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Veröffentlichungsversion / Published Version
Zeitschriftenartikel / journal article

Empfohlene Zitierung / Suggested Citation:

Paull, J. (2018). Genetically Modified Organisms (GMOs) as Invasive Species. *Journal of Environment Protection and Sustainable Development*, 4(3), 31-37. <https://nbn-resolving.org/urn:nbn:de:0168-ssoar-57626-2>

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Genetically Modified Organisms (GMOs) as Invasive Species

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Abstract

This paper frames genetically modified organisms (GMOs) as invasive species. This offers a way of considering the reception, diffusion and management of GMOs in the foodscape. “An invasive non-native species is any non-native animal or plant that has the ability to spread causing damage to the environment, the economy, our health and the way we live” (NNSS, 2017). Without any social licence, pesticide companies have thrust GMOs into the foodscape. The release of GMOs has generally been unwelcome, there has been no ‘pull’ factor from consumers and there has been vocal resistance from many. The apologists for GMOs have argued the self-contradictory conceit that GMOs are ‘same but different’. Under this logically untenable stance, GMOs are to be excluded from specific regulation because they are the ‘same’ as existing organisms, while simultaneously they are ‘different’ and so open to patenting. GMOs are patented and this demonstrates that, *prima facie*, these are novel organisms which are non-native to the foodscape. GMO apologists have campaigned intensively, and successfully in USA, to ensure that consumers are kept in the dark and that GMOs remain unlabelled - as a consequence GMOs are ubiquitous in US consumer foods. In contrast, in Australia GMOs are required to be labelled if present in consumer products and, in consequence, Australian food manufacturers do not use them. The release of a GMO calls for biosecurity measures. After trial plots of Monsanto GM canola in Tasmania in the 1990s, the sites continue to be biosecurity monitored for GMO escape, and volunteer canola plants continue to appear two decades later. In Western Australia the escape of GMO canola into a neighbouring organic farm resulted in the loss of organic certification and the monetary loss of the organic premium for produce. GMO produce sells for a 10% discount because of market forces and the consumer aversion to GMOs. Where non-GM product is accidentally contaminated with some GM grain, the whole batch is discounted and is sold as GMO. There is a lack of evidence that GMOs can be contained and many jurisdictions have banned the introduction of GMOs. GMOs have the potential and the propensity to contaminate non-GMO crops and thereby devalue them. The evidence is that GMOs are invasive species, they are unwelcome by consumers, peaceful coexistence with non-GM varieties is a fiction, and GMOs are appropriately managed as a biosecurity issue.

Keywords

Genetically Modified Organisms, GM Food, Canola, Percy Schmeiser, Canada, Western Australia, *Marsh v Baxter*, Monsanto

Received: April 25, 2018 / Accepted: May 14, 2018 / Published online: June 14, 2018

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1. Cane Toads

The intentional release of cane toads in Australia in 1935 was “championed by a herd of supporters including scientists, industry people and government officials” [1, p. 48]. The

cane toad (*Rhinella marina*, also known as *Bufo marinus*) is a native of South and Central America. It is an enlightening case study of an invasive species.

In June 1935 Reg Mungomery brought back 102 of these ugly giant toads from Hawaii with the view to using them as

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a biological control. The toads were successfully bred near Cairns in Queensland and he released 2,400 toads in the nearby sugar-growing region of Gordonvale in August 1935. The nay-sayers of the day were ignored [1].

The toads were intended to control cane beetles in sugar-cane crops. They were unsuccessful in that task [2]. Meanwhile, there are now perhaps 1.5 billion cane toads in Australia. They are expanding the frontier of their territory at about 55 kilometres per annum, and they have now spread into Northern Territory, Western Australia, and New South Wales [3]. They are poisonous at all stages of their life cycle containing powerful cardiac toxins [4]. Cane toad venom is toxic to all Australian native animals [5].

Cane toads are “identified as threatening or potentially threatening the survival, abundance or evolutionary development of native species or ecological communities ... They are extremely hardy animals and voracious predators ... Cane toads have an impressive array of highly toxic defences” [6, p. 1]. Even worse, exposure to the common agricultural herbicide glyphosate can make toads more toxic [7] which would exacerbate their deleterious effect on native wildlife.

Cane toads are described as “a national problem” for Australia [6, p. 2]. A Parliamentary inquiry concluded that “A solution to cane toads is proving elusive... the Commonwealth Government has spent \$5 million on studies of how to eradicate cane toads ... Currently hope for a solution rests with the CSIRO” [8, pp. 22-3].

Having championed their release in the first instance, the CSIRO, Australia’s peak science research organisation, now researches methods to manage cane toads, with no end in sight. It is conceded that “Due to the vast scale of the cane toad infestation and the absence of a broad scale biological solution, eradication... is not practicable” [6, p. 4].

“Could a mistake like the cane toad fiasco happen again? Could another alien organism, championed by respected scientists, government departments, and politicians, be released in Australia? Consider the 1935 proposal in the light of modern criteria for research funding ... The Cane Toad ... builds on successes in biological control ... replaces toxic pesticides ... has international scientific peer review ... is endorsed by Australia’s leading science body ... is championed by the industry ... is approved for use by the Commonwealth government. It is a dead-set winner [1, p. 48].

The question is answered in the affirmative: “Yes, it could happen again” [1, p. 48]. And the question of the present paper is it happening right now with GMOs?

2. Invasive Species

There is a general consensus that ‘invasive species’ are, firstly, organisms in places other than their prior habitats and, secondly, that they have the capacity to do harm. That harm may be, for example, to the environment, ecosystem, economy, health, lifestyle, agriculture, and/or social resources. The term is variously (but congruently) defined by the United Nations Convention on Biological Diversity and various national governments.

According to the United Nations Convention on Biological Diversity: “What are Invasive Alien Species? Invasive alien species are plants, animals, pathogens and other organisms that are non-native to an ecosystem, and which may cause economic or environmental harm or adversely affect human health. In particular, they impact adversely upon biodiversity, including decline or elimination of native species - through competition, predation, or transmission of pathogens - and the disruption of local ecosystems and ecosystem functions” [9].

In Australia: “An invasive species is a species occurring, as a result of human activities, beyond its accepted normal distribution and which threatens valued environmental, agricultural or other social resources by the damage it causes” [10].

In Britain: “An invasive non-native species is any non-native animal or plant that has the ability to spread causing damage to the environment, the economy, our health and the way we live”. ‘Non-native species’ is elaborated as follows: “The term ‘non-native species’ is ... the equivalent of ‘alien species’ as used by the Convention on Biological Diversity (CBD). It refers to a species, subspecies or lower taxon, introduced (i.e. by human action) outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce” [11].

In the USA: “What is an Invasive Species? As per Executive Order 13112 an ‘invasive species’ is defined as a species that is: (1) non-native (or alien) to the ecosystem under consideration and (2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary means of invasive species introductions” [12].

3. Genetically Modified Organisms (GMOs)

The business model of the GMO industry relies on (a) functioning genes inserted from one organism into another,

(b) the resulting organism can be patented, and (c) consumer resistance can be overcome.

The genetic modification of plants was demonstrated more than three decades ago [13]. So, the science was possible. Chemical and pesticide companies have dominated the development of genetically modified (GM) food crops. For example, Monsanto's GM canola has genes from bacteria inserted to make the canola tolerant to being sprayed with herbicide. Monsanto's Roundup Ready canola is resistant to glyphosate.

The business case for GMO has rested on the patentability of organisms. The case of *Diamond v. Chakrabarty* resulted in a US Supreme Court decision that upheld the prior decision of the US Court of Customs and Patent Appeal that "the fact that micro-organisms are alive is without legal significance for purposes of the patent law". This was a majority decision of nine judges, split 5:4 [14]. It was this *Diamond v. Chakrabarty* judgement that opened the Pandora's box of GMOs because it is only patenting rights that makes GMOs an attractive corporate proposition by potentially offering unique monopoly rights over food [15].

The final leg of GMOs as a business proposition relies on consumers. Can they be found? Well no, there are no consumers clamouring for GM food, quite the contrary. The widespread penetration of GM food into the US foodscape, for example, has been facilitated by the lack of labelling, which is to say, by keeping the consumer in the dark, and never by proclaiming the food as GM. There is an army of consumer nay-sayers (who would like to be nay-eaters) and from the outset the technology has been, and remains to this day, controversial and contested [16, 17].

Just five countries grow 90% of the world's GMOs (USA, Brazil, Argentina, India and Canada) [18] and just four GM crops (soy, corn, cotton and canola) account for 99% of global GM plantings [19]. Close to 100% of GM crops are genetically engineered for herbicide tolerance (e.g. to glyphosate) or insect resistance (e.g. the GM plants produce Bt toxin) [19]. Throughout the world, food shoppers avoid GMOs in their personal food choices [20].

3.1. The Duplicity of Substantial Equivalence

GMOs have entered the foodscape based on the self-contradictory proposition of 'same but different'. To food and agriculture regulators, GMOs are pitched as the 'same' as their non-GMO relatives. Meanwhile, GMOs are pitched to the patenting authorities as 'different' and novel and to a sufficient extent that warrants the award of a patent.

'Substantial equivalence' was introduced in a report of the Organisation for Economic Co-operation and Development

'Safety Evaluation of Foods Derived by Modern Biotechnology: Concepts and Principles' [21]. This document argued for an assumed safety of GM food: "Modern biotechnology... does not inherently lead to foods that are less safe... Therefore evaluation of foods and food components obtained from organisms developed by the application of the newer techniques does not necessitate a fundamental change in established principles, nor does it require a different standard of safety" [21, p. 10]. This is a pro-corporatist and a post-cautionary approach to health. The OECD motto of "For a better world economy" declares their priority as the economy [22].

GM crops are marketed to farmers as 'different'. Monsanto's GM canola is sold to farmers on the proposition that it can be sprayed with the herbicide glyphosate (Monsanto's 'Roundup') with impunity. Sprayed plants will die, except for the GM canola.

GM commodity ingredients are sold to food processors as the 'same', but a cheaper fungible alternative. GM canola is sold at a discount compared to non-GM. For example, GM canola sells at a discount of 10% relative to non-GMO canola [23].

In the USA there is limited right-to-know what the consumer is buying or eating. Chemical and food companies have spent much time and money to ensure that there is a cloak of invisibility thrown over the GM ingredients in food products, that they are not labelled as GMO, and that they are not distinguishable in the supermarket aisle. In consequence GM ingredients are ubiquitous in US processed food. In contrast, in Australia GM ingredients must be labelled; a consequence is that processors avoid using GM ingredients and processed food using GM ingredients is a rarity in an Australian supermarket aisle.

So, there is no 'equivalence' of genetics, of on-farm behaviour, of price in the market place, nor of fair consumer labelling. The doctrine of substantial equivalence is, in essence, a deceit of duplicity. To achieve a patent, the economic underpinning of the GMO industry, it is 'substantial difference' that has been demonstrated, rather than the 'substantial equivalence' that is otherwise claimed.

3.2. Invading the Foodscape

3.2.1. The US Shopping Cart

In Australia there has been longstanding requirements for the labelling of GM food and ingredients. Whether for that reason or others, a shopper would be hard pressed to find such an item in an Australian supermarket and there may indeed be none. There are a number of products, such as canola oil, that prominently declare themselves as GM-free. Sixty four countries require GM labelling of food [24]. The situation in USA is a great contrast to the Australian situation.

In the USA between 70% and 80% of processed food contains GM ingredients [25-27]. This is a silent invisible invasion. The incursion of GM ingredients into the US diet has proceeded in the absence of a labelling regime. When GM labelling has been proposed it has been vigorously opposed by industry. If the GM industry has its way, GM food is the food that dare not speak its name. The House of Representatives voted 275 to 150 to support federal legislation that would prevent states from requiring the labelling of GM food [28].

In 2016 the voters of California voted on a proposal to label GMO food, Proposition 47. Californians were invited to vote into law 'The California Right to Know Genetically Engineered Food Act'. Section 1 (a) declared that "California consumers have the right to know whether the foods they purchase were produced using genetic engineering". Section 1 (e) of the proposed Act declared that "Polls consistently show that more than 90 percent of the public want to know if their food was produced using genetic engineering". Voters were advised that "The purpose of this measure is to create and enforce the fundamental right of the people of California to be fully informed about whether the food they purchase and eat is genetically engineered ... so that they can choose for themselves whether to purchase and eat such foods" [29].

The Californian proposition was narrowly defeated, 47% to 53% (4,326,770 'Yes' votes and 4,884,961 'No' votes). It was opposed by a coalition of GMO companies and US multinational food companies who spent US\$45 million on advertising to urge voters to reject the proposition. The 'No' campaign was financed by GMO companies Monsanto, Dupont, BASF, Bayer, Dow, and Syngenta along with US multinational food and beverage companies including Pepsi, Kraft, Nestle, Coca-Cola, Kellogg, Campbell Soup, Hershey, Heinz, Mars, Unilever, Sara Lee and McCain. The lead contributor to the 'No' campaign was Monsanto (\$8.1 million). The biggest donor for the 'Yes' campaign was the Organic Consumers Fund (\$1.3 million) [29].

In July 2016, the US Senate passed, 63 to 30, a mandatory GM labelling bill [30] and shortly after President Obama signed S. 764 into law [26]. This bill is ostensibly a requirement to label GM food, but it may be a toothless tiger. For consumers with a desire to stop the incursion of GMOs into their diet and household, the bill creates many roadblocks and has been dubbed by critics the DARK Act (Denying Americans the Right to Know). The GMO labelling of the bill can hide behind QR codes and 1-800 numbers. Loopholes may allow GM ingredients including GM corn, GM beet sugar, and GM soybean oil to avoid labelling. The US Department of Agriculture has two years to formulate the rules for the labelling [26, 30]. It remains to be seen if the bill is just a sop for consumers and a de facto win for the GM

industry. Like the cane toad in the Australian landscape, GMOs have successfully invaded the US foodscape, and any retreat in the foreseeable future seems unlikely.

3.2.2. Tasmania's Field Trials

Tasmania, Australia's island state, has a longstanding moratorium on the growing of GM crops. But in the late 1990s and in 2000, field trials of GM canola were conducted by Monsanto and Aventis at 57 sites. Then, in 2001 the Tasmanian Government decided on a GM-free policy for the state. Ever since, the GM test sites have been monitored multiple times a year and auditing of the sites is an ongoing process. There have been 39 audits and every audit has identified canola plants, although the number of plants reported are declining, and there are containment practices to prevent viable canola material from leaving the sites [31].

This regular monitoring over two decades is to ensure that GM canola does not escape to become an invasive species for Tasmania, and in that it has been successful. Meanwhile non-GM canola is successfully grown in Tasmania [32], and as non-GM product it attracts a premium price.

3.2.3. Percy Schmeiser's Farm

Percy Schmeiser is a Canadian farmer in Saskatchewan. He had been farming for over 50 years. With 9 fields, he grew canola on 417 hectares (1030 acres) devoted to canola [33]. Five of Schmeiser's neighbours grew Monsanto's GM canola in 1997. It appears that Schmeiser's crop was contaminated with GM canola. In any event, Schmeiser saved his 1997 seed and replanted it in 1998 which was his long standing practice. In 1998 Monsanto ordered its inspectors to trespass onto Schmeiser's fields and collect samples which they later claimed included Monsanto's patented gene for glyphosate resistance. Subsequently Monsanto demanded a licence fee for growing their gene although there was no claim that it was their seed. Schmeiser refused and Monsanto sued for patent infringement. Schmeiser countersued for libel, trespass, and contaminating his fields. The case was heard in the Federal Court of Canada, Schmeiser lost [33]. From there it went to Canada's Federal Court of Appeal. Schmeiser lost again. From there it went to the Supreme Court of Canada. Once again Schmeiser lost, although it was a narrow loss, with the nine judges split 5 to 4 [34]. That was the end of the road for legal remedies for Schmeiser.

At the age of 74 years, Schmeiser stated: "It's very upsetting and nerve-racking to have a multi-giant corporation come after you. I don't have the resources to fight this". His argument had been "Nature has been moving DNA around for thousands of years". Schmeiser declared that "You can't control it. You can't put a fence around it and say that's where it stops. It might end up 10 miles, 20 miles away" [35, p. 2].

Schmeiser's reflected that "We were fighting for the fundamental right of the farmer to save his seed and use it year after year" [35, p. 3]. The court effectively overturned ten thousand years of agricultural practice, the practice of seed saving. Monsanto's GM canola has acted as an invasive species to populate Schmeiser's fields. Then Monsanto has pounced to terminate the fundamental agricultural practice of seed saving. The Monsanto licensing agreement specifically excludes the rights of farmers to save their GM seed and demands the purchase of new Monsanto seed each season. This imposition was visited on Schmeiser whose fields were contaminated by Monsanto's GM canola. As a consequence of this invasive species event, the life-long practices of Canadian farmers of seed saving is forever changed, threatened, and fraught with risk of litigation.

3.2.4. Steve Marsh's farm

Steve Marsh is a certified organic farmer at Kojonup in Western Australia (WA), the largest state of Australia. A moratorium on growing GMOs in WA, in place since 2004, was partially lifted following the election of a conservative government. Monsanto's GM canola (Roundup Ready canola) was approved for planting from January 2010. On his 477 ha (1180 acres) Marsh farms sheep and grain, but not canola. His neighbour, Michael Baxter, on 900 hectares (2,224 acres) planted his fields that adjoin Marsh's farm with GM canola. He used what was, to him, a novel method of harvesting, swathing, where the seed-laden heads of the crop are cut and dropped and left in situ for collection some weeks later. However, in the weeks that followed, Marsh collected 245 canola swathes (including heads and seeds) in his fields (in December 2010). The canola collected tested positive as GM, and Marsh's organic certification was withdrawn [36].

In an effort to protect his farm and his livelihood, Marsh initiated legal action against Baxter, seeking a finding of negligence and/or nuisance, damages, and an injunction restraining Baxter's future planting of GM crops. Marsh's economic loss was agreed between the parties at A\$85,000. Marsh's crops were still saleable despite the contamination but the organic premium was forgone.

The case was uplifted to the Supreme Court because a permanent injunction was sought by Marsh. It was heard in 2014. There was general agreement between the parties regarding the facts of the case. But that is where the agreement finished; there was no agreement as to the interpretation of those facts. Although there was no dispute that 70% of Marsh's land was impacted with GM canola, the Judge rejected the characterisation of 'contamination', preferring to characterise it as a wind-blown 'incursion'. The case of negligence and nuisance was rejected, the Judge argued that the 'incursion' was not foreseeable by Baxter.

There was no injunction regarding future practices. As for economic loss, the Judge suggested that Marsh take that up with his certifier [37, 38].

The case was appealed to the WA Court of Appeal (Perth) in 2015 where it was heard before three judges and was lost by a majority vote of 2:1. The following year, leave to appeal was sought in the High Court of Australia (Canberra). This was refused. The legal costs of the proceedings are in the order of A\$2 million (€1.4 m; US\$1.6m). Costs were awarded against Marsh [36].

The GM canola contaminating Marsh's farm appears to clearly meet the Australian Government definition for an invasive species: "An invasive species is a species occurring, as a result of human activities, beyond its accepted normal distribution and which threatens valued environmental, agricultural or other social resources by the damage it causes" [10]. This was not argued in court.

GM canola material (pods, seeds, and swathes) were found 1.2 km into the Marsh farm. The vector was taken to be wind, so that the wide dispersion of the GM canola plant material across the Marsh farm was a function of the vagaries of the weather with local winds picking up windrowed material from the neighbouring property. It has previously been reported that canola pollen can travel 1.5 km via wind and that pollen can travel far further (hundreds of km) depending on prevailing air currents [39].

Marsh's organic status has since been reinstated, material continues to be blown from Baxter's farm, Marsh has suffered economic loss, injury to his farm, his farming practices have been compromised, the amenity of his farm and his capacity to enjoy it have been constrained, and with potentially GM canola planted on his boundary, he could not contemplate growing organic canola. Baxter's costs were paid by Monsanto.

4. Conclusion

Too often, the story of invasive species is that, despite what may be the good intentions of the promoters, the law of unintended consequences kicks in with a vengeance and there is no reversibility nor retreating to the pre-introduction state, there is just managing the problem [5, 40]. In the case of GM canola, the intentions of Monsanto are economic, which is not to say they were ever 'good' other than in that very narrow sense.

In the case of Tasmania, there was the intentional plantings of GM canola two decades ago. The sites are still being monitored against the escape of GM material into the state. This would risk GM contamination of non-GM canola and

potentially other plants grown in the state (via out crossing). The risks have been managed by quarantining of the sites, biosecurity measures, and regular monitoring.

In the case of Percy Schmeiser, his life-long agricultural practice of seed saving and using the seed the following year has been threatened, his economic viability has been threatened, and his right to privacy and the quiet enjoyment of his property have been compromised. The contest with Monsanto (1998- 2004) consumed his time and resources at a time when he should have been enjoying the fruits of his labour and his senior years. Proper quarantining, biosecurity measures and containment might have avoided Schmeiser's contest with Monsanto but there is no evidence that Monsanto could ever contain GM canola and thwart the dissemination and invasion of neighbouring fields.

In the case of Steve Marsh, despite all the actions of Marsh to protect his farm from invasion of his neighbour's GM canola, in open country, nothing was ever going to stop the wind borne invasion of swathed GM canola across Marsh's farm. In Canada, Schmeiser had raised the same issue that wind disperses seed and genetics across landscapes. In WA the court offered no relief to Marsh, with the result that Baxter has contaminated with impunity. No restraints have been placed on Baxter to manage and contain the genetics of his GM crops. His neighbour, Marsh, is left guessing whether Baxter's canola crops each season are GM or non-GM, as well as when and whether the crop will be swathed (and so make dispersion of seeds much more likely). There is a permanent impost of vigilance on Marsh and of collection and disposal of invasive material. The threat of loss of organic certification is ongoing and it is at the whims of his neighbour, whether GM canola is planted, where it is planted, and how it is harvested. For the Marsh farm, GM canola is an invasive species calling for continuing vigilance, impinging on his amenity and threatening his livelihood.

If GMOs are regarded as invasive species, or potential invasive species, then they can be evaluated appropriately as a threat to health and wealth and dealt with on a risk assessment, biosecurity and quarantine basis. The onus is then on the promoters to prove, manage and be responsible for containment, risk and escape, and to maintain alerts at all points of the foodscape. Under such a scenario, the secrecy of GM crops is replaced with transparency, farms with GMOs are declared, neighbours are aware, foods with GMOs are declared, there are labelling and traceability protocols in place, and the present practices of GM-invisibility is replaced with consumer awareness and clear declarative labelling.

Acknowledgements

An earlier version of this paper was presented under the title

GMOs as Invasive Species at the Seventh International Conference on Food Studies, Università Roma Tre, Rome, Italy, 26-27 October 2017.

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