

We had to make a detour to explain the notion of use plans, so let us now return to Pols' idea of how to transfer responsibility through use plans. In the context of risk, Pols (2010) proposes five conditions for a transfer of responsibility through use plans from the engineer to the user. These conditions are as follows:

1. An engineer is morally responsible for a technology.
2. An engineer can successfully communicate at least one rational use plan for the technology to a user.
3. This use plan can (under normal conditions) physically be executed with the technology.
4. The user is able to execute the use plan.
5. The user has access to the technology.

These conditions specify how the use plan can also have a normative dimension by transferring responsibility. It is important to underline Pols' definition of responsibility and how it differs from the definition provided in this paper. Indeed, Pols provides an account based on control, so if a use plan allows to transfer the control of an artifact, it also transfers responsibility. By control, Pols means control of the artifact, i.e. a series of actions leading to certain outcomes with the artefact, but also, what he calls regulative control, i.e. actions that will react to the artefact's momentum in order to control it. He gives the example of putting chains on the tire of a car in icy road condition as an example of the first type of control, which allows the user to have regulative control over the car.

Transfer of control therefore implies transfer of moral responsibility. What is responsibility in Pols' view? Pols does not present one definition of moral responsibility. To the contrary, there are several notions to be found in his account. Pols underlines that some degree of responsibility always remains with the engineer. This is because Pols understands the responsibility of the engineer as a 'role responsibility', which could, in this context, also be understood as a professional responsibility. It seems that the user in Pols framework does not receive a role

responsibility from the transfer, but rather, the user's responsibility is defined in terms of ability to execute the use plan, and access to the artifact. Moreover, Pols' notion of responsibility seems to encompass forward and backward looking moral responsibility without very clear distinctions on who bears what kind of moral responsibility, at what point, and why.

This approach to responsibility differs from the one suggested in this paper. Indeed, in the current proposal, we focus on one definition, or aspect, of moral responsibility. Here, we understand moral responsibility for hazards as a forward-looking moral responsibility to do no harm. This is then further specified in the context of uncertainty as the cultivation of epistemic virtues that allow an agent to take actions, to learn about the artifact, and react accordingly when unexpected and undesired impacts start materializing. This is the responsibility that should be transferred when transferring ownership rights over a GM seed. So how does Pols' proposal fair in the case of GM seeds and with this more precise definition of moral responsibility?

Problems with the Framework in the Context of GM Seeds

GM seeds are not just any artefacts like a car, or a hairpin. GM seeds are first of all seeds; so they can grow if planted, create more seeds, spread beyond the place where they were intended to grow, they might even change without human intervention. Also, being seeds, many of them have the purpose of feeding humans and other animals, so their success is linked to our survival. Because of their characteristics and because of what is at stake in their use, they should not be treated like any artefacts.

There are three types of problems with Pols proposal: (a) about the underspecification of the conditions, (b) about the simplification of the conditions that is not helpful in the case of GMOs and (c) a problem at a more fundamental level.

Underspecification

First of all, it is important to point where the underspecification of the conditions are because they can lead to problem in the application of the conditions. In the formulation of conditions themselves, it is not a problem to underspecify as it allows them to be applicable to a broad array of cases.

A first underspecification can be found in condition (2) 'An engineer can successfully communicate at least one rational use plan for the technology to a user'. This condition assumes that a successful communication can be easily identified and evaluated. How can we know if the communication was successful? Also the communicated use plans makes certain assumptions about the user when in reality there is a variety of users. When applying this to the case of GM seeds, some adjustments should be made regarding what a successful communication might entail and this implies identifying who is communicating to whom.

Another underspecification is found in condition (5) 'The user has access to the technology'. This condition assumes access without defining what access means. In the example that Pols provides he explains that it is about the car and all that goes

with it. If the user has the car and all that allows driving it, then the user is responsible, according to Pols. In the case of GM seeds, farmers have access to the GM seed, but not to the 'contents' of the seed, i.e. they cannot save the GM seed and use it for breeding.

Simplification

Simplification is necessary when developing a general framework. However, when thinking about the transfer of moral responsibility and the uncertainties surrounding GMOs, some conditions seem to not quite apply.

One first such simplification is found in condition (1) 'An engineer is morally responsible for a technology'. This condition assumes a direct relationship between the engineer and the technology. In the case of GM seeds, the agro-industrial complex is much more convoluted. It involves many actors including lawyers applying for patents and drafting contracts, as well as different bio-engineers for the development and the use of the seeds, regulatory bodies, seed distributors, farmers, and retailers. The assumption of linearity in transfer, i.e. that responsibility moves from one agent onto the next is problematic. There is always a degree of responsibility that remains with the agent who has done the transfer, although that agent might no longer be a user. Pols does argue that some responsibilities cannot be transferred and that engineers "remain responsible for the complete lifecycle of the artifact" (p. 191, 2010). Pols, however, does not expand on this point beyond the examples of recalling defect artefacts or providing opportunities for recycling obsolete artefacts.

Another simplification is found in condition (3) 'This use plan can (under normal conditions) physically be executed with the technology'. What are normal conditions when dealing with uncertainties? We could encounter cases of use where there are no identifiable normal conditions. For example, in a hypothetical scenario, a certain GM seed might have unexpected interactions with another species and this unexpected interaction might change the normal conditions. There are a lot of empirical uncertainties as to how the use of GM seeds impacts environmental and human health in the long run, and furthermore, these impacts might differ depending on the type of genetic modification and the use entailed by the modification. For instance, a pesticide resistance gene entails the use of a specific pesticide with the plant. Taking into account potential hazards and uncertainties that surround the use of GM crops, the definition of transfer provided above seems insufficient because the realization of condition (2) and (3) would be challenged. Indeed, the successfully communicated use plan might no longer apply (2), and the conditions would not be normal anymore so that might have implications for its execution (3).

Last but not least, another simplification is found in condition (4) 'The user is able to execute the use plan'. This condition demands the ability to execute the use plan, which recalls what Houkes and Vermaas refer to as skills and capacity. First, these might be context-specific. Second, who decides when this ability is sufficient? When a farmer orders a bag of GM seeds, how is she supposed to know that she will have the ability to execute the use plan? How does the seller know that the farmer

will have this ability? This might create false incentives to diminish the level of ability required in order to sell more. Or the other way around, it might exclude the access to potentially better seeds because of a lack of ability. Not all farmers operate in the same context or have the same capacity for carrying out instructions. Some might be very wealthy and able to fulfill requirements, while others might be overburdened with other responsibilities. Still others might be subsistence farmers who happen to have GM crops without even knowing about it.

Shortcomings of Framework

The main problem in the suggested framework is with the definition of moral responsibility. Indeed, in the previous paragraphs, we notice many problems.

If the responsibility of the engineer is a role responsibility (or a professional responsibility), then how can this be transferred to other agents who do not have this role? It cannot. Also, in the suggested framework, the user's responsibility is defined by having a use plan and being able to follow it. If this use plan is for some reason irrational, or non-standard, then the user is not exercising a forward-looking moral responsibility. And if something goes wrong, the user would also have a limited backward moral responsibility because she was executing a use plan.

With the lack of a definition of moral responsibility to be transferred, we also cannot specifying what responsibilities remain with an agent, and what responsibilities are transferred. Also, if we consider the owners again for a moment, when an artifact is transferred, only certain specific rights are transferred over this artifact. Contracts specifically lay out what these rights are that are transferred and remain. So if we assume that different actors have different bundles of rights, we must recognize what Honoré (1961) calls split ownership; responsibility should therefore also be split in the transfer. There are no mentions of this in Pols conditions.

In order to transfer moral responsibility in a good way for GM seeds, we need to address the problems mentioned above. The next section makes a proposal to that end.

Conditions for a Good Transfer of Responsibility for GM Seeds

In this paper, we look at agents with a bundle of ownership rights over the GM seed that we call owners. An engineer has some ownership rights over a technology she develops, be it for instance by having her name on the patent. A user also has some ownership rights, simply put, the right to use. So we can read Pols' proposal by replacing *engineer* and *user* to *owner i* and *owner j*. Also, in reality, things are more complicated and an artifact will have many owners with varying rights through its life, so we can call an owner with any bundle of right at any point of that chain, an owner *i*.

In the previous section we have established the many shortcoming of the current framework for transferring moral responsibility through use plans. We have also examined what the responsibility of owner *i* entailed, namely the forward-looking moral responsibility to do no harm with the GM seed. We explained how in order to fulfill their forward-looking moral responsibility to do no harm, owner *i* would need

to cultivate her epistemic virtues in order to learn about the GM seed and be able to define a range of actions that would facilitate her learning and intervening in case some undesirable effects would manifest. These actions would differ from owner to owner given their capacities and contexts (Table 1).

What, then, would constitute a satisfactory account of the transfer of moral responsibility for GM seeds? Let us revisit the suggested conditions.

(1) *An engineer is morally responsible for a technology*

Adding a more precise definition of moral responsibility, as explained above and moving away from the engineer and her role responsibility by speaking of the owner instead allows us to formulate the following condition as follows:

(1′) *An owner i is morally responsible for a GM seed in a forward-looking way to do no harm with the technology.*

(2) *An engineer can successfully communicate at least one rational use plan for the technology to a user*

For this condition, we need to address the specificity of our case, namely include some context-sensitivity. This reformulation allows avoiding high burdens that might lead to inefficient and unfair distribution of moral responsibility, as described in (1′) and thereby failing to achieve the goal to do no harm. The condition can therefore be reformulated and specified as:

(2′) *An owner i can communicate this rational use plan x to another owner j. This use plan x is context-sensitive, i.e. ensures that the new owner j need not change the seed's intended context dramatically to be able to start using it. This allows avoiding high demands on capacities from owners who might not have them.*

(3) *This use plan can (under normal conditions) physically be executed with the technology and (4) the user is able to execute the use plan.*

We merge these two conditions in order to account for a transfer of moral responsibility where normal conditions might not be met. The fact that the use plan can be physically executed and that the user is able to execute it should not be separated because the use plan should be context specific as described in (2′). Also, the use plan should allow for a transfer of responsibility that corresponds to the capacities of the new owner, and if these use plan cannot be fully performed by the new owner, then the previous owners in the chain of transfer should make sure they can support the new owner in the execution of the use plan. So we can formulate this new condition as such:

(3′) *The new owner j has the capacity to execute the use plan and where j's capacity might be lacking, the original owner i that has executed the transfer should ensure that she helps the realization of the use plan, whether on their own or through the recruitment of more actors.*

(5) *The user has access to the technology.*

As we saw, the definition of access was very narrow. In order to realize their forward-looking moral responsibilities as defined in this paper, owners need to cultivate their epistemic virtues in order to learn about the potential hazards that might arise and take the necessary actions to prevent and/or limit their impacts. This implies a broader notion of access, as in having epistemic access to the technology, and not only having access to use the technology in a black-boxed manner. Thus, we can rephrase this condition as:

(4′) *The new owner j has epistemic access to the technology. This means that the technology does not remain a black box for j; instead, owner j should have the possibility to change and manage the technology in a context-sensitive manner. This, in turn, ensures that the new owner j has the opportunity to learn about the seed (e.g. through training).*

Now that we have revised the existing conditions, it is important to add two more considerations for this framework, updating one condition and adding another one in order to fully address the issues mentioned above.

Since we removed the notion of role responsibility for the engineer in these new conditions, it is important to make explicit that the rational use plan should have for a goal as itself to do no harm with the technology. So it is not only that the owner has a responsibility to do no harm, it is also that the use plan communicates this. We can complement condition (1′) as such,

(1′) *An owner i is morally responsible for a GM seed in a forward-looking way to do no harm with the technology. This implies that there should be at least one rational use plan x that does not result in unacceptable harm from the use of the technology.*

Connecting this condition to the notion of moral responsibility as epistemic virtues, as well as the problem of uncertainties, the reader is reminded of the distinction between duties and responsibilities drawn earlier in this paper. Duties demand specific performances and are well fitted for managing known risks. In contrast, responsibilities are self-supervisory and demand of the agent to cultivate her epistemic virtues in order to learn and intervene when uncertainties materialize.

A use plan will and may contain duties, but if the use plan is to address the problem of uncertainty, we need to formulate another condition that will allow for adaptability in the use plan. Moreover, this will make the communication chain less linear, and more dynamic between owners. Thus, we add the following condition:

(5′) *The new owner j has the possibility to create and communicate adapted rational use plans y to other owners k, when and where it is relevant to preventing harm with the use of technology.*

Table 1 Conditions for a good transfer of moral responsibility for GM seeds

(1′) An owner i is morally responsible for a GM seed in a forward-looking way to do no harm with the technology. This implies that there should be at least one rational use plan x that does not result in unacceptable harm from the use of the technology
(2′) An owner i can communicate this rational use plan x to another owner j. This use plan x is context-sensitive, i.e. ensures that the new owner need not change the seed's intended context dramatically to be able to start using it. This allows avoiding high demands on capacities from owners who might not have them
(3′) The new owner j has the capacity to execute the use plan x and where j's capacity might be lacking, the original owner i that has executed the transfer should ensure that she helps the realization of the use plan, whether on their own or through the recruitment of more actors
(4′) The new owner j has epistemic access to the technology. This means that the technology does not remain a black box for j; instead, owner j should have the possibility to change and manage it in a context-sensitive manner. This, in turn, ensures that the new owner j has the opportunity to learn about the seed (e.g. through training)
(5′) The new owner j has the possibility to create and communicate adapted rational use plans y to other owners k, when and where it is relevant to preventing harm with the use of technology

Insights from an Existing Case

The Monsanto Technology Use Guide and Technology/Stewardship Agreement

With these insights, we can now make an ethical assessment of the transfer of moral responsibility in the 2015 Monsanto Technology Use Guide (TUG) and Technology/Stewardship Agreement (MTSA) (Monsanto 2015).[4] It is important to underline that Monsanto is not the only company producing such documents to accompany the sale of its seeds, indeed Syngenta, Bayer, BASF, Dow, and Dupont[5] do so as well. In this article, we take a look at only one of these companies because the goal of this investigation is not to compare their practices. Rather, the goal of this paper is to reflect on the conditions for a good transfer of moral responsibility. All the passage cited in this section are from the TUG and the MTSA.

These two documents, the TUG and the MTSA are contained in one document. In addition, their goals seem to differ but nonetheless, they have a common aim. On the one hand, the TUG primarily instructs on proper use for different crops such as corn, or cotton, but more generally for issues of insect resistance management, integrated pest management, weed management, etc. What these instructions also create, as a side effect, is to deflect liability from Monsanto in case of improper use by the Grower. On the other hand, the MTSA defines which rights and duties are passed on from the company to the grower, and thereby protect the company's

[4] At the time of this analysis, the 2015 TUG was used. A new version, 2016, has now been released but was not the subject of analysis of this paper, mostly because the updates concerned more the products included, rather than how things are dealt with, which is the point of interest for this analysis.

[5] Also called the Big 6, by some critical observers like the ETC group, but corroborating that the largest part of patent ownership in agro biotech is with these companies.

ownership over the seeds. The MTSA is however not only about rights; an important function of the contract is also to define conditions that would remove liability from the company (paragraphs 11 and 12).

Liability is one type of responsibility, but these documents also see stewardship as a form of responsibility 'for proper management of these products' (p. 4). Also, these documents address more the management than the product as such, with a very heavy emphasis on connected technologies, i.e. pesticides. So we will analyze whether the conditions for a good transfer of moral responsibility are met. Here, the transfer is from Monsanto to the Grower or, in the language of our framework above, owner i to owner j. In other words, I ask, do the TUG and MTSA fulfill the conditions for a good transfer of responsibility? It is important to note here that the TUG communicates on the use of the seed and the technologies accompanying them, namely pesticides. Since they go hand in hand in the case of Bt technologies, they can be considered as one technology.

With regards to condition (1′), there are two main elements to consider: first that there is moral responsibility in a forward-looking way and second that at least one rational use plan x does not result in unacceptable harm from the use of the technology. Before we can answer this question for condition (1′), we need to first underline how harm is defined in these documents. There is no encompassing notion of harm, instead there are several interpretations to be found that are case specific. For instance, in the context of pest management where the need to be managed, "in a manner that is least impactful to people, property and the environment" (p. 7). Another example is in the case of corn, "sustainability of corn agricultural systems is enhanced when growers follow recommended IPM practices, including cultural and biological control tactics, pest sampling and appropriate use of pest thresholds for management practices." (p. 14). Another type of possible harm mentioned is the decreased effectiveness[6] of Bt corn technologies (p. 15) on the label itself that comes with a bag of Genuity® SmartStax® Corn. It seems that the TUG is communicating at least one rational use plan that avoids some specific harms described in the TUG. In a way, each general section in the TUG could be rephrased as places where specific types of harm might happen, with regard to resistance, pest, coexistence, etc. It also seems that it is about forward-looking moral responsibility, in the sense of avoiding certain undesirable outcomes. All in all, it seems condition (1′) is more or less fulfilled although a more encompassing notion of harm, and formulated more prominently in the goals of the TUG would be more desirable. For now, it seems like avoiding harm is a side topic to the TUG.

Looking at condition (2′), the important things to pay attention to are context-sensitivity and avoiding high demands on those who do not have the capacity to carry out responsibilities. When it comes to context-sensitivity, we need to further discern between context sensitivity for the technology, and context sensitivity for the owner, or here, the Grower. There is ample attention to the context sensitivity of the technology, for instance Growers must "use seed products, seeding rates and planting technologies appropriate for each specific crop and geographical area. As

[6] In agro biotech, including pesticides, there is a big problem with how innovations are protected as their efficiency, and effectiveness diminish over time (Timmermann 2015).

much as possible, manage the crop to avoid plant stress." (p. 7). Also, there is context-specificity for rules and regulations for the technology, like with "refuge requirements [that] vary by the type of product being planted and the location of planting. Growers must plant the amount of refuge acres for a product that is required for their growing region."(p. 6). Last but not least, there is attention to the surroundings in which Growers are using the technology, "each grower needs to be aware of the planting intentions of his or her neighbour in order to gauge the need for appropriate best management practices." (p. 10) There is, however, a lack of attention to the capacities of the Grower, which may be affected by their context, i.e. the country, the type of farming, their socio-economical background.

This is why condition (3′) is extremely important. The focus of condition (3′) is the capacity of the owner and how these will be compensated for if the demands on the new owner are too high. This is a point where the TUG and the MTSA have clear defects. In a generous reading, we find several places where attention to capacity and support can be found, such as through the "Take Action effort […] an industry-wide partnership between university weed scientists, major herbicide providers and organizations representing corn, cotton, sorghum, soybean and wheat growers to help them manage herbicide-resistant weeds" (p. 8), or growers having access to, "a free Insect Resistance Management (IRM) corn refuge calculator" (p. 19). While an online calculator might be a useful tool, it is unclear, however, how Growers can tap into the Take Action effort. The TUG also claims, "Monsanto works to develop and implement IRM programs that strike a balance between available knowledge and practicality, with grower acceptance and implementation of the plan as critical components." (p. 6). However, practicality and acceptance neither mean that capacities are there, nor how the balance is being struck. In contrast to this, the TUG and the MTSA contain many formulations where the Grower must read and follow, must comply, must cooperate, should scout, should consult, should monitor, should be aware, etc. With the lack of clear emphasis on capacities, or how they could be compensated for via other actors, and the clear number of requirements on growers, it is difficult to assert that condition (3′) is fulfilled in the current form of these documents. This could create inefficiencies and imbalances in being morally responsible in a forward-looking way since not fulfilling condition (3′) impedes a good transfer of moral responsibility.

In addition, we can observe further imbalances that also impede a good transfer of moral responsibility. Condition (4′) on the epistemic access to the technology allows us to underline another imbalance on who has what kind of epistemic access. It seems that Growers are mostly transferred epistemic access in terms of monitoring and reporting to the company or appropriate authorities. Through this monitoring and reporting, appropriate decisions should be made, e.g. for pest management. There are also hotlines, websites, training centers available to fulfill these responsibilities. I would, however, qualify this as a limited epistemic access since the technology, i.e. the seed, remains black-boxed. Indeed, seed-saving is strictly prohibited (paragraph 4 g of the MTSA). The company, however, has full epistemic access, and receives on the field information from the monitoring and reporting, allowing a continuous development of new seeds. Earlier, we saw that epistemic access was important for owners to react appropriately in the context of

uncertainty. Here, the access is limited, and the stakes are high, namely the future of our food systems. In a constantly changing environment, in order for all agents to be responsible in a forward-looking way, they should have an equivalent amount of access to the technology, and not only to the management of the technology. The argument becomes broader here, because of the goal of these types of technology, which is to feed the world, hence, the more agents, or owners, can learn about them to improve them and diversify them, the better off we would be[7].

This leads us to condition (5′), about the possibility to create and communicate new rational use plans where it is relevant to preventing harm.

It seems in the TUG and the MTSA that only Monsanto has that responsibility, given the limited epistemic access of other owners. It is necessary that at least one agent has this possibility, "Monsanto is committed to the proper use and long-term effectiveness of its proprietary herbicide brands through a four-part stewardship program: developing appropriate weed control recommendations, continuing research to refine and update recommendations, education on the importance of effective weed management and responding to repeated weed control inquiries through a product performance evaluation process" (p. 8). This is, however, not sufficient to fulfill a good transfer of moral responsibility under conditions of uncertainty. Condition (5′) underlines the need for adaptability in changing circumstances, which goes hand in hand with the idea of being actively responsible to achieve good outcomes, and acting as soon as possible.

There is more to condition (5′); not only is Monsanto the only agent with the rights to create new use plans where new harms might arise, but also the TUG and MSTA is only *use plan* that actively and legally excludes any other possible use plans and thereby makes illegal other potential good use of the GM seeds. So the current set-up of the use plan actively prohibits new owners from being responsible, and limits them to fulfilling a set of duties.

There are other points we did not touch upon because we were looking at the conditions for a good transfer of moral responsibility but the TUG and MTSA have a punitive nature, so if an agent X fails to do an action, then access to the technology will be denied. As mentioned above, the grower is bestowed with a lot of duties, or obligations, phrased as an agent X must do A and yet very little rights. These documents present the rationale as such, "These new technologies bring enhanced value and benefits to growers, and growers assume responsibilities for proper management of these products." (p. 4). Except these are not responsibilities as we understand them in this paper, rather, they are duties.

All in all, it seems like the TUG and MTSA have the potential for transferring forward-looking moral responsibility to do no harm but in the end do not. Also, the transfer may not be partial, either moral responsibility is transferred or it is not. There are other kinds of responsibilities that are transferred here, like duties, or obligations. These are also forward-looking, but they do not correspond to the definition we provided, namely as cultivating epistemic virtues in order to define a range of actions that will help react in the context of uncertain use and effects of

[7] More could be said about how we innovate and what kind of innovation models would be more desirable in the agriculture, especially where it concerns basic goods, such as food.

new technologies. This is because they do not take into account the capacities of the new owner and they do not grant a real epistemic access to the technology. This will also have an impact on backward-looking moral responsibility and who can be held blameworthy in cases where things would go wrong.

Conclusion

If we now return to the main questions of this paper, namely, if ownership can be transferred, and if ownership comes with responsibilities, then how is moral responsibility transferred? And how should it be transferred?

To remind the reader, we connected the issues of ownership and moral responsibility in order to address the problem of hazards. Indeed, in conditions of uncertainty with the use of a technology, those who reap benefits off of it should also bear moral responsibility. There are different definitions of moral responsibility. The one suggested in this paper is forward-looking and aims at avoiding harm. It is further specified as being the cultivation of epistemic virtues that allow owners that chose to use GM seeds to define a range of actions that will allow them to learn and react when uncertain hazards materialize. If this responsibility is transferred properly, then, it is more likely that owners will be able to react on time.

A good transfer should be set up so that this type of moral responsibility can be transferred, especially when dealing with technologies such as GM seeds which have high potential benefits for society but also unknown hazards. After reviewing the existing proposal for transferring responsibility through use plans, I suggested a new set of conditions that would allow the transfer of responsibility. These are listed in Table 1. What is important to note about these conditions is that the transfer does not imply a linear transfer where responsibility leaves one agent to go to the next. To the contrary, a good transfer of moral responsibility will grant new responsibilities to new owners, but it will not remove responsibility from the original owner, as long as this one retains ownership rights because these entail moral responsibility. Further research would be to look into what happens to moral responsibility when ownership is removed. So as ownership is split, so is moral responsibility. Here, the notions of capacity and context become very important. Indeed, the conditions do not want to overburden one owner because it could lead to negative outcomes.

With the help of this framework, we looked at a case, which is a practical implementation of a use plan, namely the MTSA and the TUG. We find that while these do transfer rights and legal duties, and obligations, it is still too little to claim that it is a good transfer of forward-looking moral responsibility for hazards. Such documents have, however, the potential to do so. Or perhaps new platforms should be created for the communication of desirable use plans with GM seeds.

If anything, one thing this investigation underlines is that with technological innovations, social and legal innovations are needed. The current way of transferring moral responsibility when we deal with uncertainties is insufficient from an ethical standpoint. Further steps for this research line would be to think about practical means of meeting the conditions for a good transfer of forward-

looking moral responsibilities for hazards of GM seeds. Also we should reflect on possible exceptions such as the expiry of ownership. Reflections in the field of ethics can help finding the directions for using GM seeds in a responsible way.

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