Journal of Agrarian Change, Vol. 10 No. 3, July 2010, pp. 367–388.

Impeding Dispossession, Enabling Repossession: Biological Open Source and the Recovery of Seed Sovereignty

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Corporate appropriation of genetic resources, development and deployment of transgenic varieties, and the global imposition of intellectual property rights are now widely recognized as moments of accumulation by dispossession. Though robust and globally distributed, opposition to such processes have been largely defensive in orientation, and even accommodationist in demands for the development of market mechanisms for compensating those from whom germplasm is being collected. A more radical stance founded on legal and operational mechanisms drawn from the open-source software movement could not only function to impede processes of dispossession, but might actually facilitate the repossession of 'seed sovereignty'. Implementation of 'biological open-source' arrangements could plausibly undergird the creation of a protected commons populated by farmers and plant breeders whose materials would be freely available and widely exchanged, but would be protected from appropriation by those who would monopolize them.

Keywords: seed sovereignty, open source, accumulation by dispossession

INTRODUCTION

The law locks up the man or woman
Who steals the goose from off the common
But leaves the greater villain loose
Who steals the common from off the goose . . .
And geese will still a common lack
Till they go and steal it back.

(Anon., English, *c*. 1821, quoted in Boyle 2008, 42)

Readers of this *Journal* will doubtless recognize the foregoing poem as an expression of opposition to the enclosures movement that forcibly separated workers from the land throughout Europe over the course of several centuries. Marx (1977, 873) referred to this process of agricultural expropriation as 'primitive accumulation' inasmuch as divorcing the producer from the soil – that most fundamental means of

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The author is grateful to the editors of this special issue for their comments on earlier drafts.

production – constituted an original and essential 'point of departure' for the initiation and elaboration of capitalism. Recently, there has been much attention to understanding primitive accumulation not simply as the agrarian, 'prehistory of capital', but as a generalized and ongoing phenomenon. Most notably, David Harvey (2003, 144) has introduced the phrase 'accumulation by dispossession' as a substitute for Marx's term in order to emphasize the contemporary relevance of the process and to focus analysis on its diverse, current manifestations.

As a result, the rich stock of historical scholarship on resistance to enclosures and other forms of primitive accumulation is now being supplemented by a wealth of studies on how present-day dispossession by accumulation is being imposed, and on how it is being impeded by the struggles of those being dispossessed. Still, as the anonymous nineteenth-century author reminds us in the poem's final line, the real challenge is not just to understand or to prevent appropriation of the commons, but to find the means to actually 'steal it back'. I am interested here in exploring what we might call 'repossession', the actual recovery or reacquisition of what has been lost, and even the proactive creation of new, commons-like spaces in which more just and sustainable forms of social production might be established and elaborated.

Ironically, it is agriculture – the very *locus classicus* of primitive accumulation – that presents a significant and plausible opportunity to both impede accumulation by dispossession and to enact a novel and fertile form of repossession. The particular terrain of struggle I am concerned with is not the landscape *per se*, however, but the gene-scape and the mind-scape.

The concentration of corporate power in the life sciences industry, the global imposition of intellectual property rights (IPRs), the privatization of public science, the spread of genetically modified (GM) crops, the development of 'Terminator' technologies and the proliferation of bioprospecting for both genetic resources and associated cultural knowledge have been explicitly recognized as contemporary moments of primitive accumulation/accumulation by dispossession (Mooney 1979; Kloppenburg 1988; Harvey 2003; Hardt and Negri 2004). The seed itself is very often the object and substance of these instances of appropriation. As both foodstuff and means of production, seed sits at a critical nexus where contemporary battles over the technical, social and environmental conditions of production and consumption converge and are made manifest. Who controls the seed gains a substantial measure of control over the shape of the entire food system.

In response, over the past decade agrarian, environmental and social advocacy groups and organizations have been working in the context of a highly diffuse but powerful social movement that has had success at slowing – though certainly not stopping – what has come to be broadly understood as the project of corporate 'globalization' in agriculture (Schurman and Kelso 2003). A leading edge of this oppositional movement has been the transnational network of farmer groups, organized as La Vía Campesina, that has taken the achievement of 'food sovereignty' as its global objective (McMichael 2006; Desmarais 2007). But if 'food sovereignty' is to be achieved, control over plant genetic resources must be wrested from the corporations that seek to monopolize them and be restored to, and permanently vested in, social groups and/or institutions with the mandate to sustain them and to facilitate their equitable use. That is, realization of food sovereignty is predicated in no small part on the repossession of 'seed sovereignty'.

It is my contention here that while resistance to contemporary forms of genetic and epistemic dispossession have had some success, attempts to create progressive alternatives such as farmers' rights, participatory plant breeding, a revitalized public science, the development of agro-ecology and support for decentralized and community-based seed distribution and marketing have found insufficient traction. Further, it also seems to me that the mechanisms that have been pursued to address the inequities of such practices as bioprospecting have too often actually functioned to articulate farmers and indigenous communities more closely to the market system rather than to construct new and positive spaces for alternative action. Specifically, inasmuch as they have accepted the principle of privatization – rather than sharing – as their constitutive basis, they have all proved inadequate even at impeding accumulation by dispossession, much less at facilitating the recovery of seed sovereignty.

The homogenizing ambitions of what McMichael (2008, 207) calls 'the globalization project', and what Hardt and Negri (2000) name simply as 'Empire', are not limited to food and agriculture, but are manifested across all social, economic and biophysical spaces. Whatever the specific context, a central element of the neoliberal initiative is the appropriation of that which is shared in 'the commons' or 'the public domain' and its transformation into an exclusive, commodified form. Not only are enclosures not unique to land, they are not limited to what are conventionally understood to be 'material' resources. Thus, copyright and patent law have been developed to appropriate and commodify the ideas that are the product of human creativity, a process that Boyle (2008, 45) argues is 'the second enclosure movement . . . the enclosure of the intangible commons of the mind'.

Wherever and whenever they are imposed, enclosures call forth modes of resistance. A particularly powerful and fertile response has been manifested by the 'free and open-source' software movement (Raymond 1999; Boyle 2008). Finding their creativity, productivity and contributions to the community limited by copyright, patents and restrictions on exchange of software code, programmers have devised ways to use contract and copyright law to create legal mechanisms that have allowed them to enforce sharing rather than exclusion. Further, the provisions that can be incorporated into open-source and related 'copyleft' arrangements can also effectively prevent the appropriation of code by companies that would use it for exclusive purposes. Not only is appropriation of the public domain impeded, but a 'protected commons' is established that serves as a relatively autonomous space for the nurturing of diverse forms of innovative, social production.

A variety of analysts have begun to think about the ways in which open-source principles and legal mechanisms might be applied to the production of biological knowledge, technologies and products. I am especially interested in exploring how specifically *biological* open-source arrangements for plant germplasm have been proposed, and how their deployment might undergird the creation of a protected commons of farmers and plant breeders whose materials would be freely available and widely exchanged but would be effectively protected from appropriation by those who would monopolize them. In what follows, I will examine how biological open source might be concretely operationalized not simply in defence against accumulation by dispossession, but in the service of actual repossession of a protected space into which plant improvement practices and institutions with transformative capacity can be introduced and elaborated.

AGRARIAN DISPOSSESSION: THE EROSION OF SEED SOVEREIGNTY

The penetration and imposition of capitalist commodity relations has been exceedingly uneven in time, space and economic sector. Indeed, agriculture has itself proved remarkably resistant to complete subsumption under such arrangements. The persistent and, to many, unexpected survival of 'peasants' in the global South and of 'family farmers' in the global North has engendered complex debates regarding the analytical and political utility of various forms of agrarian theory and class analysis (Bernstein 2007; McMichael 2008; van der Ploeg 2008). While parsing differentiation is a central concern for those of us engaged with the 'agrarian question', here I want to focus principally on something that all agricultural producers share rather than on what distinguishes groups of them from each other. Accordingly, I deploy the term 'farmer' to refer to a global range of producers encompassing a wide variety of scales, technical capacities and class positions.

Whatever their differences, all producers of horticultural and agronomic crops put seeds in the ground. A Nicaraguan *campesino* might plant soybeans by hand on half a hectare, while an Iowa farmer could be using John Deere's DB60 planter to simultaneously sow 36 rows of soybeans on 2,500 acres. But both producers could well be planting seed purchased from Monsanto – or saved from a previous harvest. Increasingly and worldwide, farmers of all types find themselves confronting commodified, patented/protected, high-priced, corporate seed. They find themselves in similar structural positions in relation to Monsanto and Syngenta and DuPont, companies that are working aggressively to separate them from self-provisioning of that most fundamental of means of production, the seed. What interests me in this convergence is the potential for conscientization and perhaps even mobilization of diverse types of farmers around a common concern for 'seed sovereignty'.

A variety of natural (Mann and Dickinson 1978) and social (Friedmann 1980) obstacles to the penetration of agriculture by capital have been identified as factors enabling resistance to the decomposition of agrarian petty commodity production. The natural characteristics of the seed have been among the most potent of these obstacles to commodification (Kloppenburg 1988). As a living, reproducing organism, the seed possesses a dual character that links both ends of the process of crop production: it is both means of production and, as grain, the product. In planting each year's crop, farmers also reproduce a necessary part of their means of production. This linkage, at once biological and social, is antagonistic to the complete assimilation of seed (as opposed to grain) under the commodity form. A farmer may purchase seed of an improved plant variety, and can subsequently propagate the seed indefinitely for future use. As long as this condition holds, there is little incentive for capital to engage in plant breeding or commercial seed production. The ability to autonomously reproduce a key component of the means of production preserves for the farmer a partial degree of independence from capital. This 'plant-back' has historically been the major constraint on the expanded reproduction within the seed industry.

Until the 1930s, farmers in both the global North and global South enjoyed nearly complete sovereignty over their seeds. That is, they decided what seeds to plant, what seeds to save and who else might receive or be allocated their seed as either food or planting material. Such decisions were made within the overarching norms established by the cultures and communities of which they were members. While these customary arrangements often recognized some degrees of exclusivity in access to genetic resources, they were largely open systems that operated on the bases of reciprocity and gift exchange rather than the market. Indeed, these customary arrangements usually functioned to stimulate and facilitate – rather than restrict – the wide dissemination of seed (Zimmerer 1996; Salazar et al. 2007). The sharing of seed resulted in the continuous recombination of genetic material, which in turn produced the agronomic resilience that is characteristic of farmer-developed crop varieties and landraces. This historic creation and recreation of crop diversity not only fed particular communities and peoples, but collectively constitutes the rich repository of genetic resources on which future world food production must depend.

Since the 1930s, farmers' sovereignty over seeds has been continuously and progressively eroded, while the sovereignty of what is now a 'life sciences industry' has been correspondingly enlarged. The development of inbreeding/hybridization in maize first separated the farmer from the effective reproduction of planting material and created the opening needed for private capital to profit from the seed sector (Kloppenburg 1988). Hybrids were subsequently developed in all crops that were amenable to this biological convention. Most recently, genetic engineering has been used to develop 'Genetic Use Restriction Technologies' that prevent a seed from germinating unless proprietary chemicals are applied. Dubbed 'Terminator Technologies' by activist groups (ETC Group 2002), their development has no agronomic function but is intended to solve industry's plant-back problem in crops where hybridization has proven elusive (wheat, soybeans) and in nations in which IPRs are non-existent or their enforcement is ineffectual.

A second route to the expropriation of farmers' access to the reproducibility of seed has been the progressive development of ever more restrictive IPR legislation. The 1961 creation of the Union for the Protection of New Varieties of Plants by six European nations stimulated passage of the 1970 Plant Variety Protection Act in the United States. Though the specific legal and policy mechanisms have been somewhat different between Europe and North America (Bocci 2009), all have fostered a regulatory environment that has resulted in continuous contraction of the spaces and modalities available to informal seed exchange and growing restrictions on the 'farmers' privilege' (as opposed to the 'breeders' rights') to save and replant seed of protected varieties. Over the last two decades, standard utility patents have increasingly been applied to crop genetics in both North America and Europe. The absence of farmers' privilege/exclusion clauses in patent law has rendered plant-back unambiguously illegal in Canada and the USA, and companies such as Monsanto and Syngenta have initiated a brutal propaganda and legal assault against farmers found to be violating their property rights (Center for Food Safety 2004).

Both national and transnational structures of governance are being used to promulgate and extend this legal framework at a global scale. The World Trade Organization now requires all member-states to offer some form of IPRs for plants. Such a provision was imposed on Iraq by the US occupation administration, and similar – if less transparently coercive – pressures are being applied by the advanced capitalist nations in trade negotiations with partners in the global South. As a result, many countries have established laws that attenuate farmers' rights to save and replant seed (GRAIN 2003). Not only are these regulations effectively an enclosure of farmers' practices as well as their genetic resources, but as incentives for private investment they become a platform and justification for the debilitation of public breeding programmes.

Farmers are not the only ones to find choices about how to perform their work – or if they can even undertake it – constrained by the growth of IPRs. Public plant scientists especially find their 'freedom to operate' being circumscribed by proliferating 'patent thickets' (Graf et al. 2003). The ongoing emasculation of public research institutions (e.g. US land grant universities, government facilities, the CGIAR system) and the subordination of their work to corporate objectives has resulted in an overwhelming focus on the private-sector development of GM varieties (Gepts 2004). The failure of public science to provide an alternative to corporate seeds has permitted the global dissemination of crop varieties that do not meet the needs of resource-poor and organic farmers, that often cannot be legally saved, that reinforce the expansion of unsustainable monocultures and that too often contaminate other varieties with proprietary transgenes (Quist and Chapela 2001; Rosset 2006).

Ironically, the very development of agronomically useful and novel (and therefore patentable) plant varieties has been and continues to be predicated on access by breeders to the enormous pool of biodiversity that has been produced and reproduced over the millennia by peasant farmers and indigenous peoples. Systematic appropriation of landraces from farming communities by university and government scientists, their storage in gene banks controlled by governments, corporations and non-governmental organizations and their subsequent use in breeding programmes is a practice of long standing. It continues today, as illustrated by the US Department of Agriculture's screening of 15,000 accessions of soybean germplasm for resistance to the Asian Rust that threatens US soybean production (Grooms 2009). This ongoing privatization of biodiversity has increasingly been understood as a form of 'biopiracy' in so far as no or insufficient benefits flows reciprocally to the communities and peoples who freely shared the collected materials as the 'common heritage of mankind' (Mgbeoji 2006).

Marx (1977, 875) defined primitive accumulation as 'nothing less than the historical process of divorcing the producer from the means of production'. The historical use of agricultural research and legislative initiative to separate farmers from the reproduction of a pivotal element of their means of production, and to arrange for it to confront them as a commodity, is a form of primitive accumulation (Kloppenburg 1988). Further, the collection of genetic resources from farmers worldwide under the legitimating trope that their seed is 'common heritage' is a manifestation of primitive accumulation in its simplest, most directly predatory form (Kloppenburg and Kleinman 1987). Since these processes not only persist but are being actually being expanded today, they represent instances of what Harvey names 'accumulation by dispossession'.

OPPOSING DISPOSSESSION: ACCOMMODATION OR RESISTANCE?

The processes of accumulation by dispossession described above have not been unopposed. Much of the resistance that has been pursued on genetic resources over the last 25 years has been undertaken under the rubric of the construct called 'farmers' rights'. Written into the 1989 'agreed interpretation' of the FAO's (Food and Agriculture Organization) International Undertaking on Plant Genetic Resources, farmers' rights were to have balanced breeders' rights by conferring on farmers a moral and a material recognition of the utility and value of the labour they have expended, and continue to expend, in the development and regeneration of crop genetic diversity. However appealing in conception, farmers' rights as they have actually been implemented in international fora have been little more than a rhetorical sleight of hand, a means of diverting activist energies into prolonged negotiations with corporate lobbyists and state bureaucrats. The final result of 12 years of talks was, in 2001, approval of an International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) that neither effectively impedes genetic dispossession nor provides any material recompense for what is being taken (Kloppenburg 2004, 342–4).

A second line of action has involved efforts to exploit an opening in the WTO's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). Article 27.3(b) of TRIPS requires WTO member nations to offer some form of intellectual property rights in plants through patenting, plant breeders' rights (PBR) arrangements, or an 'effective *sui generis* system'. In theory, this option provides nation-states with an opportunity to shape legislation to protect the interests and needs of farmers and indigenous peoples, and to craft IPR arrangements that respect and reward collective invention. In practice, many nations – often under pressure from the USA and other advanced capitalist nations – simply adopt a PBR framework rather than develop an alternative approach (De Schutter 2009, 6).

With international and national-level institutions insufficiently attentive to their needs and rights, communities of farmers and indigenous peoples have in some cases turned to a third mechanism – direct bilateral arrangements – in an effort to establish rights over crop biodiversity, manage bioprospecting and derive a flow of benefit from genetic materials. These have ranged from detailed and highly legalistic models typical of Western patent law to frameworks that are more like a treaty than a contract. The evidence produced by a number of assessments of these arrangements shows that not only have they failed to deliver any significant benefits; they have also frequently caused considerable social disruption, and have too often actually been actively damaging to the contracting communities (Hayden 2003; Greene 2004).

It should not be surprising that these modalities have been so ineffective. The existing IPR regime is a juridical construct shaped to serve corporate interests. When confronted with initiatives that would recognize collective invention or recognize community-based invention, companies and their state allies obstruct such efforts or, when forced to accept them, press for their dilution and their incorporation into the dominant system in a way that is minimally disruptive. Moreover, the collective character of the production of crop genetic resources and their wide distribution and exchange almost always makes appropriate allocation of 'invention' to a person, to persons, to a community, to communities, or even to a people or peoples an impracticable – and often divisive – task (Kloppenburg and Balick 1995). Even if some legitimate partner can be identified, it is difficult to see how farming and/or indigenous communities or organizations can provide informed consent to bioprospecting activities and construct exchange agreements adequately sensitive to their own interests. Further, the indeterminacy of the value of any material at the point of collection, the difficulty of distinguishing the magnitude of value added in subsequent breeding and marketing, and the imbalance of power between donor and collector render the flow of any material benefit via such instruments as access fees, licensing fees and royalties uncertain at best.

Beyond these practical difficulties, there is a larger issue. The nature of property is called into question when the individuals or communities identified as prospective 'owners' reject the very notion of owning seeds or plants that they may regard as sacred or as a collective heritage (Hurtado 1999; Salazar et al. 2007). IPRs are actually a means of circumventing and obscuring the reality of social production and subsuming the products of social production under private ownership for the purposes of excluding others from use. How can they be anything but antagonistic towards social arrangements that encompass more co-operative, collective, commons-based forms of knowledge production?

If another world is going to be possible, might its development not be facilitated more by the expansion of opportunities for humans to enact the principle of sharing than on the extension of the reach of the principle of privatization? The really radical route to establishing a just and agronomically productive regime for managing flows of crop germplasm is not to arrange payment for access to genetic resources, but to create a mechanism for germplasm exchange that allows sharing among those who will reciprocally share, but excludes those who will not. What is needed is not recreation of the inadequate open-access commons, but creation of a 'protected commons'.

OPEN SOURCE: FROM LINUX TO BIOLINUX

In his book, *Free Culture: The Nature and Future of Creativity*, Lawrence Lessig (2004) describes the history of copyright law. He follows its transformation from a means for providing highly limited protection to individual authors to a corporate tool for severely restricting the uses to which copies can be put. Lessig is particularly concerned about the way in which extensions of the reach and term limits of copyright law impair the expression of the very creativity that intellectual property arrangements are allegedly intended to induce. At a time when the rapid development of digital and information technologies opens the possibility of expanding and democratizing the range of creators and creations, corporations are working hard to prevent others from building on and transforming the works whose copyrights they hold. Lessig (2004, 255) suggests that what industry really wants is

> . . . that the public domain will never compete, that there will be no use of content that is not commercially controlled, and that there will be no use of content that doesn't require *their* permission first . . . Their aim is not simply to protect what is theirs. *Their aim is to assure that all there is is what is theirs.*

Accordingly, Lessig (2004, xiv) calls for resistance to this developing 'permission culture' and a vigorous defence of the tradition of 'free culture' in which 'follow-on creators and innovators remain *as free as possible*' to share and build on and transform the music, ideas, writing, images, software – and, I suggest here, the seeds and genetic resources – of other creators and innovators.

Nowhere in recent years has the issue of expropriation of the public domain been played out more clearly than in the field of software development. Advances in hard and soft digital technologies have galvanized the rapid emergence of productive sectors of enormous power and value. Although creative capacity in software development is globally distributed among individuals, universities and variously sized firms, a few companies have attained a dominant market position from which they have used copyright and patent arrangements to reinforce their own hegemony by restricting the use of their proprietary software, especially of operating system code. Frustrated by these expanding constraints on their ability to add to and to modify and to share as freely as seemed personally and socially desirable, software developers have sought ways to create space in which they can develop content and code that can be liberally exchanged and built upon by others.

The resultant emergence of a dynamic 'free and open-source software' (FOSS) movement has been widely documented and analyzed (Raymond 1999; Stallman 2002; Boyle 2008). The FOSS movement is quite diverse, encompassing a considerable range of organizations and methods (e.g. Creative Commons, FOSSBazaar, Free Software Foundation, Open Source Initiative). What unifies these initiatives is a commitment to allowing software users to access and modify code and, critically, to implementation of an enforceable legal framework that preserves access to the original source code and to any subsequent modifications and derivatives.

Software released under open-source arrangements is copyrighted and made freely available through a licence that permits modification and distribution as long as the modified software is distributed under the same licence through which the source code was originally obtained. That is, source code and any modifications must be freely accessible to others (hence 'open source') as long as they in turn agree to the provisions of the open-source licence. Note that the 'viral' effect of such 'copyleft' arrangements enforces continued sharing as the program is disseminated. Just as importantly, this form of licensing also prevents appropriation by companies that would make modifications for proprietary purposes since any software building on the licensed code is required to be openly accessible. Thus, software developed under open-source arrangements is released not into an open-access commons, but into a 'protected commons' populated by those who agree to share (Cassier 2006, 267).

The FOSS movement has enjoyed considerable success. Thousands of open-source programs are now available, the best known among them being the operating system Linux. The originator of this program is Linus Torvalds, whose express objective was to develop a functional computer operating system as an alternative to those offered by Microsoft and Apple. Realizing that he could not undertake so large a task on his own, he released the 'kernel' code of the program under an open-source licence and asked the global community of programmers to contribute their time and expertise to its elaboration, improvement and modification. He subsequently involved thousands of colleagues in an ongoing, interactive process that has made Linux and its many iterations and 'flavours' an operating system that competes with Microsoft and Apple.

The practical utility of this collective enterprise is captured in what is known as Linus' Law: 'Given enough eyeballs, all bugs are shallow' (Raymond 1999, 30). That is, the mobilization of large numbers of people working freely together in 'decentralized/distributed peer review' generates what Eric Raymond (1999, 31) calls a 'bazaar' – as opposed to a 'cathedral-builder' – approach to innovation. Users are transformed from customers into co-developers and the capacity for creative, rapid, site-specific problem-solving is greatly multiplied. The social utility of such a collective enterprise is that, as a result of the open-source licensing arrangements under which work proceeds, the results of social labour remain largely socialized and cannot be monopolized.

That they cannot be monopolized does not mean that they cannot be commercialized. Many of the programmers working on open-source projects are motivated by peer recognition and the opportunity to contribute to the community (Raymond 1999, 53; Boyle 2008, 185). But labour can (and should) also be materially rewarded. As the Free Software Foundation has famously observed, 'Free software is a matter of liberty not price. To understand the concept, you should think of free as in free speech, not as in free beer' (Free Software Foundation 2008). Open-source software need not be made available at no cost, but it must be available free of restrictions on further expression via derivative works.

A number of analysts have begun to look to the FOSS movement as a model for development of biological open-source practices – 'BioLinuxes' (Srinivas 2002) – that might be the basis for resisting enclosure of the gene-scape and for reasserting modalities for freer exchange of biological materials and information (Deibel 2006; Hope 2008). Efforts have been made to apply open-source and 'copyleft' principles to a variety of bioscience enterprises (Cassier 2006) including mapping of the haplotypes of the human genome (International HapMap Project), drug development for neglected diseases in the global South (the Tropical Diseases Initiative), the standardization of the components of synthetic biology (BioBricks Foundation) and a database for grass genomics (Gramene).

By far the most substantial of such initiatives has been that undertaken by Richard Jefferson and his colleagues at the non-profit CAMBIA. Convinced of the utility of advanced genetics for improving agriculture in marginal and inadequately served communities, he had been frustrated by the narrow uses to which corporations have put genetic engineering and deeply critical of the constraints they place on the sharing of patented technology (Jefferson 2006). Jefferson has formally institutionalized the principles of BIOS (capital 'I') in the charter and operations of a programme known as BiOS (lower case 'I'), an 'innovation ecosystem' designed to 'democratise problem solving to enable diverse solutions through decentralised innovation' by ensuring 'both freedom to operate and freedom to cooperate' in a protected commons (CAMBIA 2009). BiOS involves integrating cutting edge biological research with open-source licensing arrangements that 'support both freedom to operate, and freedom to cooperate' in a 'protected commons' (CAMBIA 2009). The 'copyleft' provisions of the BiOS licence have proven effective in deflecting companies seeking to access CAMBIA's portfolio of vectors and biotechnologies for the purpose of developing derivative products that would not be shared except on their terms. A protected commons can be – indeed, has been – created.

The seed sector appears to offer some interesting potentials for elaboration of a 'BioLinux' approach to open-source innovation (Douthwaite 2002; Srinivas 2002; Aoki 2008). Millions of farmers the world over, mostly but not exclusively in the global South, are engaged in the recombination of plant genetic material and are constantly selecting for improvements. Even more massively than their software programmer counterparts, they are effectively participating in the process of distributed peer production that Eric Raymond has characterized as the 'bazaar'. Like programmers, farmers have found their traditions of creativity and free exchange being challenged by the IPRs of the hegemonic 'permission culture' and have begun looking for ways not just to protect themselves from enclosure and dispossession, but also to reassert their own norms of reciprocity and distributed innovation.

Moreover, farmers have potential allies in this endeavour who themselves are capable of bringing useful knowledge and significant material resources to bear. Although its capacity is being rapidly eroded, public plant science yet offers an institutional platform for developing the technical kernels needed to galvanize recruitment to the protected commons. And in the practice of 'participatory plant breeding' there is an extant organizational vehicle for articulating the complementary capacities of farmers and scientists in the North (Murphy et al. 2004) as well as the South (Salazar et al. 2007). Could 'copyleft' arrangements establish a space within which these elements might coalesce and unfold into a movement for the recovery of something resembling seed sovereignty?

The recent appreciation of the potential utility of open-source methods for the seed sector was preceded by a similar apprehension on the part of a member of the plant breeding community itself. At the 1999 Bean Improvement Conference, University of Guelph bean breeder Tom Michaels presented a paper titled 'General Public License for Plant Germplasm' (Michaels 1999). In it, he noted that as a result of

> . . . the opportunity to obtain more exclusive novel gene sequence and germplasm ownership and protection, the mindset of the public sector plant breeding community has become increasingly proprietary. This proprietary atmosphere is hostile to cooperation and free exchange of germplasm, and may hinder public sector crop improvement efforts in future by limiting information and germplasm flow. A new type of germplasm exchange mechanism is needed to promote the continued free exchange of ideas and germplasm. Such a mechanism would allow the public sector to continue its work to enhance the base genotype of economically important plant species without fear that these improvements, done in the spirit of the public good, will be appropriated as part of another's proprietary germplasm and excluded from unrestricted use in other breeding programs. (Michaels 1999, 1)

The specific mechanism that Michaels goes on to propose is a 'General Public License for Plant Germplasm (GPLPG)' that is explicitly modelled on a type of licence common to open-source arrangements in software. This mechanism is simple, elegant and effective. It can be used by many different actors (individual farmers, communities, indigenous peoples, plant scientists, universities, non-governmental organizations, government agencies and private companies) in many places and diverse circumstances. Properly deployed, it could be an effective mechanism for creating a 'protected commons' for those who are willing to freely share continuous access to a pool of plant germplasm for the purposes of 'bazaar'-style, distributed peer production.

IMPEDING DISPOSSESSION, ENABLING REPOSSESSION?

Implementation of open-source mechanisms such as the GPLPG could have significant effects consistent with strategies of both impeding dispossession and enabling repossession. In terms of resistance, the GPLPG would:

- *Impede the patenting of plant genetic material.* A GPLPG would not directly prohibit patenting (or any other form of IPR protection) of plant genetic material, but would render such protection pointless. The GPLPG mandates sharing and free use of the subsequent generations and derivatives of the designated germplasm. In effect, this prevents patenting, since there can be no income flow from the restricted access to subsequent generations and derivative lines that it is the function of a patent to generate. Further, the viral nature of the GPLPG means that as germplasm is made available under its provisions and used in recombination, there is a steadily enlarging the pool of material that is effectively insulated from patenting.
- *Impede bioprospecting/biopiracy.* The GPLPG could be similarly effective in deterring biopiracy. Faced with a request to collect germplasm, any individual, community or people could simply require use of a materials transfer agreement (MTA) incorporating the GPLPG provisions. Few commercially oriented bioprospectors will be willing to collect under those open-source conditions.
- *Impede the use of farmer-derived genetic resources in proprietary breeding programmes.* Because neither the germplasm received under a GPLPG nor any lines subsequently derived from it can be use-restricted, such materials are of little utility to breeding programmes oriented to developing proprietary cultivars. Any mixing of GPLPG germplasm with these IPR-protected lines potentially compromises their proprietary integrity.

In addition to its capacity for reinforcing *resistance*, the GPLPG may have even more potential for repossession, for the creation of effective space for the elaboration of transformative alternatives. Implementation of the GPLPG would help to:

- *Develop a legal/institutional framework that recognizes farmers' collective sovereignty over seeds.* The GPLPG relies on the simple vehicle of the materials transfer agreement that is already established and enforceable in conventional practice and existing law. It uses the extant property rights regime to establish rights over germplasm, but then uses those rights to assign sovereignty over seed to an open-ended collectivity whose membership is defined by the commitment to share the germplasm they now have and the germplasm they will develop. Those who do not agree to share are self-selected for exclusion from that protected commons.
- *Develop a legal/institutional framework that allows farmers to freely exchange, save, improve and sell seeds.* For farmers, the feature of the space created by implementation of the GPLPG that is of principal importance is the freedom to plant, save, replant, adapt, improve, exchange, distribute and sell seeds. The flip side of these freedoms is responsibility (and under the GPLPG, the obligation) to grant others within the collectivity the same freedoms; no one is entitled to impose purposes on others or to restrict the range of uses to which seed might

be put. In the face of increasing restrictions on their degrees of freedom to access and use seed, application of the GPLPG offers a means for farmers to create a semi-autonomous, legally secured, 'protected commons' in which they can once again work collectively to express the inventiveness that has historically so enriched the agronomic gene pool.

- *Develop an institutional framework in which farmers co-operate with plant scientists in the development of new plant varieties that contribute to a sustainable food system.* The 'protected commons' that could be engendered by the GPLPG can, and must, also encompass scientific plant breeders whose skills are different from but complementary to those of farmers. Many new cultivars will be needed to meet the challenges of sustainably and justly feeding an expanding global population in a time of energy competition and environmental instability. The open-source arrangements that have undergirded the successes of distributed peer production in software could have a similar effect in plant improvement. If in software it is true that 'to enough eyes, all bugs are shallow', it may follow that 'to enough eyes, all agronomic traits are shallow'. Participatory plant breeding offers a modality through which the labour power of millions of farmers can be synergistically combined with the skills of a much smaller set of plant breeders. The GPLPG offers plant scientists in public institutions a means of recovering the freedoms that they – no less than farmers – have lost to corporate penetration of their workplaces. Public universities, government agencies, and the CGIAR system should be the institutional platform for knowledge generation based on the principle of sharing rather than exclusion. Public plant breeders, too, can be beneficiaries of and advocates for the protected commons.
- *Develop a framework for marketing of seed that is not patented or use-restricted.* The GPLPG is antagonistic not to the market, but to the use of IPRs to extract excess profits and to constrain creativity through restrictions on derivative uses. Under the GPLPG, seed may be reproduced for sale and sold on commercial markets. By carving out a space from which companies focusing on proprietary lines are effectively excluded, the GPLPG creates a market niche that can be filled by a decentralized network of small scale, farmer-owned and co-operative seed companies that do not require large margins and that serve the interests of seed users rather than investors.

Seed sovereignty cannot be achieved by farmers alone. It must be manifested as a system encompassing producers, plant scientists, public scientific institutions and seed marketers. GPLPG/BioLinux/open-source/'copyleft' arrangements could plausibly constitute a legal/regulatory framework that could open an enabling space within which these different social actors could be effectively affiliated.

ENACTING REPOSSESSION: DIFFERENTIAL POSTIONINGS

But can these different social actors be effectively affiliated? Will a Zimbabwean subsistence farmer and a Canadian wheat farmer see 'seed sovereignty' in similar enough terms to feel part of a common endeavour? Will the Dutch participatory plant breeder feel that there is common ground with the bean breeder at CIAT or the soybean gene jockey at the University of Minnesota? Especially, with scientists and farmers and indigenous communities and states commonly taking defensive stances in regard to what they increasingly see as 'their' genetic resources and looking for ways to exclude others from access to those materials, what will be attitudes to an open-source initiative that asks them to *share* more *widely*?

I suggest that what is so powerful and potentially transformative about open-source principles is precisely the manner in which they encourage us to look beyond the constraints of the taken-for-granted, dominant system and ask us to embrace the potentialities of freely given and shared social labour. One of the hallmarks of opposition to the current economic and social formation is the emergence of a sense of the plausibility of coalescing local struggles into a global mass movement (Kingsnorth 2004; Bello 2007). Hardt and Negri (2004, xiii, xv) call this coalescence the 'multitude, the living alternative that grows within Empire' and suggest that the challenge facing the multitude is not to homogenize, but to discover '*the common* that allows them to communicate and act together'. Hardt and Negri (2004, xv) further claim that 'the common we share, in fact, is not so much discovered as it is produced'. Application of open-source principles to plant genetic resources offers a concrete and critically important context in which to materially enact that production.

Use of the GPLPG by farmers, indigenous communities and progressive plant scientists could initiate the establishment and elaboration of an alternative network of varietal development and seed production and exchange. Given the power of agribusiness, the co-opted and compromised character of public agricultural science and the constraints of many national agricultural policies, that is now no easy task. If a protected commons based on open-source principles can be birthed, its midwives must be the constellation of diverse social movements now working around the globe for a more just and sustainable agriculture. What are the prospects for implementing a GPLPG/BioLinux programme in different geopolitical circumstances?

BioLinux and the South

It is in the geopolitical South that farmers would be most receptive to a BioLinux approach and that open-source arrangements could be most rapidly implemented and disseminated. Farmers from Mali to India to Indonesia to Colombia are keenly aware of the way in which the transformation of plant breeding and the seed/life industries sector has damaged their interests and is threatening their livelihoods. Many have organized themselves to resist corporate efforts to spread GM varieties and IPRs, to pursue seed-saving, to work for farmers' rights, to create community gene banks and to continue the traditions of landrace exchange and development (Argumedo and Pimbert 2006; Salazar et al. 2007).

Proliferating linkages between these organizations, facilitated by NGO allies and digital communications, provide a network through which understanding and implementation of a global BioLinux/GPLPG initiative can be widely and effectively promulgated (Desmarais 2007). If large numbers of farmers chose to refuse to supply seeds to any representative of any organization except with an accompanying GPLPG-MTA, a protected commons could be rapidly and virally enlarged. Many, and probably most, farmers in the global South freely exchange seeds now and will probably be glad to continue that practice with any individual or any organization that is willing to reciprocate. Protection from appropriation for varieties produced by farmer-breeders would be effectively established, agricultural biopiracy would be eliminated and a barrier to the rampant spread of corporate cultivars would be erected.

Such defensive measures could be complemented by proactive cultivation of an institutional and technical platform for development of open-source crop varieties. There already exist a variety of quite robust participatory breeding programmes that have produced productive collaborations between farmers and plant scientists (Almekinders and Hardon 2006; Salazar et al. 2007). The fertility and dynamism of bazaar-style distributed peer production in participatory breeding programmes will in significant measure be a function of the number of farmer 'eyes' available. It will also be critical, however, to enlarge the number of plant scientists bringing complementary, formal knowledge to bear on agro-ecological problems. Recruitment of plant scientists to work in the protected commons will be facilitated by the opportunity to use the full range of tools available in contemporary genetics.

In this regard, it may be useful for farmers' organizations and the NGOs and advocacy groups supporting them to rethink rejectionist positions towards the techniques and products of biotechnology and to consider their potential for contributing to a just and sustainable agricultural development (Jefferson 2006; Ruivenkamp 2008). A failure to distinguish between biotechnology and *corporate* biotechnology has too often led to impoverishment of debate and a discursive climate in which the dystopian construct of 'Frankenfood' confronts the utopian construct of 'Golden Rice'. What will attract farmer innovators and scientific innovators alike to the bazaar/protected commons will be access to materials that are exciting and useful, and they could even be transgenic constructs as well as landraces.

Intensive efforts would also need to be made to develop an institutional platform for promulgation of GPLPG/BioLinux approaches. At the national level, this will mean confronting state assertion of 'national sovereignty' over genetic resources and the role of national agricultural research services. At the international level, this will mean pushing the CGIAR centres and the Mulitlateral System of the ITPGFRA in open-source directions. This will be difficult, but not necessarily unworkable. The CGIAR system in particular yet retains a commitment to public purpose and its broad germplasm holdings and experience with participatory breeding would be invaluable resources for building the protected commons. Moreover, the MTA now officially adopted by the CGIAR centres contains an open-source element which, even in diluted form, has already led private firms to balk at its use (Saenz 2008). Given its declining status in the global constellation of agricultural research enterprises, the CGIAR system might be made amenable to some significant restructuring if appropriate pressures could be brought to bear by social movements.

BioLinux and Indigenous Peoples

If many farmers in the global South would probably be receptive to an open-source approach to crop genetic resources, indigenous peoples in both the South and the North can be expected to take a considerably more cautious attitude. Although the designation of social groupings as 'indigenous' is analytically and operationally contested, some crop genetic resources are in fact closely and even exclusively associated with a particular native people (LaDuke 2007). Indigenous peoples have deep historical experience with many types of colonialism and multiple forms of appropriation. They are rightfully suspicious of proposals made by those outsiders who purport to make proposals on their behalf or in what are alleged to be their best interests. Should they be anything but extremely sceptical of a BioLinux imaginary that would ask them to share more widely, when what sharing they have previously undertaken – voluntary or imposed – has almost always resulted in asymmetric extraction? As Lorenzo Muelas Hurtado (1999, 15) of the Movimiento Autoridades Indígenas de Colombia puts it, sharing for indigenous peoples has meant that 'what is theirs is theirs, but what is ours is everybody's'.

And, in truth, implementation of open-source principles among indigenous peoples does indeed ask that what is 'theirs' should become the 'ours' of a larger social enterprise. The critical distinction is that it is not the 'ours' of Hurtado's 'everybody' (i.e. an open-access commons') but the 'ours' of a 'protected commons' populated by those who agree to reciprocally share both the resources for and the fruit of their collective labour. For indigenous peoples this should at least be conceivable, since in some ways it is but the projection of some of their own internal practices and commitments to a larger social context.

But that projection is fraught with hazards. There may be materials so imbued with spiritual or cultural meaning that, even if they can be shared, it may be unacceptable to relinquish control over subsequent uses to distributed peer production. However, these may not be insurmountable barriers to participation in a BioLinux. Just as 'copyleft' software licences have been developed that do not permit completely unrestricted derivative use, it may be possible to write GPLPG licences that specify 'some rights reserved' to encompass the concerns or needs of indigenous peoples.

BioLinux and the North

In 1999, the horticultural scientist Tom Michaels proposed the use of the GPLPG both to his fellow bean breeders and to a Canadian expert committee on cereal breeding. He reports to me that 'no-one voiced opposition or even criticism, but neither did they get excited enough to volunteer to help with the cause' (Michaels, 2007, personal communication). This response isn't really surprising. Public breeders have long been aware of the way in which their freedom to operate has been progressively circumscribed (see especially Coffman 1998; Sears 1998) but have never generated much resistance to long-term corporatization trends that they have apparently regarded as inevitable or irresistible. Most North American farmers, for their part, have been preoccupied with just staying in business and have not yet mounted broad opposition to growing restrictions on their ability to save or sell seeds. This could now be changing. Farmers in Canada and the USA find themselves the objects of a blitzkrieg of lawsuits from Monsanto, which is determined to make sure that seed serfdom, not seed sovereignty, is their unquestioned future (Center for Food Safety 2004). The introduction of crop varieties with 'stacked' GMO traits, the continuing acquisition of independent seed companies by the Gene Giants and the withering of public varietal release mean that soon it may be that, as Lawrence Lessig fears for society as a whole, 'all there is is what is theirs'.

Farmers in the North are increasingly restive under seed price hikes and the decreasing availability of anything but GM varieties. Both the Saskatchewan Canola Development Commission and the Canadian Seed Growers Association have plans to develop farmer-owned seed companies. The Canadian Wheat Board has floated a plan for farmers to fund the breeding of varieties to which they would retain ownership. In Europe, José Bové (2005) has called for the complementary addition of a free seed exchange movement ('semeurs volontaires') to the work of the anti-GM reapers ('fauchers d'OGM'), and a 'Liberate Diversity' network is opposing restrictive seed directives promulgated by the European Commission. Critical to the success of such efforts to build an alternative to corporate seed will be the revitalization of public breeding. In contrast to farmers in the South, few producers in the North systematically select or breed cultivars. However, there is in both North America and Europe a vibrant community of public plant scientists who are committed to various forms of participatory breeding (Almekinders and Jongerden 2002; Murphy et al. 2004). Such scientists generally demonstrate a commitment to organic/agro-ecological approaches to plant improvement and are also often actively resistant to extensions of corporate power (see especially Jones 2004).

Would a BioLinux approach be attractive to farmers and public plant scientists in the North? On the one hand, these Northern actors have a considerable volume of political and institutional capital to deploy in working towards seed sovereignty. The consequences of continued inaction cannot be much clearer than they are now, and a BioLinux approach at least offers a refreshingly aggressive orientation. On the other hand, both farmers and public scientists are deeply embedded in existing norms and practices, and this profound path dependency makes radical change appear implausible. Still, trapped as they are in a narrowing seed market, farmers would probably warm to a protected commons of public varieties if it offered them the cultivars they need and want.

In its debilitated condition, however, public plant breeding is not now producing those cultivars (Wright 1998; Kloppenburg 2004). Application of the GPLPG is no simple, and certainly not a quick, solution. Few public plant scientists will see it as a practical possibility. The protected commons might seem attractive in some abstract future, but there is a severe threshold constraint to be overcome. A functional protected commons capable of innovative and fecund production requires a significant population of participants and a stock of quality material on which to work. What scientists will be willing to move their personal and genetic resources into that space, especially since the 'protection' gained by the GPLPG also means isolation from the huge stocks of proprietary materials and methods with which they necessarily now work?

A tactic that might at least partially resolve these threshold and institutional constraints would be to focus efforts on a subsector of plant improvement. An obvious candidate for this approach is the development of cultivars for organic production systems. The organic sector is appealing for several reasons. Because of its small size relative to the overall seed market, organics has not yet attracted substantial interest or investment from the dominant firms of the private sector. This means that the breeders and small companies and independent research institutions working in the area now have a comparative advantage in germplasm improvement and varietal development over conventional industry. It also means that they have been able to maintain a relatively autonomous scientific, commercial and genetic space that is not immediately subject to appropriation or control by dominant firms. Further, the values that motivate and guide participants in the organic sector – farmers, independent breeders, public breeders, seed companies, farmer co-operatives – are not solely reducible to the financial bottom line and incorporate clear commitments to the public interest, to public service and to both social and environmental sustainability. A corollary to such attitudes is often active resistance to extensions of corporate power (Jones 2004).

The proscription of genetic engineering by organic regulations might be an obstacle to some plant scientists' willingness to participate in development of a protected commons in this area. But transgenics is no longer the only advanced technique relevant to classical breeding, and technologies such as marker-assisted selection offer additional, permitted paths to organic variety development. With a full complement of farmers, farmer-breeders, plant scientists, private research institutions, public research institutions, small independent and co-operative seed companies and information networks, the organic sector offers a complete and established ideological, intellectual, institutional, production and commercial framework within which an effective open-source initiative could be plausibly constructed.

CONCLUSION

Enclosure of the agricultural commons was the original and archetypal form of primitive accumulation. Contemporary processes of accumulation by dispossession continue not only with regard to land itself, but are now applied to the gene-scapes and mind-scapes within which farmers – and many plant scientists – have been accustomed to freely exchange both genetic resources and ideas. The principal vehicles through which this appropriation is taking place are the development and deployment of new agricultural technologies and the global extension of laws and regulations governing IPRs, which serve the interests and intentions of agriscientific capital.

Certainly the sorts of dispossession I have described here constitute substantial challenges to the independence and well-being of farmers worldwide. They represent an especially sharp threat to many resource-poor farmers in the global South, who depend on their ability to save and replant seed as a condition of their very survival. For commercial farmers in the North and South, dispossession involves being bound every more closely and subserviently to capital and seeing what degrees of freedom they yet retain being further eroded as what Marx (1977, 899) called the 'silent compulsion of economic relations' pushes them inexorably into the position of the propertied labourer. And inasmuch as all of us on this planet eat and benefit from the myriad ecosystem services provided by the biosphere, most of the world's population is rendered the poorer as enclosures of genes and ideas foreclose the options available to us by empowering a narrow set of decision-makers sitting in the boardrooms of the corporate 'Gene Giants'.

What is at stake in the genetic and epistemic dispossession now under way is nothing less than control over one of humanity's most fundamental means of production in a time of profound uncertainty and challenge. Food must be provided for a global population that is going to increase to 9–10 billion by 2050. How can this be accomplished in a period when, as a result of climate change, the biosphere is radically altering in ways that we understand only poorly? Who will make the critical decisions about what crop varieties are developed to respond to the rapidly evolving circumstances that confront us? Will it be the executives of Monsanto, DuPont and Syngenta, making determinations based on market signals and profitability and directing their breeders and genetic engineers to give those of us who can pay cheap feed for our cattle and biofuels for our cars? Or could it be a much broader set of decision-makers responsive to a wide set of goals and constituencies, who factor social justice and sustainability into the way they recombine plant genes? Enclosures of genetic resources and creative capacity narrow the range of technical and social options available to humanity at a time when creativity and ingenuity are most sorely needed.

The aggressions of the neoliberal project must, of course, be impeded whenever possible. However, resistance must be complemented by creative actions that are not just reactions to corporate/neoliberal depredations, but which are offensive, affirmative, positive, proactive undertakings designed to repossess and maintain alternative, (relatively) autonomous spaces. Biologial open source appears to offer some interesting possibilities. We cannot now say whether or not open-source movements might be capable of catalyzing and/or contributing to significant changes in capitalist property relations. The point is that space for change could be created by using existing property relations themselves. In a kind of institutional Aikido, open-source mechanisms could use the structure and the momentum of intellectual property and contract law itself to move that system in directions that its corporate architects did not intend and that undermine their hegemony.

The proximate manifestation of repossession of the gene-scape and mind-scape might be something called 'seed sovereignty'. This would be comprised of a set of linked features that together constitute a coherent and robust structure. The central and organizing feature of this structure would be a commitment to institutionalized recognition of genetic resources and associated cultural/indigenous/community knowledge as a broadly social product, a collective heritage of farming communities that is to be freely exchanged and disseminated for the benefit of all. Seed sovereignty therefore entails creation of a legally defined space in which sharing is unimpeded but is protected from appropriation by monopolists. In this kind of repossessed, protected commons, farmers could continue to apply their ingenuity in the service of an agriculture that sustains not only their communities but the environment. In this, farmers would not be expected to work alone. Public scientific institutions would co-operate in the enterprise of plant breeding and improvement, albeit in a more equitable manner that embraces participatory engagement with farmers themselves and is directed to the production of diverse range of socially and environmentally sustainable plant varieties.

Achieving repossession, manifested as seed sovereignty, will not be easy. What is required is simultaneous and linked development of concepts and applications among farmers, plant scientists, seed vendors, public institutions and civil society advocacy groups in the face of corporate and state opposition. Biological open source is no panacea. It is a tool, one means of beginning a process. But it is a plausible and fecund modality for impeding further dispossession and for the pursuit of concrete initiatives for the actual repossession of a relatively autonomous space within which practices and ideas with transformative potential can be enacted. Should we not, therefore, take the advice offered by farmer, activist and McDonald's trasher José Bové (2005)? He has suggested that 'We should sit down with the legal people who drew up the Creative Commons licenses and see whether farmers could use a similar approach with seeds.' Yes, let's talk.

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