Chapter 2
Cui bono? Gauging the Successes of Publicly-funded Plant Breeding in Retrospect

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Introduction

In the 2013 US Supreme Court case, *Bowman v. Monsanto Co.*, a particular view of plant breeding and its history emerged, one which attributed successful breeding to plant breeding firms and their ability to claim strong intellectual property.[1] This view reflected the status quo at the time of the case; in the first years of the twenty-first century commercial breeding and strong intellectual property have been in the ascendency. Justice Roberts' court in *Bowman v. Monsanto Co.* ruled in favour of Monsanto and extensive intellectual property protection in plant breeding. In reaching this opinion, the Justices and several contributors considered and dismissed the alternatives: publicly funded plant breeding and weak intellectual property protection. The case documents of *Bowman v. Monsanto Co.* reveal a view of plant breeding history seen from the perspective of a privatised industry and a legal institution that was long-used to dealing with the industry and partly responsible for its stronger intellectual property.

Two features of the pro-commercial, pro-intellectual property view of plant breeding advanced at *Bowman v. Monsanto Co.* are striking. The first is the tendency, apparent in industry briefs presented to the court and in the Justices' remarks during oral arguments, to consider publicly-funded schemes and their aims unimportant, or even counter-productive to agricultural development. The second feature of the case is the Supreme Court's view of what it means to

1 An earlier version of this chapter was presented at the Griffith University workshop, 'GMOs Driving Legal Developments – Updates from the Front', Coolangatta, 18 October 2013. I would like to thank the participants at the workshop for several helpful suggestions as to how to develop the paper. Finally, I would like to thank Graham Dutfield, Jay Sanderson, Brad Sherman and Brendan Tobin for providing comments and feedback which have no doubt made this chapter stronger. All remaining errors are, of course, my own.

Bowman v. Monsanto Company Co., 133 S.Ct. 1761 (2013). Case documents relating to *Bowman v. Monsanto Co.* are available at *SCOTUSblog*. [Online]. Available at: http://www.scotusblog.com/case-files/cases/bowman-v-monsanto-co/ [accessed 25 February 2014].

'make' in plant breeding and what this means for infringement of patent claims concerning deoxyribonucleic acid (DNA) sequences embodied in a GMO. The Supreme Court Justices' conceptualisation of making – in this case, the mere appearance of DNA sequences in a plant's genome, however they came to be present, reflects US policy − at the time of the case − of granting extensive intellectual property to commercial plant breeders.

This chapter examines two historical aspects of the court's decision in *Bowman v. Monsanto Co.* On one hand it looks to the historical view of plant breeding revealed in this signal gene-patent case; on the other hand, the chapter analyses what has been called the 'de-historicised gene'; 'discrete, interchangeable, binary … the path through which it passed from one organism to another, whether in the lifetimes of individuals or across centuries, [makes] no difference to its identity or capacities'.[2] The de-historicised gene, cut adrift from the history of its genesis or propagation, lies at the centre of Monsanto's DNA sequence claims and is the object the court found Bowman to have infringed. However, setting the court documents of *Bowman v. Monsanto Co.* against their historical context, demonstrates in vivid relief that profits are not the only incentive to plant breeding and that a focus on DNA as the locus of creation by contemporary intellectual property law is one that favours profit-making plant breeding at the expense of other schemes which, recognising the fluctuating, historical nature of varieties, rewarded stewardship.

The chapter begins with an outline of *Bowman v. Monsanto Co.* and two controversial pieces of legislation from the 2010s. The context of plant breeding revealed by these legal events is then contrasted with the historical development of agricultural funding and research in the US and Britain. From this historical background we turn back to the *Bowman v. Monsanto Co.* court documents and the view of plant breeding history they reveal. Finally we turn to the narrow conceptualisation of making described in *Bowman v. Monsanto Co.* contrasted with a much broader historical concept of making that was dominant amongst plant breeders in the 1930s.

Outline of *Bowman v. Monsanto Co.*

The most obvious feature of *Bowman v. Monsanto Co.* – which did not turn out to be the test-case Monsanto, Bowman, the anti-GMO lobby or anyone else involved wanted it to be – was just how consistently the court, and several groups filling

2 The term 'de-historicised gene' is borrowed from historian-of-science Dominic Berry's work on pure line theory and its failure to influence plant breeding. Berry, D. 2014. The plant breeding industry after pure line theory: Lessons from the National Institute of Agricultural Botany. *Studies in the History and Philosophy of Biological and Biomedical Sciences,* 46, 25–37; 28. See also Palladino, P. 2002. *Plants, Patients and the Historian: (Re)Membering in the Age of Genetic Engineering.* Manchester: Manchester University Press.

amici briefs in support of Monsanto, spoke to a belief that commercial plant breeding is the best means to achieve agricultural development, and intellectual property is the best means to spur commercial plant breeding.

A wide range of groups filed briefs. In total 22 amici briefs were submitted to court. Seventeen briefs were submitted in support of Monsanto, the remaining five in support of Bowman. The American Seed Trade Association (ASTA), American Soybean Association, Pioneer Hi-Bred and Croplife (America and International) filed briefs supporting Monsanto; the Center for Food Safety and Save Our Seeds filed for Bowman. Several more generally intellectual-property-focused groups also filed on both sides; the Intellectual Property Owners Association and New York Intellectual Property Law Association filed for Monsanto and the American Antitrust Institute and Public Patent Foundation filed for Bowman. Finally, several groups from different industrial sectors filed briefs on both sides, for example BSA – The Software Alliance – filed a brief in support of Monsanto while the Automotive Aftermarket Industry Association filed in support of Bowman.

The Missouri-based Monsanto Company has become a focal point for debates around commercial plant breeding, intellectual property and GMOs. One of the anti-GMO movement's concerns is that the application of patent protection to DNA sequences has facilitated a concentration of the seed industry into the hands of a few large corporate entities.[3] Monsanto has certainly not been shy in protecting its intellectual property.[4] However, if the company's attitude to litigation has sometimes verged on the pathological, the philosophy behind such actions is increasingly widespread.[5] Several academics are now promoting the ideas that: (a) commercially-produced GM varieties are the best way to face the

3 The Center for Food Safety has been one of the loudest proponents of this view. See Center for Food Safety. 2005. *Monsanto vs. U.S. Farmers*. Washington, DC: Center for Food Safety; Center for Food Safety and Save our Seeds. 2013. *Seed Giants vs. U.S. Farmers*. Washington, DC: Center for Food Safety.

4 One infamous early case was that of Canadian farmer, Percy Schmeiser, sued by Monsanto for planting protected seeds which Schmeiser claimed had blown in on the wind. Interestingly in 2013, this worm turned as organic farmers began suing Monsanto for contamination of their GMO-free crops. See Kondro, W. 2004. Monsanto wins split decision in patent fight over GM crop. *Science,* 304, 1229. See also *Organic Seed Growers and Trade Association, et al., v. Monsanto Company, et al*. S. Ct. 13–303, covered here: Laskawy, T. 2011. Reversing roles, farmers sue Monsanto over GMO seeds. *Grist*. [Online]. Available at: http://grist.org/sustainable-food/2011–03–31-reversing-roles-organic-farmers-sue-monsanto-over-gmo-seeds/ [accessed 24 February 2014].

5 See Kevles, D. *Enforcing intellectual property rights in fruit trees and plants: Contracts, patents and the courts in the 1920s and now*, symposium presentation at 'Intellectual Property and the Biosciences', White Rose IPBio Symposium and Summer School (7–8 July, 2010), University of Leeds. [Online]. Available at: http://ipbio.org/daniel-j-kevles-enforcing-intellectual-property-rights-in-fruit-trees-and-plants-contracts-patents-and-the-courts-in-the-1920s-and-now.htm [accessed 24 February 2014].

challenges of population growth and climate change and (b) strong intellectual property encourages new GM varieties to market.[6]

Bowman v. Monsanto Co. stands at the end of a series of cases which Monsanto has brought against farmers it believed to be infringing on its patent protected Roundup-Ready soybeans.[7] A complicating feature of these cases has been Monsanto's technology agreement contract. A document signed with any purchase of Monsanto's seed − the contract which requires farmers to comply with Monsanto's restrictions on saving and replanting of seeds (among other things) – means these cases have been about the interplay between contract law and intellectual property law.[8]

For Indiana soybean farmers there are one and a half growing seasons in the year. The year's first crop is the one on which they stake their livelihood. But with luck it is possible to squeeze a second, riskier, crop into the year. Vernon Hugh Bowman purchased Monsanto's soybeans for his first crop of the year and signed the company's technology agreement with these purchases. However, for his second crop, Bowman did not want to spend money on seeds that might fail if the weather was bad. To get around this problem, in 1999, Bowman – while continuing to purchase seeds from Monsanto for his first crop – began purchasing seeds for his second crop from a grain elevator. Grain elevators are large storage facilities where soybeans are collected into a generic pool to be channelled into the livestock and human feed industry. Bowman bought beans from the elevator at a much lower price than he would have paid Monsanto. Guessing that within this mix of pooled beans there would be some descendants of Monsanto's patented Roundup-Ready plants, Bowman planted his elevator purchases. When the beans grew he treated them with Monsanto's weed killer – Roundup – and through this selection established which plants were, like Monsanto's, Round-up resistant. Bowman harvested beans from these plants to use for his yearly second crop.[9]

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6 See for example, Tait, J. and Barker, G. 2011. Global food security and the governance of modern biotechnologies. *EMBO Reports*, 12, 763–768; Thompson, P. 2011. *Agro-technology: A philosophical introduction*. Cambridge: Cambridge University Press on the necessity of GMOs and intellectual property over GMOs. See also, Marie Brown, N. and Fedoroff, N. 2004. *Mendel in the kitchen: A scientist's view of genetically modified foods*. Washington: Joseph Henry Press and Kingsbury, N. 2011. *Hybrid: The history and science of plant breeding*. Chicago: University of Chicago Press.

7 See *Monsanto Company v. David,* 516 F.3d 1009 (2008); *Monsanto Company v. Parr, 545* F.Supp.2d 836 (2008); *Monsanto Company v. Vanderhoof* 2007 WL 1240258 (2007); *Monsanto Company v. Strickland,* 2007 WL 3046700 (2007); *Monsanto Company v. Scruggs, 459* F.3d 1328 (2006); *Monsanto Company v. Good,* 2004 WL 1664013 (2003); *Monsanto Company v. McFarling,* 302 F.3d 1291, (2002). *Monsanto Company v. Trantham, 156* F.Supp.2d (2001) and *Monsanto Company v. Dawson,* 2000 WL *33953542* (2000).

8 For a roundup of previous cases and on the interplay between intellectual property and contract law, see Lawson, C. 2011. Juridifying the self-replicating to commodify the biological nature future: patents, contracts and seeds. *Griffith Law Review*, 20(4), 851–882.

9 For an outline of the case see Crouch D. 2013. US Government brief: Farmer who purchases commodity soybeans cannot replant those beans without committing patent

Bowman believed he had found a way to get around Monsanto's technology agreement (which he had not signed when making purchases from the grain elevator) and the company's patent claims. On Bowman's reading the exhaustion doctrine curtailed Monsanto's patent rights after the first sale of seeds. In brief, the exhaustion doctrine – established in the nineteenth century – safeguards the right freely to use purchased items (including reselling them) without deference to a patent holder's rights. The original intention behind the doctrine was to support the assumption that a purchase entails a whole transfer of property from vendor to customer. One thing users are not allowed to do – in most circumstances – is use their purchased item to make copies.[10] Accordingly, one of the key battle grounds on which the exhaustion doctrine has evolved has been over the point at which use and (re)making can be distinguished. Maintenance and repair work are the shades of grey which have blurred that distinction.[11] Relying on this interpretation of the doctrine, Bowman believed he was buying seeds from which Monsanto's intellectual property had been exhausted.

In 2007 Monsanto arrived in Indiana to investigate Bowman's crops. When they discovered that Bowman's second crop was resistant to Roundup, Monsanto sued for infringement of its US Patent Nos. 5,352,605 and RE 39,247E (which included claims covering DNA sequences relating to resistance). The Federal Court of Indiana found in Monsanto's favour: Bowman's activity constituted infringement. Damages of $84,000 were awarded to Monsanto. When Bowman appealed to the United States Court of Appeals for the Federal Circuit, the lower court's judgement was upheld. In late 2011, Bowman filed petition for a writ of certiorari with the Supreme Court on the grounds that:

> Patent exhaustion delimits rights of patent holders by eliminating the right to control or prohibit use of the invention after an authorized sale. In this case, the Federal Circuit refused to find exhaustion where a farmer used seeds purchased in an authorized sale for their natural and foreseeable purpose – namely, for planting. The question presented is: Whether the Federal Circuit erred by (1) refusing to find patent exhaustion in patented seeds even after

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infringement. *Patently O.* [Online]. Available at: http://patentlyo.com/patent/2013/01/us-government-brief-farmer-who-purchases-commodity-soybeans-cannot-replant-those-beans-without-committing-patent-infringemen.html [accessed 24 February 2014]; Liptak, A. Supreme Court supports Monsanto in seed-replication case. *The New York Times.* 14 May 2013, B3. [Online]. Available at: http://www.nytimes.com/2013/05/14/business/monsanto-victorious-in-genetic-seed-case.html?_r=0 [accessed 14 May 2014].

10 However, Art. 30 of TRIPS provides some space for legal making under certain conditions.

11 See the extended discussion of exhaustion in Lawson above n 8, 861–873; Sheff, J. 2013. Self-replicating technologies. *Stanford Technology Law Review,* 16(2), 229–256 and Ghosh, S. 2013. *The implementation of exhaustion policies: Lessons from national experiences*; ICTSD Programme on Innovation, Technology and Intellectual Property; Issue Paper No. 40. Geneva: International Centre for Trade and Sustainable Development.

> an authorized sale and by (2) creating an exception to the doctrine of patent exhaustion for self-replicating technologies?[12]

In October 2012 the petition was granted. Oral arguments were held in February 2013 and on 13 May 2013 Justice Kagan delivered the court's opinion. In a unanimous, yet narrowly-tailored, decision the court held that Bowman's activity was not protected by the exhaustion doctrine and upheld the lower courts' decisions and award of damages.

Commercial Plant Breeding in the Twenty-first Century

The court's opinion refused to define any sort of precedent but instead adopted a 'business as usual' statutory interpretation. However, if the case was not precedent setting, the status quo it revealed was a positive attitude to commercial breeding and intellectual property protection, embodied in many of the briefs filed in support of Monsanto. The section headings of the ASTA's amici brief make such an ethos particularly obvious. The brief begins with Section I, the section title proclaiming the benefits, but also the financial costs, of patented seed technology:

> Section I. Patented Seed Technology provides numerous benefits to society but is costly and time consuming to research and develop.[13]

The brief runs through to Section III, whose title makes obvious that intellectual property is an essential incentive, before raising the spectre of how the public might be deprived, if commercial plant breeding could not continue:

> Section III. Removing protection for each generation of patented seed would devastate the nation's seed industry, evaporate investment in patented seed technology and deprive the public of this technology's current and future benefits.[14]

In the statement of interest contained in their brief ASTA explicitly laid out their members' position, tying together the financial costs, putative benefits and need for intellectual property:

> ASTA members annually invest billions of dollars researching and developing patented seed technology to make American agriculture more productive and the

12 *Bowman*, above n 1, writ of certiorari, question presented, i.

13 *Bowman*, above n 1, Brief Amicus Curiae of the American Seed Trade Association in support of respondents, i–ii.

14 Ibid.

> Nation's food supply more plentiful and nutritious. To protect this investment these entities seek patent protection for their discoveries.[15]

The view of agricultural development and plant breeding advanced by ASTA – as an activity best conducted by private firms incentivised by intellectual property – is based on the incentive argument: the view that intellectual property operates to incentivise innovation, through the promise that research expenditure can be recouped during a temporary period of monopoly. However, intellectual property is not the only way to create a monopoly. The biological features of some plant species and regulatory systems for plant varieties can also restrict the sale of seeds into the hands of a few companies.

In the US, from the 1930s onwards, commercial plant breeding companies came to dominate plant breeding and the seed market. This capture was largely facilitated by double cross F1 hybrid corn, a new type of agricultural variety that included its own biological means of dissuading farmers from saving seed or breeding plants themselves and encouraging them to return each year to the seed merchant for fresh stocks.[16] The relative un-importance of corn in much of European agriculture goes some way to explaining the later ascendance of commercial plant breeding outside of the US. The most important crop in Europe and Britain – wheat – offers no such biological control of seeds despite numerous attempts to produce double cross F1 hybrid wheat varieties. Unable to repeat this monopolising trick with all plant species, commercial breeders have increasingly turned to intellectual property as a means of securing control over seed supplies. We return to the type of intellectual property that has resulted in the last section of this chapter. However, a second area of the law, regulation, has also aided commercial plant breeding in recent years.

Two pieces of legislation, one from the US and one from the EU, both on their respective legislature's agendas in 2013, illustrate the dominance of commercial plant breeding and the concentration of seed control. In the US a rider on the *Consolidated and Further Continuing Appropriations Act 2013*, known as the Farmer Assurance Provision, was momentarily sworn into legislation.[17]

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15 Ibid., 2.

16 The classic work on the problems of double cross hybridisation as a method of plant breeding is from rural sociologist Jack Kloppenberg and Marxist scholars Richard Lewontin and Richard Levins: see Kloppenburg, J. 1988. *First the seed: The political economy of plant biotechnology*. Cambridge: Cambridge University Press; Lewontin, R. 1990. The political economy of agricultural research: The case of hybrid corn, in *Agroecology* edited by C. Carroll, J. Vandermeer and P. Rosset. New York: McGraw Hill, 613–626; Lewontin, R. and Berlan, J.-P. 1986. Breeders' rights and patenting life forms. *Nature,* 322(6082), 785–788; Levins R. 1986. Science and progress: Seven developmentalist myths in agriculture. *Monthly Review*, 38(3), 13–20.

17 Farmer Assurance Provision, Section 735 (formerly Section 733) of US H.R. 933 – *Consolidated and Further Continuing Appropriations Act 2013*, 113th Congress (2013–2014). See the chapter from Matthew Rimmer in this volume for more on the

The provision was renamed the Monsanto Protection Act by opponents who claimed the provision exempted GMO varieties from judicial challenges over their safety. On this view, the bill meant that the US Department of Agriculture (USDA) could overturn court rulings on the safety of GMO varieties and allow their planting. Enactment of the provision caused a backlash, including a *March against Monsanto* and the wording was stripped from the wider act.[18] The removal of this provision has generated much hope in the food safety movement that Monsanto's influence in Washington is waning. However, the fact that it was enacted speaks just as loudly to the contemporary situation as its overturning does to the future. Monsanto's operational requirements – that safety certifications on new varieties need to be stable to be profitable – were ranged directly against the public's right to challenge safety certifications in court. For a moment, at least while nobody seemed to be watching, the US administration explicitly prioritised Monsanto's needs over considerations of public access, through courts, to the regulatory system.

In Europe new seed regulations, now being drafted, would make it necessary for plant breeders to register all new varieties. Part of the registration requirements would entail something like distinctness, uniformity and stability testing and productivity testing.[19] These regulations would, furthermore, restrict farmers to using only seed that have been tested and registered in this manner.[20] The effects of the proposed new regulations would be somewhat similar to the results of tight laboratory safety procedures and strong regulation in the biotech industry. The cost

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provision and its impact on GMO food labelling. See also Godoy, M. 2013. Did Congress just give GMOs a free pass in the courts? *NPR: The Salt,* [Online]. Available at: http://www.npr.org/blogs/thesalt/2013/03/21/174973235/did-congress-just-give-gmos-a-free-pass-in-the-courts [accessed 24 February 2014].

18 See the *March against Monsanto*'s official website. [Online]. Available at: http://www.march-against-monsanto.com/ [accessed 24 February 2014] and Alliance for Natural Health, 2013. Success! The Monsanto Act has been repealed-this time for good! [Online]. Available at: http://www.anh-usa.org/monsanto-protection-act-has-been-repealed/ [accessed 24 February 2014].

19 European Commission. 2013. On the production and making available on the market of plant reproductive material. Brussels, 6.5.2013 COM(2013) 262 final. 2013/0137 (COD).

20 On similar regulations in the French national context see Anvar, S. Introduction to 'plant variety product licensing' and its impact on plant breeding and plant intellectual property rights (PIPR), in *Living Properties: Making Knowledge and Controlling Ownership in Modern Biology*, J.-P. Gaudillière, D.J. Kevles and H.-J. Rheinberger (eds)*.,* Berlin: Max Planck Institute for the History of Science Preprint 382, 57–64. On seed systems more generally see: Louwaars, N. 2007. Seeds of confusion: The impact of policies on seed systems. Unpublished PhD dissertation, Wageningen University. Formal seed systems, as proposed in this EU legislation, can be fruitfully contrasted to participatory seed breeding increasingly conducted by community groups in developing countries. See Tapia, M. and Tobin, B. 2013. Guardians of the seed: the role of Andean farmers in the caring and sharing of agrobioversity, in *Common pools of genetic resources: Equity and innovation in international biodiversity law,* edited by E. Kamau and G. Winter. Abingdon: Routledge, 79–100.

of compliance, so the industry claims, acts as a bar to conducting research for companies without substantial capital. In this case the new legislation presumes that the only reason for plant breeding is for profit: hence the regime's close alignment with the criteria already established by the International Union for the Protection of New Varieties of Plants (UPOV) for plant breeder's rights. Plant breeders working for their own bliss are not only invisible in this legislation; they are actively excluded from the production and sharing of new varieties by the costs of registration. In response to protests from small and organic plant breeders and farmers, a modified version of the legislation has been drafted. However, even in this new form, the proposed regulatory scheme will probably act as a bar to less capitalised plant breeders operating in the EU seed market.[21]

The rise of commercial breeding has not been entirely welcomed and concentration of breeding into the hands of an increasingly small number of corporations has caused much concern. These problems were recently acknowledged in the British Government's Foresight report on the future of agriculture:

> Over the last two to three decades a relatively small number of companies have come to dominate in the global food supply chain. This trend is apparent all along the supply chain, from agri-business (including seeds, crop protection) through to commodity wholesalers, manufacturers and retailers. Concerns have been raised regarding the exercise of this concentration of corporate power, for example in retail markets and purchase contracts with suppliers (particularly smaller farmers); wider public access to agricultural intellectual property and the transparency of governance in the food system.[22]

It is important to note that although commercial entities now dominate the production and sale of seeds, a great deal of publically funded research is still being conducted. However, as a result of an ongoing and often ideological rearrangement of the sector, publicly funded research is largely aimed at basic research, the results of which are then passed to commercial breeders to prepare for market and, often, protect with a plant variety registration or patent. This is the near and far market distinction that was promoted so vehemently in late-Thatcherite economics and is

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21 For analysis of the new regulations see Rabesandratana, T. 2013. Overhaul of EU seed regulations triggers protests. *Science Insider*. [Online]. Available at: http://news.sciencemag.org/europe/2013/05/overhaul-e.u.-seed-regulations-triggers-protests [accessed 24 February 2014]. The campaign is being taken up by several groups, see for instance, EU Seed Legislation Reform [Online]. Available at: http://www.saveourseeds.org/en/dossiers/eu-seed-regulation.html [accessed 24 February 2014].

22 Government Office for Science. 2011. *Foresight. The future of food and farming executive summary*. London, UK: The Government Office for Science, 23. Better access to intellectual property and to intellectual property protection were the major suggestions, short of direct market intervention, from this group as to how to tackle such industry concentration.

being revived in the twenty-first century, which underpins the policy decision that activities near to the market (such as commercialisation) should be conducted by the private sector, while those far from the market (such as basic research) should be conducted by the public sector.[23]

The foregoing discussion illustrates the relative dominance of seed production and sales in the early twenty-first century by commercial entities which are favoured by contemporary legislation.[24] That such entities should be chiefly concerned with profit making, ('greater yields, healthier crops and higher revenues than ever') and that the rules of the game prioritise this motive and facilitate its prosecution will be no surprise.[25] However, the alliance of groups protesting against seed legislation in the US and EU, reveals a quite different picture of non-commercial plant breeding. In the US, public protest was raised against the consolidation of corporate plant breeding power; in the EU, protest by amateur and organic plant breeders was instead directed against the exclusion of non-commercially motivated breeders from the market.

The history of publicly funded plant breeding in the nineteenth and twentieth centuries provides another view of how and why plant breeders might be motivated to produce seeds without profits. In the nineteenth century US Republic and the British Empire of the late nineteenth century plant breeding was deployed for the 'good of the nation' and 'the empire' in ways that demanded that the virtuous would give freely of their time.

Historical Context of Agricultural Research

In the early twentieth century publicly funded plant breeding was enjoying a heyday in the US and across much of Europe.[26] Beginning in the 1830s the United States Patent and Trademark Office (USPTO) collected and then redistributed

23 On this policy and the privatisation of the UK's Plant Breeding Institute see Webster, A. 1989. Privatisation of public sector research: the case of a plant breeding institute. *Science and Public Policy*, 16 (4), 224–232. More generally, see Edgerton, D. and Hughes, K. 1989. The poverty of science: A critical analysis of scientific and industrial policy under Mrs Thatcher. *Public Administration*, 67(4), 419–433 on Thatcherite innovation policy.

24 For more evidence of the sway held by such corporations over the US legislature see the chapter on GM labelling from Matthew Rimmer in this volume.

25 ASTA and Croplife. *The guide to seed treatment stewardship*. [Online]. Available at: http://seed-treatment-guide.com/about/overview/ [accessed 5 May 2014].

26 For an overview of that history with reference to private and public research themes see Pardey, P. and Beintema, N. 2001. Slow magic: Agricultural R&D a century after Mendel. Washington: IFPRI. See Harwood, J. 2012. *Europe's Green Revolution and others since*. London, Routledge (on the constellation of public funding research institutes in Germany and across central Europe and their historical development). See Palladino, above n. 2 and Charnley, B. 2012. *Agricultural science, plant breeding and the emergence of a Mendelian system in Britain, 1880–1930*. Unpublished PhD Thesis. University of Leeds (on the development of publicly funded research in Britain and its colonies).

increasingly large quantities of foreign seed.[27] Collection was orchestrated through a network which became increasingly large and formalised over time. Initially, naval officers and embassy staff operated as collecting agents. This work was conducted in free time and often without adequate funding to ensure the safe passage of samples back to the US. During this early period the USPTO was involved in an oversight role without providing any large amount of direct funding. This was work – essential for plant breeding – undertaken for the good of the nation. If collection was run on a shoe string in these early years, so was distribution. Parcels of seeds were sent out under congressional franks (a free postal privilege of congressional members). Through the rest of the nineteenth century the scheme was funded, defunded and refunded according to political whim but, in one form or another, it persisted until 1924. In later years specialist collecting agents were hired and several seed houses in Britain, France and across Europe were enlisted as official suppliers. By the 1880s the programme was being run by the newly formed USDA (that was initially a sub-department of the USPTO) and roughly 10 million parcels of seed were being distributed to farmers annually.[28]

Whether the scheme operated to provide commercial quantities of seed to farmers or samples for trialling new varieties in new geographical regions remains an open historical question. However, it is clear that one of the main aims of the scheme (however it sought to prosecute this aim) was to expand US agricultural acreage. Undoubtedly, seed provided by the scheme, along with seeds brought from Europe by immigrants, were an essential feature of the westwards expansion of the wheat belt, the equivalent expansion of maize acreage and the horticultural colonisation of California and Florida.[29] Furthermore, during this dramatic colonisation of new growing areas, often with less favourable conditions, or with new pests and diseases, yields remained somewhat constant. Biological innovation, including seed distributed by the US government played an important maintenance role in protecting yields against adverse conditions.

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27 On the scheme see: Kloppenburg, above n 16; Blair, D. 1999. Intellectual property protection and its impact on the US seed industry. *Drake Journal of Agricultural Law*, 4(1), 297–331; Fowler, K. 2000. The Plant Patent Act of 1930: A sociological history of its creation. *Journal of the Patent and Trademark Office Society*, 82(9), 621–44; Klose, N. 1950. *America's crop heritage: The history of foreign plant introduction by the Federal Government*. Ames: Iowa State College Press.

28 Fowler, ibid., 623.

29 See Olmstead, A. and Rhode, P. 2008. *Creating abundance: Biological innovation and American agricultural development*. Cambridge: Cambridge University Press. A similar agricultural expansion, also assisted by public plant breeding, was occurring in several places around the world at the turn of the century, including Australia, see Olmstead, A. and Rhode, P. 2007. Biological Globalization: The Other Grain Invasion, in *The New Comparative Economic History*, edited by Timothy J. Hatton, Kevin H. O'Rourke and Alan M. Taylor. Cambridge, Mass.: Massachusetts Institute of Technology Press, 115–140.

Several pieces of US legislation, enacted concurrently with the free seed scheme, established even more direct government involvement in agriculture. The *Morrill Act 1862* established the land-grant universities, a series of institutions that received land (and later funds) from government grants 'in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life', agriculture included.[30] The *Hatch Act 1887* established funding of US$15,000 for each of the land-grant universities to found experimental stations, which became hotbeds of progressive plant breeding.[31] It was at these institutions that genetics found its most enthusiastic reception in the US.[32] Finally, the *Smith-Lever Act 1914* extended this funding and gave experimental stations responsibility for a new cooperative extension programme intended to educate farmers in the new scientific farming.[33]

The free seed scheme and public plant breeding initiatives of the US government facilitated a huge expansion of agriculturally productive land and the maintenance of yields in these new areas. In the period 1850–1940 the amount of land in farms grew from around half a million square miles to over 1.75 million square miles. Total output grew steadily, if unspectacularly, over the same period.[34] As well as expanding acreage, the F1 double cross hybrid maize varieties which so aided the development of commercial plant breeding in the US, were a product of publicly funded plant breeding.[35]

In Britain, government intervention in agriculture has a similarly thoroughgoing history, albeit one that starts slightly later in the century.[36] In 1890 the Residue Grant – known as the whiskey money – rolled into government.[37] These were funds raised through taxes on alcoholic beverages. The idea had been to redistribute these extra funds to the holders of alcohol vending licences. However, in a context in which the temperance movement still held a great deal of influence, this idea

30 *Morrill Act 1862* (7 U.S.C. § 301 *et seq*.).

31 *Hatch Act 1887* (ch. 314, 24 Stat. 440, enacted 1887–03–02, 7 U.S.C. § 361a *et seq*.).

32 On the reception of Mendel's work in the US see Kimmelman, B. and Paul, D. 1988. Mendel in America: Theory and practice, 1900–1919, in *The American Development of Biology* edited by R. Rainger, K. Benson and J. Maienschein. Philadelphia: University of Pennsylvania Press, 281–310.

33 *Smith-Lever Act 1914* (ch. 79, 38 Stat. 372, enacted 1914–05–08, 7 U.S.C. § 341).

34 Alston, J., Andersen, M., James, J. and Pardey, P. 2010. *Persistence Pays U.S. Agricultural Productivity Growth and the Benefits from Public R&D Spending*. London: Springer, 15–17.

35 On the history of hybrid maize see Kloppenburg, Lewontin and Levins above n. 16 and Crow, J. 1998. 90 Years Ago: The Beginning of Hybrid Maize, *Genetics,* 148, 923–28.

36 For the general contours of this history see Russell, E. 1966. *A History of Agricultural Science in Great Britain, 1620–1954*. London: Allen and Unwin. esp. chapter 8 and Palladino above n 2.

37 Richards, S. 1988. The South-Eastern Agricultural College and public support for technical education, 1894–1914. *The Agricultural History Review,* 36(2), 172–87.

was abandoned. The newly available funds were instead diverted toward the county councils to provide technical education. The South Eastern Agricultural College at Wye was one of the first institutions to receive funds. As the century turned several university agricultural departments and more technical institutions such the College of Agriculture and Horticulture at Holmes Chapel in Cheshire and the Midland Agricultural and Dairy Institute at Kingston, Nottinghamshire were receiving whiskey money.[38]

Previous government interventions in industry had focused on ad hoc provisions which allowed certain privileges to a specific group. For instance in the saltpetre industry, government granted saltpetremen access to private land to collect saltpetre − a key weapon in early colonial expansion.[39] In contrast, schemes funded with whiskey money where the result of direct government intervention in industry development through the funding of technical instruction and research. The government's Board of Agriculture was renamed and expanded several times in the next quarter century to reflect this new direct role in industry.[40]

In 1909 David Lloyd George announced in his 'People's Budget' the creation of a £1,000,000 fund for rural development, including funding for plant breeding. In the following years, and especially after the First World War, this fund grew significantly.[41] In 1912, a Plant Breeding Institute was established at Cambridge using these funds. After the war, the National Institute of Agricultural Botany (NIAB) was established with 50 per cent of its funding coming from government funds. Increased post-war reconstruction funding, combined with legislative changes which created the *Seed Testing Act 1920* – replete with enforcement mechanisms and funding for an Official Seed Testing Station (a pre-war institute rehoused in NIAB's new buildings after the war) – amounted to a quasi-nationalised system of plant breeding, prosecuting what it claimed to be the latest genetic methods of breeding. In a context dominated by publicly bred varieties, commercial plant breeding firms struggled to stay in business.[42] In the nineteenth

38 Ibid., 185. See also Thomas, W. 2012. Agricultural colleges in Britain. *Ether Wave Propaganda.* [Online]. Available at: http://etherwave.wordpress.com/2012/03/26/agricultural-colleges-in-britain/ [accessed 25 February 2014].

39 On the case of saltpetre see Cressy, D. 2013. *Saltpeter: The mother of gunpowder*. Oxford: Oxford University Press.

40 The Board of Agriculture, which had been re-established by the Board of Agriculture Act 1889 was renamed the Board of Agriculture and Fisheries in 1903 and, from 1919, the Ministry of Agriculture and Fisheries. During the war a Department of Scientific and Industrial Research was also established, see Clarke, S. 2010. Pure Science with a Practical Aim: The Meanings of Fundamental Research in Britain, circa 1916–1950, *Isis*, 101, 285–311.

41 See Olby R. 1991. 'Social imperialism and state support for agricultural research in Edwardian Britain', *Annals of Science,* 48, 509–26 and Brassley, P. 1995. 'Agricultural research in Britain, 1850–1914: Failure, success and development', *Annals of Science,* 52, 465–80.

42 On fraught relations between public and commercial plant breeders in Britain see Charnley, B. 2013. Why didn't an equivalent to the US Plant Patent Act of 1930 emerge in Britain? Historicising the boundaries of un-patentable innovation, in *The Intellectual*

century a majority of the plants grown on British farms came from saved seed.[43] By the early 1980s, 90 per cent of Britain's wheat seeds were derived from public funding.[44] When the Plant Breeding Institute was privatised in 1987, Unilever purchased the near-to-market aspects of the Institute – which was broken up in the process – for between $100 and $130 million.[45]

In Britain, much of the motivation for this activity stemmed from a desire to increase home production and manage agriculture in the tropical colonies more efficiently.[46] This was a process from which small scale farmers, in Britain and abroad, were often excluded. In the US case 'agricultural development' was also a process that had winners and losers. Well capitalised farmers were set to reap the benefits of scientifically aided agriculture, developed with public funding, in ways that were unavailable to their poorer rivals. These sorts of considerations militate against any simplistic reading of publicly funded agricultural research as being as good as, or better than, commercially funded plant breeding. However the charge laid against historical publicly funded plant breeding at *Bowman v. Monsanto Co.* was that these schemes failed to develop agriculture.

The History of Plant Breeding Presented in the *Bowman V. Monsanto Co.* Court Documents

During Mark Walters's oral arguments for Bowman, Justice Roberts interrupted Walters in mid-flow and demanded, 'Why in the world would anybody spend any money to try to improve the seed if as soon as they sold the first one anybody could grow more and have as many of those seeds as they want?'[47] An even more explicit view of plant breeding history was included in the court documents. In the amici brief put forward in support of Monsanto by various US soybean growers' associations, collectively the American Soybean Association, the Association

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Property and Food Project: From feeding the world to rewarding innovation and creation edited by C. Lawson and J. Sanderson. Farnham: Ashgate, 103–23.

43 Brassley, P. 2000. Crop Varieties, in *The Agrarian History of England and Wales, 1850–1914*, edited by E.J.T. Collins. Cambridge, Cambridge University Press, 522–32.

44 Thirtle, C. *et al.* 1998. The rise and fall of public sector plant breeding in the United Kingdom: A causal chain model of basic and applied research and diffusion, *Agricultural Economics,* 19, 127–43, 141.

45 See Palladino, above n 2, 39; Stewart, A. 1987. Sale of lab to Unilever endorsed. *The Scientist,* [Online] Available at: http://www.the-scientist.com/?articles.view/articleNo/8971/title/Sale-of-Lab-To-Unilever-Endorsed/ [accessed 25 February 2014] and Murphy, D. 2007. *Plant Breeding and Biotechnology: Societal context and the future of agriculture*. Cambridge: Cambridge University Press, 132.

46 On British plans for more efficient, scientific, utilisation of tropical resources see Hodge, J. 2007. *Triumph of the Expert: Agrarian doctrines of development and the legacies of British colonialism*. Athens: Ohio University Press.

47 *Bowman*, above n 1, Oral arguments, 3, ln. 21–4.

claimed that the US free seed scheme actually stifled innovation in the seed industry. The US Government, on this view, acted as an incumbent in the seed market, dissuading investment in research by seed companies. The evidence brought forward for this claim is a putative drop of five bushels per acre in the soybean crop yield from 1866–1930.[48] This statistic hides the massive expansion of the area under agriculture (often into less agriculturally favourable areas) that occurred during this period. On one tally the soybean crop went from less than 50,000 acres in 1907 to around 5.5 million in 1935.[49] Much of this expansion (even in the years after the end of free seeds in 1924) was the result of varietal tinkering, initially facilitated by free seed programmes and later by research at the land grant universities.

The view of historical plant breeding typified in the Association's brief delineates the possibilities for future research by narrowing the range of legitimate aims to which research can be put. Having judged a particular scheme a failure, why in the world would anyone want to replicate that? The Association's mistake in taking yield to be the only measure of a successful agricultural sector is part of a wider history of trait selection which also has ramifications for the current GMO debate. Improving varieties can mean a huge range of things from environmental adaptation, increasing disease or insect resistance, through packaging and storage qualities to experiential qualities at the point of consumption, including but not limited to taste.[50] One of the most consistently highlighted problems with first and second generation GMOs is how little they improved the consumers' experience. If improving quality (not just for farmers but also for consumers) was the Association's aim then on this account their efforts have been a failure.

Bringing the history of publicly funded plant breeding back into view makes two points obvious. Firstly, incentives to innovation have not always been financial. Personal passion, considerations of the good of the nation and national agricultural development have been just as effective in stimulating individuals and institutions in the past. Secondly, this history reveals the widely different aims of commercial and publicly funded plant breeding. The first of these points undermines the incentive to innovate argument – that innovators need strong intellectual property to incentivise them. A second line of argument behind strong intellectual property is the substitution argument – the idea that absent strong rights to exclusivity, purchasers of seed can compete directly with vendors in the market.[51] On the Supreme Court's narrow construction of making, it might seem as though Bowman could have posed a threat to Monsanto by competing with them. However, on a broader construction of making this argument breaks

48 *Bowman v. Monsanto Co.* S.Ct. 11–796, Brief of American Soybean Association Illinois … as amici curiae in support of respondents, 10–13.

49 Olmstead and Rhode 2008, above n 29, 278.

50 See Tait and Barker, above n 6, Figure 1, 765 for a glimpse of the changes to trait focus now underway.

51 See Sheff, above n 11, on the substitution argument.

down. Indeed, Bowman continued to buy Monsanto's seeds for his first crop because there were parts of Monsanto's breeding process which he did not have the time or resources to replicate.

The Supreme Court's Concept of Making

The Supreme Court's decision in *Bowman v. Monsanto Co.* was blunt: 'The question in this case is whether a farmer who buys patented seeds may reproduce them through planting and harvesting without the patent holder's permission. We hold that he may not.'[52] A key part of Bowman's defence was the 'blame the bean' argument: Bowman did not make Monsanto's Roundup-Ready beans, having planted his grain elevator purchases (which he claimed as a legitimate use) the beans took care of the creative process. The court rejected this argument, however they failed to create a clear picture of what Bowman actually had done by way of making. On several occasions, as in the quote above, the court referred to making as constituted by the acts of 'planting and harvesting'. This phrase appeared front and centre at the top of the opinion. The application of Roundup (to select for Roundup-resistant seeds) was mentioned as part of Bowman's activities, but as of secondary importance. Yet if Bowman had simply planted and harvested he would hardly have reproduced Monsanto's seeds (note the plural used in the opinion above). Before Bowman treated his elevator purchases with Roundup he was in a similar position to farmers with windblown contamination of GMO seeds. Although Monsanto have promised not to sue in such cases, *Bowman v. Monsanto Co.* has upheld their right to do so in the future. While this possibility seemed to concern Justice Kagan during oral arguments, when she noted, addressing Monsanto's lawyer, Seth Waxman, 'your position … has the capacity to make infringers out of everybody … seeds can be blown onto a farmer's farm by wind … and the … farmer is infringing', these concerns disappeared from the Court's opinion.[53]

Rather than analysing the precise biological elements of making and, crucially, the relation of Monsanto's protected DNA sequences to the plant as a whole, there was much talk by Justice Breyer of 'magic boxes' and intertwined bunches of grass.[54] These arguments were intended to show that the method of making was irrelevant. During Walters' oral arguments, as a preamble to his magic box thought experiment, Justice Breyer made a telling remark. The case involved several generations of seeds and plants. Breyer interrupted Walters to crack-wise, 'There are three generations of seeds. Maybe three generations of seeds is enough.'[55] Breyer's joke refers to one of the most reviled instances of

52 *Bowman*, above n 1, 1765.
53 *Bowman*, above n 1, Oral arguments, 41, ln. 7–14.
54 Ibid. 8, ln. 2–15.
55 Ibid. 7, ln. 8–9.

value judgement in American judicial history (he was also wrong. Bowman had planted, treated and grown several generations in the years before Monsanto arrived in Indiana).

In *Carrie Buck v. John Hendren Bell*, a case which also focused on reproduction, the issue at question was the State's right to forcibly sterilise the daughter of a family who had been deemed 'imbeciles': a pseudo-scientific term at the time.[56] The Supreme Court's remit in hearing the case was to adjudicate on whether Virginia's sterilisation laws contradicted fourteenth amendment guarantees to due process. Justice Oliver Wendell Holmes, Jr. in concluding his argument, declared that: 'Three generations of imbeciles are enough.'[57] In reaching its decision, to sanction forced sterilisation, the court claimed to be acting on the latest scientific evidence. Indeed, Virginia's sterilisation law was derived from model legislation drafted by Harry Laughlin of the Eugenics Record Office based at the Cold Spring Harbor Laboratory. Judging scientific standards retrospectively is poor sport, however, and the science on which Holmes relied – as to judging what constituted imbecility and the efficacy of sterilisation – was far from universally accepted in 1927.[58] The case is now remembered as an example of the use of science to dress up ideological views as objective. Along with Justice Scalia's abstention in part from the Supreme Court's decision in 2013's other stand-out gene patent case – *Association for Molecular Pathology v. Myriad Genetics, Inc.* – on the grounds that the science was beyond him, Breyer's remark indicates that the court has a less advanced understanding of the science in these cases than it sometimes suggests.[59] Remembering Holmes's opinion in *Buck v. Bell* is a fair warning against trusting the scientific basis of the Court's opinion.

The products of plant breeding – what it is that plant breeders suppose they produce – are a moving historical target. Given this ambiguity about what plant breeders take themselves to be making, the court's hard and clean definition looks difficult to sustain. In the 1950s and 60s, despite the US *Plant Patent Act 1930* and UPOV, and the legal arguments around inventorship behind such legislation, many plant breeders still saw themselves as stewards of somewhat natural variability, rather than as inventors. The varieties they produced had to be constantly maintained, otherwise a variety might 'run out', becoming heterogeneous and unruly. This stewardship role – enshrined in breeders' practices – was a key selling point in catalogues which proclaimed the length of time varieties had been maintained and purified. In accordance with population genetics of the period,

56 *Carrie Buck v. John Hendren Bell, Superintendent of State Colony for Epileptics and Feeble Minded,* 274 U.S. 200, 47 S. Ct. 584; 71 L. Ed. 1000; 1927.

57 Ibid., 207.

58 See Searle, G. 1979. Eugenics and politics in Britain in the 1930s. *Annals of Science.* 36(2). 159–69, 163–4; Kevles, D. 1986. *In the Name of Eugenics: Genetics and the uses of human heredity*. Berkeley: University of California Press, 47–9.

59 *Association for Molecular Pathology v. Myriad Genetics*, 569 S. Ct. 12–398 (2013), Opinion of Scalia, J.

varieties were thought of more as moving populational targets. Over the decades since mid-century the variety has slowly been ossified as a fixed and discrete unit. Variability has been recast within acceptable boundaries which do not threaten a variety's integrity.[60] In the years since 1980, this conception of variety has in turn been displaced as the product of plant breeding by allegedly fixed identifiable entities around which intellectual property protection could be circumscribed, without the need for maintenance − DNA sequences. Even a basic understanding of biology undermines this fiction: all biological material varies over time, asexually reproducing organisms evolve and PCR amplification – the process of creating enough copies of a DNA sequence to be able to work with – introduces fidelity errors in much the same ways as naturally occurring transcription and translation – the processes which copy DNA in the wild. The law's recent focus on DNA sequences, as though they were static and unchanging over time, degrades the importance of stewardship roles (especially those conducted by small scale farmers in maintaining land races).

A single embodiment of a patented invention is enough to constitute infringement. Likewise, a single plant in isolation or in a mixed population is enough to infringe upon a UPOV registration. When he used Roundup, to check his plants were resistant and to ensure the next generation was homogenously resistant, Bowman was clearly utilising Monsanto's technology. As Stephen Hubicki's chapter in this volume shows, in Europe and Canada, discussions over infringement of patented DNA sequences in those jurisdictions have considered the utilisation of the sequence in the allegedly infringing plant. Even Monsanto's lawyer, Waxman, seemed open to such arguments. On his view, without the application of Roundup,

> There would be inadvertent infringement … but there would be no enforcement of that … The farmer wouldn't know, Monsanto wouldn't know, and in any event … if the farmer doesn't want Roundup Ready technology and isn't using Roundup Ready technology to save costs and increase productivity, the – the royalty value would be zero.[61]

However, the court did not argue on this basis and instead pointed vaguely to planting and harvesting.

Concluding Thoughts

Plant breeding has changed a great deal in the last 150 years. The varying mix of groups who conduct plant breeding – amateurs, farmers, seed firms and publicly funded researchers – has shifted greatly in favour of seed firms over this period.

60 Berry, above n 2, 35.

61 *Bowman*, above n 1, Oral arguments, 43, ln. 15–24.

Bowman v. Monsanto Co. exemplifies that shift. Plant breeding is increasingly concentrated in a commercial system that aims to generate profits through increasing quality and yield. At the same time the law pertaining to intellectual property in biological objects has also shifted.[62] The *Bowman v. Monsanto Co.* decision shows that the court is relying on a common legal view of plants and their DNA, which would be alien to most plant breeders, scientific or commercial, throughout the century, as well as alien to the facts of biological reproduction.

One feature of these changing relations – documented here – has been a forgetting of history. What is more, a forgetting that has occurred despite botanists' and plant breeders' historical inclinations for much of the nineteenth and arguably well into the twentieth centuries. The history of plant breeding presented by the American Soybean Association was one which forgot the aims of the free seed schemes and much of government intervention in agriculture over the century − to increase acreage, something such schemes were arguably very successful in doing. A de-historicised view of plant breeding is one that omits the importance of government. This is part of a pattern of undervaluing the importance of public projects.[63] As current economic fashion swings towards *laissez faire* and small government, all the while as we are faced with collective, societal problems, such as climate change, the aims and success of historical public schemes that promoted the good of the nation (albeit clumsily, and unfairly) are worth keeping in view. The importance of such schemes is underscored by them having been undertaken at the height of nineteenth and twentieth century free-trade economics. There are some types of plant breeding that the government has done very well and perhaps government intervention presents a better way to address problems faced by farmers who do not produce enough profit to interest multi-nationals. As economist Thomas Piketty has noted, 'There are nevertheless ways democracy can regain control over capitalism and ensure that the general interest takes precedence over private interests, while preserving economic openness and avoiding protectionist and nationalist reactions.'[64]

The view of making presented by the Supreme Court is one that neglected the historical dimension of biological nature. In focusing on bare DNA, and treating it as a static object, the Supreme Court is colluding in a fiction about the nature of hereditary material that benefits large commercial firms while undermining the importance of stewardship work. This construction of intellectual property works in favour of the large commercial entities that have been so keen to employ its extensive protection.

Comparing history to the current situation clearly demonstrates that (despite what Justice Roberts might think) 'It ain't necessarily so': there is nothing

62 On the long-running history of patentable subject matter see, Beauchamp, C. 2013. Patenting nature: A problem of history. *Stanford Technology Law Review.* 16(2), 257–312.

63 Mazzucato, M. 2013. *The entrepreneurial State: Debunking public vs. private sector myths*. London: Anthem.

64 Piketty, T. 2014. *Capital in the Twenty-first Century*. London: Belknap-Harvard, 1.

inevitable about the situation in which we find ourselves today.[65] If plant breeding has taken a particular path of development, to the benefit of particular social groups, the opportunity to change paths, or even turn back is still available. While *Bowman v. Monsanto Co.* illustrates the status quo, of concentration and extensive intellectual property, there are signs in the wake of *Association for Molecular Pathology v. Myriad Genetics* – discussed by Dianne Nicol in this volume – that this might also be a high watermark.

65 The title of Richard Lewontin's famously anti-deterministic manifesto: Lewontin, R. 2001. *It ain't Necessarily So: The dream of the human genome and other illusions*. New York: New York Review Books. See also Lewontin's recent piece in *New York Review of Books* asking to whose benefit the new synthetic biology will be put: Lewontin, R. 2014. The new synthetic biology: Who gains? *New York Review of Books*. May. [Online]. Available at: http://www.nybooks.com/articles/archives/2014/may/08/new-synthetic-biology-who-gains/ [accessed 6 May 2014].