‘LINUX FOR LETTUCE’: OPEN SOURCE BIOTECHNOLOGY AND AGRICULTURAL INNOVATION

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CONTENTS

I INTRODUCTION

Genetic Modification (‘GM’) crop technology is increasingly perceived as an important solution for overcoming the agricultural strains caused by climate change. This is reflected in the exponential growth in the patenting of so-called climate ready genes. This patenting, undertaken by a small group of life science companies, will make it difficult for researchers to obtain access to proprietary DNA and to research tools such as genetic markers, mutants, binding factors, transcription factors, etc. This article questions whether the Open Source approach, derived from the open source software movement, can be taken to secure access to proprietary DNA and seeds.

II GENE PATENTING

The patentability of genetic materials and gene fragments, such as expressed sequence tags (‘ESTs’) and single nucleotide polymorphisms (‘SNPs’), as well as enabling gene-based technologies led to what has been described as a ‘genomic

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gold rush' in the 1990s as vast numbers of gene-based patent applications were filed, particularly in the USA. These patents were filed both on improved plants and medical treatments, as well as on the tools and enabling technologies by which those products were engineered.

Significant misgivings with these developments have been expressed by numerous commentators. Probably the most influential among these are HelIer and Eisenberg[1] who suggested that genetic research tool patents could create a 'tragedy of the anticommons' in which multiple patent owners would tie-up genetic materials in a thicket of IP patent rights.[2] This was perceived by Correa to be a particular problem for the genetic improvement of crops since this is an incremental process and each new patent would constrain the 'freedom to operate' particularly of public agricultural research institutes.[3] Significant transaction costs attend the navigation through the patent thickets and access to research tools comes with some significant licence fees. This is obviously a problem for researchers in developing countries.[4]

A particular problem for agricultural innovation based upon gene technologies is that it has become an expensive enterprise and primarily for this reason has largely shifted from the public to the private sector.[5] This development is reflected in the shift from farmer-led, user-based innovation to mass-market, seller-based innovation and corporate research.[6]

Exacerbating this situation is the impact of climate change upon agriculture and upon patenting. Somvanshi in a 2008 study identified 30

[1] Michael A Heller and Rebecca S Eisenberg, 'Can Patents Deter Innovation? The Anticommons in Biomedical Research' (1998) 280 *Science* 698.
[2] See E Richard Gold et al, 'Are patents impeding medical care and innovation?' (2010) 7(1) *PLoS Medicine* e1000208.
[3] Carlos M Correa, 'Trends in Intellectual Property Rights Relating to Genetic Resources for Food and Agriculture', FAO, Commission On Genetic Resources for Food and Agriculture, Background Study Paper No. 49, Rome FAO, 2009.
[4] See Ademola A Adenle et al, 'Analysis of open source biotechnology in developing countries: An emerging framework for sustainable agriculture' (2012) 34 *Technology in Society* 256.
[5] See Dario G Frisio et al, 'Public vs. Private Agbiotech Research in the United States and European Union, 2002–2009' (2010) 13(4) *AgBioForum* 333.
[6] Keith Aoki, 'Free Seeds, not Free Beer: Participatory plant breeding, open source seeds, and acknowledging user innovation in agriculture' (2009) 77 *Fordham Law Review* 2276, 2277, cited in Elsa Tsioumani et al, 'Following the open source trail outside the digital world: open source applications in agricultural research and development' (2015) University of Edinburgh School of Law Research Paper Series, No 2015/38, 3.

patents relating to drought tolerant genes.[7] These included: (i) patents related to Proline biosynthesis; (ii) patented dehydration responsive element binding factors (DREB) and C-repeat sequences binding factors (CBF); (iii) patents related to Protein Kinases; (iv) various patents awarded for transcription factors involved in improving drought stress tolerance in plants; and (v) patents related to miscellaneous drought tolerance genes.[8] Two years later the ETC Group noted 'a dramatic upsurge in the number of patents published (both applications and issued patents) related to "climate-ready" genetically engineered crops' from June 30 2008 to June 30 2010, identifying 262 patent families and 1663 patent documents.[9]

III COMPETITION IMPLICATIONS OF GENE PATENTING

Equally significant to the growth of the patenting of climate ready genes is the small number of companies involved. The ETC report noted that the top ten seed companies account for 67% of the global proprietary seed market, with Monsanto accounting for 23% of that market.[10] This report referred to a 2006 study which revealed that roughly 74% of each of the 12 chromosomes in the rice genome was recited in US patent applications by Monsanto.

A parallel development with important implications for agriculture, is the growth of patenting of plant varieties. The UN's Special Rapporteur on the Right to Food, in his 2008 Report warned that:

> extending patents to plant varieties ... would accelerate the 'verticalization' of the food production chain, as agricultural producers would become dependent on the prices set by companies for the seeds on which they have patents and would be denied the traditional right to sell and exchange seeds among themselves, as well as to save part of their crops in order to retain seeds for the next planting season – either as a

[7] Vishal S Somvanshi, 'Patenting Drought Tolerance in Organisms' (2009) 3 *Recent Patents on DNA & Gene Sequences* 16, Table 2.
[8] Detailed in Michael Blakeney, 'Climate change and gene patents' (2012) 2 *Queen Mary Journal of Intellectual Property* 2, 10.
[9] ETC Group, 'Gene Giants Stockpile Patents on "Climate-ready" Crops in Bid to become "Biomassters": Patent Grab Threatens Biodiversity, Food Sovereignty' Issue no 106, October 2010, <http://www.etcgroup.org/upload/publication/pdf_file/FINAL_climate-readyComm_ 106_ 2010.pdf>. 52. Ibid, Appendix A.
[10] Ibid.

> consequence of the protection of patents or by the use of 'technology use agreements' by companies selling seeds.[11]

In addition, to the patenting of DNA, the large life sciences companies also own most of the key enabling technologies. Kloppenburg identified this as a significant barrier to market entry and a driver of the further concentration of the market as companies seek to navigate patent thickets by acquiring competitors.[12]

The dominant oligopolists are in a very strong lobbying position to secure a benign international IPR regime. The requirement of Article 27.3(b) of the World Trade Organization ('WTO') Agreement on Trade Related Aspects of Intellectual Property Rights ('TRIPS') that WTO Members protect plant varieties through patent laws, *sui generis* laws or by a combination of both, has been translated in the various free trade agreements to which the USA is a party, to require the enactment of legislation based on the 1991 version of the UPOV Convention.[13] This version of the UPOV Convention, which was first formulated in 1961 and then recast in 1978 establishes the least favourable regime for the saving of seed by farmers for subsequent plantings.

The market dominance of the life sciences companies also has an important influence upon the sort of agricultural research which is undertaken, for example, directing it towards Northern concerns away from Southern food priorities.[14] It has been estimated that only one per cent of the research and development budgets of multinational corporations is spent on crops likely to be useful in the developing world.[15] Almost entirely neglected by these corporations are the five most important crops of the poorest, arid countries: sorghum, millet, pigeon pea, chickpea and groundnut.[16]

[11] Report of the Special Rapporteur on the Right to Food (2008), United Nations, General Assembly A/63/278* <http://www2.ohchr.org/english/issues/food/docs/A.63.278_en.pdf> 13.

[12] Jack Kloppenburg, 'Re-purposing the Master's Tools: The open source seed initiative and the struggle for seed sovereignty' (2014) 41 *The Journal of Peasant Studies* 1225, 1230.

[13] The Convention establishing the International Union for the Protection of New Varieties of Plants (Union internationale pour la protection des obtentions végétales).

[14] Julian M Alston, Philip G Pardey and Johannes Rosenboom, 'Financing Agricultural Research: International Investment Patterns and Policy Perspectives' (1998) 26 *World Development* 1045.

[15] Prabhu L Pingali and Greg Traxler, 'Changing Focus of Agricultural Research: Will the Poor Benefit from Biotechnology and Privatization Trends?' [2002] *Food Policy* 27.

[16] Human Rights Council, Report of the Special Rapporteur on the Right to Food, Jean Ziegler, A/HRC/7/5, 10 January 2008, [44].

IV THE OPEN SOURCE SOLUTION

The application of the Open Source approach to software development, to overcome the domination of the information technology sector by the large software companies has been mirrored by the suggestion that the Open Source philosophy should be applied to biotechnology as a counterbalance to the influence of the multinational life sciences companies.[17] The free or open source software movement proposed the making available of computer source code under a free or open source copyright license that permitted members of the public to use, change, and improve the software, and to redistribute it in modified or unmodified form ,

It has been suggested that the traditional sharing of seeds by farmers in developing countries emulates the free exchange of computer codes by software programmers.[18] However, it should be noted that this practice is constrained by the requirement in Art 15(2) of the 1991 version of the UPOV Convention which confines seed saving by farmers "to use for propagating purposes, on their own holdings, the product of the harvest which they have obtained by planting, on their own holdings."

An open source approach was taken in the International Treaty on Plant Genetic Resources for Food and Agriculture. Article 12.3(d) provides that the recipients of plant genetic material 'shall not claim any intellectual property or other rights that limit the facilitated access to the plant genetic resources for food and agriculture, or their genetic parts or components, in the form received from the Multilateral System'. The critical question is what is meant by 'in the form received'? One answer, which is borrowed from the 1991 UPOV Convention, is that the form would be considered to have changed if the material is used to create a plant variety which cannot be said to have been 'essentially derived' from the supplied material. However, the meaning of essential derivation also requires clarification.

Janet Hope, in her doctoral study traced the origins of open source biotechnology to a number of suggestions made by researchers working on the

[17] See Maurice Cassier, 'New "Enclosures" and the Creation of New "Common Rights" in the Genome and in Software' (2006) 15(2) *Contemporary European History* 255.
[18] Adenle et al, above n 4, citing Boru Douthwaite, *Enabling innovation: a practical guide to understanding and fostering technical change* (Zed Books, 2002) and K Ravi Srinivas, 'The case for biolinuxes: and other pro-commons innovations' in Ravi S Vasudevan et al (eds), S*arai reader 2002: the cities of everyday lif*e (Center for the Study of Developing Societies, 2002) 321–8.

mapping of the human genome.[19] She mentioned the 1999 proposal by researchers working at the Sanger Institute explored the possibility of licensing sequence data on share-alike terms,[20] but which failed because of concerns about private corporations, such as Craig Venter's Celera, patenting improvements to the data.[21] Learning from this failure, the international haplotype mapping ('HapMap') project, which was a private–public collaboration to create a haplotype map of the human genome,[22] developed a 'click-wrap' licence requiring those who accessed the HapMap database to agree that they would not file patent applications where HapMap data had been accessed. According to a notice on the site, the open source software licence directly inspired the terms of the click wrap agreement, but because of implementation difficulties the requirement was withdrawn before the Project was completed.[23]

The difficulty of applying open source software concepts to biotechnology has been attributed in part to the different proprietary regimes that apply to software and biotechnology. Software is primarily protected by copyright, whereas biotechnological innovations are protected by patents.[24] The cost of patent protection can be substantial, whereas copyright protection arises automatically and without cost to the owner. To make patented material or technologies available to others will involve philanthropy on the part of the patentee or recouping some of the expense of patenting from licence fees. The grant back of improvements is a feature of open source biotechnology and this is often susceptible to antitrust abuse.[25]

The different cultures of software creators and biotechnology researchers also has to be acknowledged. Software developers work online with their

[19] Published as Janet Hope, *Biobazaar: The open source revolution and biotechnology* (Harvard University Press, 2008).
[20] Referring to John Sulston and Georgina Ferry, *The Common Thread* (Random House, 2002) 211–13.
[21] See Arti K Rai, 'Open and Collaborative Research: A New Model for Biomedicine', in Robert Hahn (ed.), *Intellectual Property Rights in Frontier Industries: Biotechnology and Software* (AEI-Brookings Joint Center for Regulatory Studies, 2005) 131, 142-3.
[22] Halotypes are patterns of genetic variation linked to disease phenotypes.
[23] See Donna M Gitter, 'Resolving the Open Source Paradox in Biotechnology: A Proposal for a Revised Open Source Policy for Publicly Funded Genomic Databases' (2006-2007) 43 *Houston Law Review* 1475.
[24] P2P Foundation, 'Open Source Biotechnology' <http://p2pfoundation.net/Open_Source_Biotechnology>.
[25] See Robin Feldman, 'The open source biotechnology movement: is it patent misuse?' (2004) 6 *Minnesota Journal of Law Science & Technology* 118.

products being tested instantly by a community of users and contributors.[26] This is to be contrasted with biotechnology research which may take several years before yielding agricultural results. Also agricultural innovation involves diverse communities of traditional farmers who provide germplasm agricultural research institutes of specialist scientists.

It has been suggested that universities and other public research institutions might be able to develop technologies and products which could be placed in the commons. However, there are among the obstacles to this are the requirements in the IP statutes of many of those institutions, that patent rights be sought for the inventions produced by its employees. This may also be required by the bodies which fund research or by national legislation, such as Bayh-Dole type statutes which require IP rights to be secured in relation to nationally-funded research. Often there may be overlapping rights on the IP generated by multiple parties. Commercial relationships between public research institutions and life sciences companies may impair the sharing of research products. For example, a life science company making its proprietary enabling technology available to a research institute will often impose a moratorium on publications by the research institute until the commercialisation possibilities resulting from research have been evaluated.

V CAMBIA 'BiOS' Initiative

Often cited as a successful example of open source biotechnology is the Biological Innovation for Open Society ('BiOS') initiative of CAMBIA ('Center for Application of Molecular Biology in International Agriculture') based in Canberra.[27] This Centre was established in Canberra by Richard Jefferson, who had patented a gene transfer technology.[28] CAMBIA used the patent revenues to create a funding base to underpin an open source system applicable to biotechnologies. To deal with the transaction costs of negotiating open source

[26] Elsa Tsioumani et al, 'Following the open source trail outside the digital world: open source applications in agricultural research and development' (2015) University of Edinburgh School of Law Research Paper Series, No 2015/38, 11.
[27] See Hassan Masum et al, 'Open Source Biotechnology Platforms for Global Health and Development: Two Case Studies' (2011) 7 *Information Technologies & International Development* 61, 62-5.
[28] Described in Richard A Jefferson, Tony A Kavanagh, and Michael W Bevan, 'GUS fusions: beta-glucuronidase as a sensitive and versatile gene fusion marker in higher plants' (1987) 6 *European Molecular Biology Organization Journal* 3901.

licenses, in 2005, CAMBIA made available to researchers three different strains of bacteria that could be substituted for existing proprietary methods of introducing genetic material into plants. This technology was used as a nucleus to generate a protected commons for researchers in the life sciences, which became known as BiOS. CAMBIA offered free access to its discoveries, but subject to an Open Source-type licence. This required licensees wanting to use the BIOS technologies to extend to other participants in the BiOS initiative 'a worldwide, non-exclusive, royalty-free, fully paid-up license' to any improvements they might make.[29] Under the BiOS licences, products derived from the licensed technology could be patented and commercialized subject to a number of constraints. These included a requirement that a broadly defined class of improvements be non-exclusively granted back to CAMBIA. This grant-back obligation, together with other controls over 'follow-on innovators' were said to take the BiOS licences outside the open source paradigm and in part explained the lack of success of this model.[30]

On the other hand, it has been suggested that BiOS 'has been at the forefront of promoting open source for sharing biological innovation', particularly in the field of agriculture.[31] Tsioumani et al refer to research at Cornell University which used Cambia open source research tools to fight a papaya virus.[32]

VI THE OPEN SOURCE SEED INITIATIVE

The Open Source Seed Initiative ('OSSI') was formulated in 2011 emerged from two meetings held in the US in April 2010 and May 2011, which were attended by public and private plant breeders, farmers, and NGOs' and indigenous groups' representatives.[33] The idea was to 'combat the erosion of farmer sovereignty over seed – via corporate appropriation of plant genetic resources,

[29] See Katherine M Nolan-Stevaux, 'Open Source Biology: A Means to Address the Access & Research Gaps?' (2007) 23 *Santa Clara Computer & High Technology Law J*ournal 271, 3036.
[30] See Janet Hope, 'Open source Biotechnology: Real life experiments in open source biotechnology' <http://opensourcebiotech.anu.edu.au/Open_Source_Biotechnology/Practice.html>.
[31] Ademola A Adenle et al, 'Analysis of Open Source Biotechnology in Developing Countries: An Emerging Framework for Sustainable Agriculture' (2012) 34 *Technology in Society* 256, 263.
[32] Tsioumani et al, above n 26, 38.
[33] Jack Kloppenburg, 'Re-purposing the master's tools: the open source seed initiative and the struggle for seed sovereignty' (2014) *The Journal of Peasant Studies* <https://opensource.com/sites/default/files/images/law-uploads/Kloppenburg%202014%20re-purposing%20the%20master's%20tools%20(JPS).pdf>.

growing monopoly power in the seed industry, the development of transgenic crops and the global imposition of intellectual property rights'[34] by encouraging the sharing of germplasm to revitalize public plant breeding. A key tool for achieving these goals was the development of open source licenses to preserve the right to use material for breeding, as well as the right of farmers to save and replant seed.[35]

A foundation member of the Board of OSSI and its leading publicist is Professor Jack Kloppenburg author of *First the Seed: The Political Economy of Plant Biotechnology, 1492-2000.*[36] In a 2014 evaluation of the OSSI initiative he reported 'a variety of technical, legal obstacles to drafting workable licenses' and a concern that the licensing approach to germplasm exchange was alien to 'the food sovereignty advocates' of the Global South, with whom 'OSSI would like to make common cause'.[37] This was because of a perceived distrust of an initiative 'whose dependence on a formal license appears as one more application of the legal tools of the master which have already been so destructive of farmer sovereignty over seeds'.[38] The North American genesis of OSSI also reflects the structure of the seed industry in that part of the world which is dominated by plant breeders employed by public, 'land grant' universities and private breeders who expect to be rewarded for their contributions.

To deal with this situation the OSSI has developed two licences: a 'free seed' and a 'royalty-bearing' licence.[39] Recipients of genetic material transferred under 'free seed' licence may grow the seed, may reproduce the seed, may share the seed, may sell the seed, may conduct research with the seed and may breed new varieties with the seed, and farmers may save and replant the seed. The only restriction is that licensees may not restrict the freedom of others to use the seed in whatever way they wish. The 'royalty-bearing' license allows collection of royalties on the seed, but may not restrict usage in any other way. Recipients of genetic material transferred from the originator under this license may be required to pay royalties on commercial sale of the seed, but may grow the seed, may reproduce the seed, may share the seed, may sell the seed, may

[34] Ibid 1.
[35] Ibid 2.
[36] (University of Wisconsin Press, 1988).
[37] Kloppenburg, above n 33, 2
[38] Ibid 3.
[39] Ibid 16.

conduct research with the seed and may breed new varieties with the seed, and farmers may save and replant the seed.

The problem which Kloppenburg has identified with these licences is the fact that they are governed by contract law principles, requiring the terms of the licences to be brought to the attention of recipients and the probability that the seven pages of these licences will be transmitted for more than a few iterations is very low, negating the likelihood that the licence would virally propagate.[40] Compounding these technical obstacles is the 'sense among OSSI members that implementing a mandatory, legally binding, lengthy, confusing, unwieldy, restrictive license would bring us perilously close in style and substance to the practices characteristic of the Gene Giants'.[41]

VII CONCLUSIONS

Proposals for the unconstrained availability of open source biotechnology has been encouraged by the economic success of the open source model in software development. However, as has been indicated above, the software and biotechnology environments are quite distinct. Software engineers have considerably greater freedom to make their codes available to the IT world, provided that their creations are not claimed by employers or co-developers. In the case of biotechnology, there are numerous potential obstacles to open sourcing. Elements of a new piece of biotechnology may be claimed by patentees or the owners of PBRs, opening recipients, or the providers of germplasm to infringement claims. Often the development of biotechnology involves the use of valuable laboratory resources generating claims by the owners of those resources for a share in what has been developed. For example, the research centres of the Consultative Group on International Agricultural Research ('CGIAR'), which was at the forefront of the Green Revolution, making improved seeds available gratis to farmers, now allows third parties to establish IP rights over germplasm when such action is 'necessary for the further improvement of such Intellectual Assets or to enhance the scale or scope of impact on target beneficiaries'.[42] In part, this position has been taken by the CGIAR in response to the exploitation of its improved seeds by third

[40] Ibid.
[41] Ibid 17.
[42] Quoted ibid 7.

parties, as its donors expect it to defray costs by doing what these third parties have done.[43]

It has been pointed out that the effective use of open source systems requires pre-existing legal infrastructures, knowledge and skills, which makes it more likely that enterprises and individuals in industrialised countries are in a better position than those in the South.[44] As an open source licence is a contract its enforcement will depend upon the financial and organizational capacity of parties to pursue remedies through the courts. Biotechnological assets, unlike software assets, will usually have to be protected through the patent of PBR systems, which involves a financial capacity to register and to protect through infringement actions. One suggestion which is made to deal with the considerable expense of patenting, is for the developers of germplasm to file provisional patent applications. This will have the effect of destroying novelty and placing innovations in the public domain.

The open source software movement originated in an anti-intellectual property critique derived from a reaction to the considerable prices for and profits from proprietary software. The open source biotechnology movement has a similar anti-intellectual property origin deriving in part from the fact that most privatised germplasm is derived from biological resources thought to be the endowment of humankind,[45] as well as the fact that agricultural innovations utilising this germplasm are often the results of farmer innovations rather than research by patentees.[46]

There is a considerable literature lamenting the inequalities between farmers and the Gene Giants, this parallels the equally voluminous literature concerning the lack of an effective international legal regime to regulate access to genetic resources and the sharing of benefits from the exploitation of those

[43] See Michael Blakeney, ‘Agricultural Research: Intellectual Property and the CGIAR System’ in Peter Drahos and Ruth Mayne (eds), *Global Intellectual Property Rights: Knowledge, Access and Development* (Palgrave Macmillan, 2002) 108-24.

[44] Selim Louafi, and Eric Welch, ‘Open Systems versus Strong Intellectual Property Rights: disentangling the debate on open access for meeting global challenges in life science’ in Y.T Grosclaude, L. Tubiana, and R. K. Pachauri, Eds, *A Planet for Life 2014: Innovation for Sustainable Development*, New Delh,: Teri Press, 2014, 145-160.

[45] See Keith Aoki, ‘Neocolonialism, Anticommons Property, and Biopiracy in the (Not-So-Brave) New World Order of International Intellectual Property Protection’ (1998) 6 *Indiana Journal of Global Legal Studies* 11.

[46] See Keith Aoki, ‘Free Seeds, not Free Beer’: Participatory plant breeding, open source seeds, and acknowledging user innovation in agriculture’ (2009) 77 *Fordham Law Review* 2276.

resources. The open source biotechnology suggestion is an attempt to propose a practical solution. A parallel suggestion, which is being considered by the World Intellectual Property Organization ('WIPO') is for an international treaty dealing with genetic resources. The duration of the debates within WIPO on this subject, which have now exceeded 16 years suggests that this solution might still be some distance in the future as the bio-exploiting countries have no strong incentive to embrace a regime which may involve them in some expense.

The most practical solution is for these matters to be part of a composite deal in which access to biotechnology and farmers' innovations are bundled up with the same sort of trade subjects as secured the passage of the TRIPS Agreement as part of the WTO package of agreements. This might not be too fanciful at a time of climate change when knowledge of local and traditional farmers is used to identify useful germplasm to resist climate stresses.[47]

[47] See, eg, Louis Lebel 'Local knowledge and adaptation to climate change in natural resource-based societies of the Asia-Pacific' (2013) 18(7) *Mitigation and Adaptation Strategies for Global Change* 1057; Sawon Istiak Anik and Mohammed Abu Sayed Arfin Khan, 'Climate change adaptation through local knowledge in the north eastern region of Bangladesh' (2012) 17(8) *Mitigation and Adaptation Strategies for Global Change* 879.