Cultural risks generated by biotechnology:

A case study of gene-edited rice in Japan

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Table of Contents

1. Introduction

Human activity has impacted so much of the natural world that it is has triggered a new age, the 'Anthropocene'. As a result of this, the line between natural disasters and man-made ones is being increasingly blurred. For example; the 'Triple Disaster' in Japan in 2011, in which an earthquake created a tsunami that caused the Fukushima Daiichi nuclear reactor meltdown and subsequent radiation disaster (Walker, 2015); or the COVID-19 zoonotic pandemic in 2019-2021, in which environmental degradation triggered the uncontrolled spread of the coronavirus (Andersen, 2020). The 21st century promises to continue to present many more of such complex and interrelated challenges.

Government officials at the times of these disasters used terms like 'unimaginable' and argued that the events were beyond any scientifically anticipated scale, and as such there was "no merit in reflecting on it" (Walker, 2015:300). However, some scientists, such as from the discipline of Responsible Research and Innovation (RRI), would argue that this is not the case. Many of such disasters and so-called 'wicked' problems, like climate change, are increasingly being understood not as random, nor as the result of failed technologies or a lack of innovation, but instead as being caused (at the very least, in part) by the consequences or 'dark' side effects of *successful* innovations and technologies (van Loon, 2002; Beck, 2015; Biggi and Giuliani, 2020). For example, the loss of biodiversity is connected to successful innovations in agricultural technology and land use practices (FAO in Goedde et al. 2016).

Scholars from RRI would argue that insofar as emerging technologies purport to solve problems, they may also create new challenges, not least in spatially and temporally different contexts (von Schomberg & Hansen, 2019). It is thus imperative that research and innovation be holistically and critically assessed- not only in hindsight, but also in contemporary innovations, in order to address tensions and mitigate side effects (Owen et al., 2012).

One such innovation that is of interest to the field of RRI is gene-editing (e.g. via the tool CRISPR), which has the ability to directly edit the genome of mammalian embryos and plant cell lines (Tabei, 2019). This powerful innovation may intend to achieve good for societies, such as the alleviation of food insecurity by creating disease resistant crops (Gould et al. 2018), but concerns have emerged around the safety of the technology (Tabei, 2019). While scholarship on these contemporary debates and potential negative aspects is growing, the research tends to be primarily focused on health and environmental risks (see Komoto et al. 2016; Reiher and Yamaguchi, 2017; de Graeff et al. 2019; Farid et al. 2020), has low

disciplinary diversity, especially from the social sciences and humanities, and there remains a notable lack of academic engagement regarding public perceptions (de Graeff et al. 2019).

Using the Japanese agricultural context of rice, I aim to explore these emerging knowledge gaps to study the 'dark sides' of adopting gene-editing in relation to *culture*. Thus, in addition to the important research being done on health and environmental risks, my research question explores: *How can the adoption of biotechnology generate cultural risks in Japan?* I begin in Section 2, by briefly describing the concept of Japanese nature and the significance of rice to Japanese culture. In Section 3, I present my framework by explaining Kopytoff's theory on singularities and commodities, and by describing cultural risk. In Section 4, I detail the case of gene-edited rice in Japan. Section 5 hosts the discussion, in which I assert that because of rice's significance to Japanese society, it is not solely an economic commodity, but also has *singularity* to the culture (e.g. irreplaceable, symbolic, etc. to a specific group of people, in this case the Japanese). If gene-edited rice is framed as unnatural, current policy approaches may mean that *all* domestic rice may lose its singularity, and thus pose a risk to the Japanese culture. I conclude with areas for further research.

Note that this article is meant to be exploratory rather than definitive, thus the purpose is two-fold; first, to demonstrate that in addition to health and environment, biotechnology should be examined by its impacts to other fundamental values, such as those embedded in culture; and second, to serve as an example of the insidious and unintended side effects that successful emerging technologies may have in the future, should I not take a more reflective and responsible approach to research and innovation.

2. Context

2.1. Japanese vision of nature

Nature is perhaps one of the most complex words in the human language (Kirby, 2011). I thus do not intend to define nature, but to instead clarify the perspective on this concept as it relates to the Japanese context that is used in this article. The Japanese philosopher Watsuji Tetsurô (1889-1960) believed that people are a direct product of their environments, as the interconnected elements (animals, plants, soil, water, climate, topography, etc.) come to shape the Japanese people and culture (Walker, 2015). He believed, "all inquiries into the culture of Japan must in their final reduction go back to the study of her nature" (Walker, 2015:184). In

examining Japanese nature, it becomes very apparent that a cultural value is present- where nature refers both to the "Japanese love of nature, as well as the Japanese *idea* of Japanese love of nature, [and] revolves partly around nostalgia for what are considered *traditional relations* with nature" (italics my own, Kirby, 2011:69).

In contrast to many Western views, the Japanese vision of nature is not necessarily one of 'untouched' nature, but often one that is in fact transformed- such as through the traditional cultivation of land, for example, by the creation of rice paddies (Ohnuki-Tierney, 1994). While generally void of people and animals (though not the impacts of people), Japanese nature does include plants inhabited with 'souls' or spirits (Ohnuki-Tierney, 1994). This article follows the understanding that it is in the *relationship* with nature and such souls that the value lies.

This is supported by the contemporary Japanese philosopher Masahiro Morioka, who analysed Japanese responses on their views about life, and found these views are closely linked to nature, and that the meaning of life lies in the interconnectedness. Watsuji described this as, "[l]ife is irreplaceable because it is interrelated. Life is interrelated because it is irreplaceable" (Morioka, 2017:17). This paper understands the contextual 'natural' as not a total absence of human interaction with nature, for example, something wild, but rather through a valued *relationship*. Natural thus represents something that upholds or reflects this relational value of nature and something unnatural represents something that pollutes or compromises it. Note that *nature* is understood in this paper as more of a dichotomy- human/nature- as that the discussion of this view verses a more fluid view is outside the scope.

2.2. Cultural significance of rice in Japan

One of the most evident examples of the Japanese historical and cultural value of nature is through the relationship with rice. "Rice farming in Japan, with a history of 2,300 years behind it, has greatly influenced all areas of national life, including social order, religious worship, festivals, food, clothings and housing, thus molding the prototype of Japanese culture" (Zenchū in Ohnuki-Tierney, 1994:109). In the book *Rice as Self* (1994), Japanese anthropologist Emiko Ohnuki-Tierney describes the significance of rice as largely symbolic, where "in Japanese culture [it] is the rice paddies that stand for agriculture, the countryside, and the past- all symbolizing nature with its soil and water and, ultimately, the Japanese nation and its people" (Ohnuki-Tierney, 1994:120).

There are thus two perspectives on rice: first, rice as Japanese food, and second, rice paddies as Japanese land (Ohnuki-Tierney, 1994). Their importance has been expanded upon at great length in *Rice as Self* (1994), so for this short article, I will discuss the cultural significance of rice only briefly through Japanese cosmology and national identity.

Cosmologically, rice can be represented as both 'soul' and 'deity' (Ohnuki-Tierney, 1994). Despite the heterogeneity of rice, it has always been considered the most important food for Japanese rituals (Amino in Ohnuki-Tierney, 1994). This is because, in line with the Japanese view on nature, each grain of rice is believed to contain a soul (Yanagita in Ohnuki-Tierney, 1994). Furthermore, rice has historical meaning through Japanese myths, and the soul of rice, a deity, is central to Japanese origin stories (Ohnuki-Tierney, 1994:52). Due to this sacred meaning, rice has always been conceived of as a 'pure' object that is relational through the creation of socio-cultural and cosmological bonds (Ohnuki-Tierney, 1994).

In rice production, for example, this is represented in the original gift of rice seeds from the deities and the return gift of humans nurturing the rice crops on the land until harvest (Ohnuki-Tierney, 1994). In rice consumption, this is represented in the "exchange of soul and bodies between deities and humans" (Ohnuki-Tierney, 1994:57-58). A relationship is evident here, where in "consuming rice, the Japanese internalize the divine power of being, which then becomes part of the human body and its growth" (Ohnuki-Tierney, 1994:55).

Rice also has another culturally symbolic meaning, as national identity. This is demonstrated in the 'agrarian Japan' images of rice paddies (Ohnuki-Tierney, 1994). While it can be argued that a degree of this image is a constructed one, it is also grounded in the historic lives of Japanese peoples who gradually moved from the mountains to become rice farmers (Ohnuki-Tierney, 1994). Regardless of its construction, what is most relevant is the link between historical agrarian ideology and subsequent development of agricultural values, as these shaped Japanese identities and came to define its 'Japaneseness' (Ohnuki-Tierney, 1994). While farming areas have experienced tremendous depopulation (Goedde et al. 2016; Reiher and Yamaguchi, 2017), this reality does not conflict with the idea of nature, such as how "the Japanese continue to search for nature in the countryside, now nostalgically referred to as *furusato* (old homestead, 'one's home region')" (Ohnuki-Tierney, 1994:123).

This modernisation also does not devalue rice as nature: "the symbolism of rice has remained more important for the Japanese than rice agriculture itself" (Ohnuki-Tierney, 1994:97) as it is already embedded in the culture and imbued with symbolic significance. While

culture is of course, dynamic, these values are still represented today, even where it is not direct or deliberate. This is described in the ethnographic experience depicted in *Rice as Self* (1994):

> "[S]ome scholars insisted that the Japanese diet had changed to such an extent that white rice was no longer essential. When I asked, however, if they could envision a day when the Japanese would offer something other than white rice, perhaps fried rice, to the ancestral alcove, everyone emphatically agreed that it would never happen" (Ohnuki-Tierney, 1994: 95).

3. Framework

3.1. Singularities as culture

The significance of rice to Japanese culture is thus evident by both historical and contemporary cultural accounts. However, in a contemporary setting, it is challenging to determine the delineation between rice as being significant for cosmological (such as ritualistic) reasons, rice that is symbolically significant (such as in shaping identity), and rice that is a simply product being bought and sold. In order to examine this more clearly, I use Igor Kopytoff's writings on singularities and commodities from *The Cultural Biography of Things* (1986).

According to Kopytoff, commodities are things that have use value and exchange value where commensurate exchange is possible (Kopytoff, 1986). For example, when a bag of rice is purchased for money at a grocery store, this demonstrates it is a commodity via the exchange of rice for a price. The rice purchased is determined as being worth (or is equal to) the certain amount of money exchanged for it as evidenced by the purchase. However, Kopytoff sees an exemption to this concept of an exchange value when *reciprocity* is involved, such as through gift exchanges (Kopytoff, 1986).

All things bare the possibility of commodification, where Kopytoff argues that the counter then to mass commodification, is culture (Kopytoff, 1986:73). This is because when a society marks something as 'sacred' it is unmistakably singular, unique, or 'priceless', which means it will function in opposition to a commodity. "Culture ensures that some things remain unambiguously singular, it resists the commodization of others; and it sometimes resingularizes what has been commoditized" (Kopytoff, 1986:73).

What Kopytoff describes in his theory is thus a dynamic rather than static process where commodities can become singular or be recommodified (Kopytoff, 1986). Furthermore, the

same object can be both a commodity (e.g. via commensurate economic value) in one perspective, as well as a singular (e.g. via culturally irreplaceable value). Determining where an object lies in the process of commodification in a given context, is what Kopytoff refers to as examining the 'biography of a thing'. He argues that what is interesting is the *process,* in other words, "not the fact that an object is adopted into a culture, but in *how* it is culturally re-defined and put to use" (italics my own, Kopytoff, 1986:67). Given that rice is an object with a multitude of uses and values, this is the theory that this article uses to examine how rice is culturally defined and the associated processes working to commodify or singularise it.

3.2. Cultural risk

A wealth of resources examine risk in relation to Japan, particularly with studies related to agriculture focusing on economic and health risks (Reiher and Yamaguchi, 2017). As this article focuses on *cultural* risks in Japan, I must first clarify what a cultural risk is. Risk has many definitions, but if we understand it as the possibility of a negative occurrence, it holds both an objective (calculable) definition as well as a subjective (perceptive) understanding (Arnoldi, 2009; Reiher and Yamaguchi, 2017). In line with the above, it is the subjective understanding of risk I use, and is thus the *subjective framings* that are of the most interest: as this framing defines what is *at* risk, *to* whom, and *from* what (O'Brien, 2013).

For this article, I use the term cultural risk to describe a threat to cultural heritage and values, such as the identities, beliefs, practices, and traditions of a people. Rather simply, when examining risk to a singularity, I only refer to the risk of the *status* as singular. In the case of rice, a cultural risk would occur if something threatens the status of rice as singular. This means that, for example, economic impacts to the price of rice, would not pose a cultural risk, as these would be related instead to its status as a commodity. It is also important to note that a cultural risk is *highly* contextual and is capable of being fluid and dynamic, as Kopytoff suggested. Thus, the risk could greatly differ with the same object in a different culture (or sub-culture), differ in the same culture with a different object (or different component of the object), or even the same type of risk could occur in relation to an entirely different object and culture altogether.

4. Case Study: Gene-edited rice in Japan

In Section 2, I detailed a cultural and primarily historical account of rice in Japan. In this section, I will briefly summarise how the situation with the rice *itself* has changed in recent years, in terms of the evolution of the biotechnological practices and related government policy.

Cultivated rice originally used conventional breeding which involves the repeated crossing of individuals to illicit different characteristics and promote desired traits. This is a practice that has occurred to some degree since the very earliest farmers. However, the conventional process has strong limitations, as it takes a great deal of time and resources, and crossing often passes both desired and undesired traits. In the 1990s, new technologies were developed that began to allow for new processes of more targeted engineering (Tabei, 2019).

One result of these modern genetic engineering techniques is gene 'modification' or *idenshikumikae* (遺伝子組み換え), and while its exact definition varies, it is generally understood as a process where the genome of an individual is altered in a way that is not naturally/reproductively possible, such as by adding genetic material from outside species. This generates what is called a genetically modified organism (GMO). While the production and sale of GMOs in Japan are regulated (Nishizawa and Renn, 2006), and Japan is one of the largest importers of GMO food, it has what is criticised as a "lax policy of mandatory GMO labelling" (Ishii, 2017:256), which has led to a high degree uncertainty on whether gene alternations have been made to the food in Japan or not (Akatsuka, 2010; Ishii, 2019).

The most recent technique is called gene 'editing' or *genomu henshū* (ゲノム編集), which is often considered a more natural process because it can edit the genome in living organisms (as opposed to extracted tissues) by purposely triggering an otherwise natural process of damaging/repairing and inserting/deleting DNA. In this way it has been hailed as a 'breakthrough' by some scientists as allowing for progress in precision engineering while decreasing the perceived risks associated with GMOs (Farid et al. 2020). Nevertheless, there is no consensus among scientists. While few (if any) risks have been identified thus far, for some, that does not equate the situation to zero risk. For example, there are around risks of off-target effects (edits to the genome elsewhere than intended), though no substantial risks have been found yet (Tabei, 2019; Kobayashi, 2019).

The debate of interest for this article is regarding gene-edited foods and their regulation. I argue that this debate hinges on if gene-editing is framed as a natural process or not. On one

side is the argument that gene-edits represent the same natural changes in the genome that occur with breeding, and that it is furthermore not possible to distinguish gene-edited foods from conventionally bred crops (NHK, 2019; Kobayashi, 2019). This view would thus require no additional screening, labelling, or regulations. The other side of the debate asserts that due to the high degree of uncertainty in the gene transformations and the possibility of off-target effects, the process cannot in fact be considered exactly the same as conventional breeding (Tabei, 2019; Ishii, 2019). This instead frames gene-editing as an artificial process that should thus be subject to Japan's GMO regulations (Akatsuka, 2010; Ishii, 2019; Seikatsu Club, 2019).

At present, Japan has taken what is being called a 'science-based' regulatory approach (Farid et al. 2020), meaning that since no substantial risks have been discovered, gene-edited foods are framed as natural, akin to conventional breeding methods. Gene-edited foods are allowed unlabelled and are not subject to safety screenings (e.g. the Cartagena Protocol) under the Japanese Food Sanitation Law (Ishii, 2019; Giji, 2019). This decision has been backed by many academic and government institutions as well as by relevant industries (Ishii, 2019). As such, research using gene-editing techniques is already underway (The Mainichi, 2019), with 21 varieties of gene-edited rice being given cultivation permits for field tests in Japan. However, zero gene-edited varieties have been approved for commercial cultivation, distribution, or import into Japan (Ishii, 2019). These edited varieties aim to increase yield and improve utilisation of the fields, with the goal of leading to greater self-sufficiency and stable national rice supply (Zafar et al. 2020).

However, the government position of 'natural' is in notable contrast to citizens and consumer groups, who instead assert a framing of unnatural, more akin to GMO, in which regulation should be required (Ishii, 2019; Seikatsu Club, 2019). In fact, in a recent consumer survey, over 40% of respondents expressed concern over the safety of such modified/edited food products (Ishii, 2019). With a lack of strict labelling already the case for GMO food, the further lack of even safety screenings for gene-edited foods presents uncertainty for citizens on if food is "natural versus unnatural, real versus fake, and safe versus risky" (Akatsuka, 2010:7).

5. Discussion

5.1. Findings

In this section, I will demonstrate why the Japanese government policy decision ignores a principle risk: that of the cultural risk posed by their own approach to regulating gene-edited rice. To do so, I analyse the aforementioned case of gene-edited rice in effort to answer my research question: *How can the adoption of biotechnology generate cultural risks in Japan?*

In Section 2, when I discussed the cosmological significance of rice, it became evident that rice was not only economically significant as a commodity through use and exchange value among the Japanese people, but also represented a cultural (gift) exchange between man and deity (Ohnuki-Tierney, 1994). The significance of rice to Japanese society is thus not solely as an economic commodity, but also distinguishes itself as having irreplaceable singularity to the culture. This is because rice flows from nature, not as purely wild rice, but rather as through a valued *relationship* between farmer and traditional cultivation of rice (and the soul of rice) on the land.

This is, however, an ambiguous distinction that hinges on the *perception* of rice as natural. For example, today, for ritual purposes, the Japanese represent nature by cooked (steamed) polished rice (Ohnuki-Tierney, 1994). I thus argue that the conventional breeding of rice cultivars over previous centuries would not have been seen as a reduction in its naturalness or as generating an impurity of the rice, as the focus is not on the naturalness of the rice itself but on the relationship.

Insofar as rice is both a commodity and is singular, the risk to culture comes from any threats to the singularity of rice. The ambiguity and uncertainties around regulation and labelling create a confusion among Japanese consumers regarding what is genetically modified food and what is not (Ishii, 2019; Sasa, 2020) and thus what can be considered ‘natural versus unnatural’ (Akatsuka, 2010). Following Kopytoff’s theory, what is most interesting for this article is *how* rice (and in this case, gene-edited rice) is framed and interpreted in the Japanese cultural context. While the Japanese government has asserted a scientific framing of ‘natural’ for gene-edited rice, there is continued concern and even social opposition to this among citizens and consumer groups (Kato-Nitta et al. 2019), which represents a possible alternative view, in which gene-edited rice is in fact *not* the exact same as ‘natural’ rice, but is instead one of a potentially less pure or ‘artificial’ rice (Akatsuka, 2010; Sato, 2018; Ishii, 2019; Sasa, 2020).

The risk caused by this framing is evident from historical cases, for example, in the 1980s, where the use of chemicals in foreign rice symbolized its 'impurity' for which its import would have "constitute[d] a threat to the purity of the Japanese self" (Ohnuki-Tierney, 1994:111). It is also demonstrated in more contemporary cases for gene-editing (generally) as well as other types of cultivated species (see Takahashi, 2014). For example, Hiroko Yoshimori, of the Non-GM Seed Forum, alludes to this in his 2018 presentation to the Japanese Ministry of Health, Labour and Welfare on the consumer perspectives of regulating gene-edited crops. In his presentation, he calls on the government to ensure that their regulatory approaches to gene-editing do not prioritise economic interests over Japan's cultural values, arguing that they should instead support and foster sustainable agriculture in small communities which are environmentally friendly and 'value culture and tradition' (Yoshimori, 2018).

The framing of gene-edited rice as 'unnatural' by consumer groups and citizens means that this type of rice may in fact, no longer be considered pure, sacred, or singular to the Japanese culture, instead becoming solely a commodity. In this way, since traditionally, rice is *both* an economic commodity, as well as a cultural singularity, if gene-edited rice is framed of as unnatural, it may *lose* its singularity. Furthermore, if consumers cannot distinguish between 'pure' (conventional) and 'impure' (gene-modified, and potentially gene-edited) rice, *all* domestic rice may lose its singularity, thus posing a possible risk to the sacredness and significance that rice has held to the Japanese culture for centuries.

5.2. Limitations and further research

This research has been carried out primarily through a lens of how the debate is portrayed internationally through English language (and translated) sources, which is major limitation to the paper. Additionally, in this article I have focused on Japanese culture as a single static element, but in reality, like all cultures, their culture is dynamic, changing over time, and is heterogeneous, in that culture manifests in a variety of ways amongst different people, even in the same society. It is thus primarily with a lens of risk to cultural heritage and loss of tradition that the focus of this article examines, rather than a risk to culture more broadly, given its malleability.

Furthermore, the aim of this paper has been exploratory, rather than definitive: to highlight how emerging innovations can generate hitherto unexplored side effects in relation to culture. I thus place strong importance on advancing research into this area, in order to

demonstrate more responsible innovation. Some examples of biotechnology generating Japanese cultural risk that could be further analysed are; the potential of the status of life to be altered or removed, such as by removing reproductive abilities of species; and how this in turn affects notions of karma and rebirth; the effects on the value of seasonality in Japanese culture if gene-edited produce grow in the off-season or alternate landscapes (e.g. cultivating rice in the ocean); the potential of species eradication through gene-drives; or cultural risk such as the discussion here via 'naturalness' for the 3D printing of foods.

6. Conclusion

Innovations have tremendous power to shape people's lives and the changes that technology brings to societies have both 'light' side and 'dark' side. While the positives are often explicit, it is essential to explore the more hidden, negative effects of even successful innovations. The ever-blurring boundaries between man-made and natural risks demonstrates the imperative of decision-makers to evaluate the trajectories of contemporary innovations, in order to more holistically assess the wide range of impacts they can have across our planet and societies.

In this article, I have attempted to explore a 'dark side' of biotechnology by critically examining an emerging innovation: gene-editing. While contemporary discussion largely focuses on the benefits of biotechnology to economy or security, and the risks in relation to health and environment, my research has aimed to address a knowledge gap related to culture, by examining how the adoption of biotechnology can generate cultural risks in Japan, in this case within the Japanese agricultural (and natural) context and through the gene-editing of rice.

Given rice's significance to the Japanese, not solely an economic commodity, but also as an irreplaceable singularity to the culture, I have argued that if gene-edited rice is framed as unnatural, the government policy that allows for a lack of labelling and lack of safety evaluation may lead to a scenario in which *all* domestic Japanese rice may lose its singularity. This loss in the purity of rice poses a potential risk to the Japanese culture, which has held rice as sacred for centuries. While I have not aimed to define the exact degree of risk or prove definitively a cultural risk, I aimed instead to illustrate how emerging biotechnologies can create such side effects that are not traditionally considered, and encourage further research into this area.

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