Vital Seeds: An Assemblage Approach to Seed Production and Ownership

Human participants in agri-food systems select, save, plant, grow, and reproduce seeds in a variety of environs (Phillips 2008, Helicke 2015, Kloppenberg 1988). Through human and non-human inputs, an ecologically-embedded agriculture is (re)produced (Muller 2015, Bennet 2010). This is necessarily a collaborative social effort, relationships between organisms and matter are continuously negotiated and produced, forming agri-food assemblages (Delanda 2016, Carolan 2008). Agri-food assemblages involving seed-sowing are (re)constructed as seed saving/producing networks and processes develop and change across time (Phillips 2008). Because the (re)production of the seed is a vital part of these agri-food assemblages, then changes in social-seed-technology are both imparted by and unto the seed as actant, collaborator, producer, and product of the assemblage. Legal distinctions of ownership and invention (Aoki 2009, Carolan 2010, Deibel 2013, Schneider 2016) describe patentable materials as socially and semiotically stable materials. Seeds are not described as vibrant and mutable but as fixed objects, holders of plant-genetic resources (PGRS). This paper is a think piece which attempts to examine the complexities of holistic research in a brief space. I outline a theoretical positioning for environmental study based in assemblage thinking, a sometimes contentious (Hornborg 2017), but useful approach. I then demonstrate the kind of inquiry by utilizing this assemblage approach in order to explore and critique discursive-legal issues in US patent and PVPA certification legislation. The end-goal of the project is to begin exploring *how* assemblage thinking within environmental justice scholarship could imagine a more just ecologic future.

This approach responds to the legal work of Susan Schneider (2016) and Keith Aoki (2009) and builds on the social work of Michael Carolan (2010) and Lewis et al (2016) as well as the theory of Bennet (2010) and Delanda (2016). Particularly, I respond to Eric Deibel (2013)

who compellingly links open licensing principles from the free software movement to a set of proposed farmer-rights to use, re-use, and alter seed stock which they own. Ultimately, Deibel, alongside Kloppenburg (1988), proposes a protected commons for genetic seed varieties. However, this protected commons does not respect two important facets of seed lineages. First, it does not recognize the seed's vibrancy in the assemblages with which it participates. Second, a protected commons also does not address a central problem of legal-protective status: the fixed, social designation of an unfixed item. I imagine not so much deregulation of agriculture as the freedom of bio-informatics. Here, plants and seeds, without patent protection, have the potential to participate not as fixed lines of genetic code, but as vibrant and vibratory collaborators with other human and non-human actants to (re)produce a just and sustainable future.

Within the last century, agri-food production has been radically re-shaped by new mechanical, agricultural, and genetic advances in social technologies (Kloppenburg 1988). During this time, the primacy of hybrid cropping techniques was introduced, followed quickly by new trans-genetic techniques in seed breeding and production. New legal apparatuses were introduced to govern changing and new material realities of production and development of the seed (Schneider 2016, Aoki 2009). In turn, farmers changed the way they purchased and grew these seed, and eaters had new ranges or limitations of affordable food available for consumption. While interrelated, each of these sectors represents a kind of assemblage which organizes relations between humans and non-humans, including seeds. If environmental justice is a real policy concern, then our imagination must include a material reality in which objects, such as seeds, are actually engaged in several discourses (assemblages) and any governance over seeds must respect all these discourses (assemblages).

In order to explore this further, I describe the assemblage approach which directs much of my current research, and can be mobilized to imagine solutions to problems of governance, particularly governance of biological marketplaces. This is followed by a short review of the material-industrial history of seed production and a description of the two landmark legal cases (Diamond V. Chakrabarty, J.E.M. Ag Supply Inc v Pioneer Hi-bred) in governing ownership and control of seeds and plant-genetic-resources. Finally, I draw theoretical conclusions about the seeds participation in marketplaces, corporations, and farms which courtrooms seek to govern, and imagine alternative more equitable formations of governance. Particularly, I imagine an unconventional solution, drawn from freedom-of-information software movements. Particularly, I imagine the nullification of patent and PVPA protections for human ownership over plant-genetic-resources. While this would not necessitate the *production* of just results, I argue it would allow for the *possibility* of more just solutions for farmers, gardeners, and other populations historically abused by agrochemical corporations via the US legal system.

Assemblage Thinking in Environmental Scholarship

Dwiartama's assemblage-thinking study of rice in Indonesia reveals that there are "multiple meanings attached to rice, acquired through the assemblages formed with other actors… lines, relationships and assembling 'make' the worlds of rice" (Dwiartama et al 2016:85). For their team, rice was a cultural artifact as well political and economic commodity. To study its variety is to study its relations between others. Similarly, seeds, as material objects, oscillate between corporate, laboratory, agricultural, and other traditional and emerging exchange networks. Therefore, a theoretical framework which is mobile and able to address a range of social relations between humans and non-humans in a variety of assemblages is necessary. My particular theoretical approach develops from new materialist scholarship (Bennet 2010, Muller 2015, De-

landa 2016, Latour 1999), considering social issues in terms of human/non-human assemblages. This approach is new in agri-food studies, but it's importance is currently emerging because of its ability to "destabilize the orthodox categories, techniques, and methodologies with which [social scientists] work" (Lewis et al ,2016).

When describing relations in assemblages, I utilize Manuel DeLanda's (2016) coherent revisions of Deleuze and Guattari's notion of the assemblage (and the assemblage of assemblages) which are mutable, various, and inter-related (Dewsberry 2011). Assemblages are fluid and processual: always in a state of becoming (DeLanda 2006). Assemblages are *relational*, *productive*, *heterogeneous*, *deterritorializing / reterritorializing*, and *desired* (Muller 2015:35). To put it another way, assemblages are networked formations of power, where the power, agency, and identity exist in the (re)productive flows (relations) between actants. It is not constant, but rather fluxing and becoming. As seeds are produced, exchanged, grown, and sold the energetic relations continuously remake the agri-ecological assemblage. New materialist research is, in some ways an ontology (Latour 1999) more than a theory: a way of thinking about being and about social relations. In this case, I begin any theoretical inquiry about more just futures for seeds by imagining the various changing ecologies, within and outside of the laboratory which evert, via corporate litigators and lobbyists, into the legal statutes established by legislation (PVPA) and as interpreted by judicial review of cases (Diamond v. Chakrabarty, J.E.M. Ag Supply Inc v Pioneer Hi-bred).

A second central notion for new materialist approaches, is a basic speculation that objects (non-humans) in the assemblage are *real*, even while absent from human cognizance (Delanda 2016, Dewsberry 2011). This means that while purpose, semiotics, and power may be established by relational flows, an object's material presence will resist or allow specific kinds of actions

around it. The object oriented, new materialist approach imagines a "radical asymmetry in the relationship between humans and nature, the active existence and incessant becoming of the latter (from bacteria to geological processes, to humans' own bodily existence) being depicted as independent of, indifferent to, or overarching human appraisal and action" (Pelizzoni 2014). This single speculation realizes objects and systems (assemblages) of objects as vital things with distributive agency (Bennet 2010). To put it simply, the seed, and the ecology surrounding it is as vital, if not more vital than the human inputs when converting a pre-existent ecology into an agricultural system. When imagining a more just future for governing ownership over seeds, we must imaginge a system which respects the seeds materiality *outside of* as well as *in relation to* human interactions.

While newer political economic theorists do address some of these complexities by describing commodification and exchange that is decentralized and networked in nature (Hardt and Negri, 2000). Liminal or complex technologies, such as biotechnology and seed production, resist stabilizing formations of labor-value (Marx & Engels, 1967) as congealed social realities. Additionally scientific-materialist and empirical-ontological approaches, while equally integral in the development of current discourse on bio-technologies, are unable to describe mobile changes between market-assemblages which bio-technologies are always moving between (the lab, the ag-market, the direct-to-gardener market, the seed-exchange, etc). Carolan, in his extensive environmental sociological scholarship, calls for ecologic research and theory which addresses complexity, interrelating epistemic and ontological boundaries of *knowledge*, *what is*, and *what should be* in environmental and agri-foods research (Carolan 2008). Pure political economy, or traditional materialist histories lay a groundwork for further research, and are able

to criticize or elucidate specific facets of seed (re)production in the agri-ecologic assemblage, but a synthetic approach is necessary for a holistic study.

My new-materialist, object oriented discourse draws particularly from a theory of thing-power described in Jane Bennet's *Vibrant Matter* (2010) which emphasizes the vibratory characteristics of what are normally categorized as a discreet objects. In this instance, my think-piece examines changing conceptualizations of seeds in relation to material alterations in seed-material. To rephrase: a changing conceptualization is a specific kind of flow which ought to be examined when imagining just governance pertaining to seed stock. I synthesize an aforementioned, broad group of object-oriented, new materialist theory (Delanda 2016, Bennet 2010, Pellizonni 2014, Linke 2016) to examine the seed as a vibrant participant in variable assemblages which relationally and materially alter the agency of seeds in agriculture. This lays the groundwork for an exploration which reimagines the status quo created by the legal and marketing texts produced by corporations, it reimagines the possibilities or limitations of seeds produced by corporate assemblages as they evert into marketplaces, gardens, and fields in the contemporary era if these standards for governance were fundamentally altered.

In Phillip's (2008) research with various seed exchanges and seed networks. Her work reveals that conflicting notions about a seed's identity, be it a lineage, the right of a specific group, or a specific genetic code, correlates to different treatments. These conceptions are studied qualitatively at the grass-roots, and reveal complexities within seed exchanging networks and the local politics participants are involved with. For Carolan (2010), the difference in treatment between a seed bank (at CSU) and a seed exchange (The Seed Savers Exchange in Decorah, Iowa) reflect a competing notion about what the seed being saved actually is. My work also borrows from Linke's bold assemblage approach to agri-ecological structures (2016) which orients a lux-

ury food market for a specific medicinal caterpillar fungus in Nepal according to object and non-human interactions between the ecology, the caterpillar, fungal development, and only secondarily the humans who have developed a monetized market-end for these complex relational processes. Similarly, my work presumes the centrality of a number of non-human actants in an agricultural setting, most notably the centrality of the seed as a very-vital actor in any agricultural process or exchange.

It should be noted here that essays in agri-food studies and related fields in Geography, Sociology, and Anthropology which mobilize assemblage thinking (imagined broadly to include some ANT scholarship) tend to do so in service to a specific empirical-material end (Linke 2016, Dwiartama et al 2016, Gray and Gibson 2015). This is a vital research, and mobilizing a theory towards specific ecologic instances is a vital method for demonstrating the efficacy of an approach. This think-piece does imagine material outputs of an assemblage thinking approach to social problems. However, the goal of this paper is to foreground the theoretical framework's efficacy, and to only address the material issue as a cursory output, one of many possible discursive spaces generated when one imagines environment as assemblage. In the following section I review some material and economic histories of seed industry in the US and global markets, followed by legal facets to these changes. I then will mobilize a directed theoretical response imagining one possible line of inquiry arising from assemblage thinking and clarify it's power to enable the imagining of positive, potential futures.

1970-2016: The New Seed Industry: One Seed Many Ways

The corporate growth and concentration of the seed industry and the agri-foods marketplace in the age of trans-genetics and most particularly, patentable trans-genetic germplasm and resultant plant material, is unprecedented. While this growth has its roots in hybrid breeding

techniques, and the first economically sterile crops (Kloppenburg 1988), the concentration begins in earnest in 1970, a year in which the PPA was re-codified as the certificate-PVPA (Schneider 2016). Consolidation magnifies in the nineties with the development of corporate synergy between trans-genetic seed R&D and agro-chemical holdings (Wield et al 2010). These trends encourage lateral production development coupled with increasingly concentrated corporate structures that ultimately form larger networks of linked chemical and genetic holdings resulting in an increasingly globalized seed and chemical field. The effects on agri-ecologic diversity caused by these changes are wide ranging. For this section, I will begin with what is most recent, an outline of the major corporate players and their immediate mergers and work backwards along a developmental narrative to the PVPA re-codification court case in 1970.

As of 2007, the top six (in order, by sales in US$m) agro-chemical corporations in the world are as follows:

> Bayer (7,458),
> Syngenta (7,285),
> BASF (4,297),
> Dow AgroSciences(3,779),
> Monsanto (3,599),
> Dupont (2,369)
> (Wield et al, 2010:345).

As of 2010, the top eight seed companies (also in order, by sales in US$m) are eerily similar

> Monsanto (7,297),
> DuPont (4,641),
> Syngenta (2,564),
> Groupe Limagrain (1,252),
> Land O' Lakes (1,100),
> KWS AG (997),
> Bayer(700),
> Dow AgroSciences (385)
> (ETC Group 2011:21).

Of the nine companies listed between these two lists, five have agreed upon various mergers, which are now (in the fall of 2016) at various stages of approval by trade regulators. Dupont and Dow have agreed to a merger which is under some scrutiny concerning their re-organization by EU regulators (Pop in WSJ, 2016). Syngenta has agreed to a buyout by state-owned ChemChina for what would be China's largest national acquisition to date (Fioretti in Reuters 2016). Here, EU antitrust regulators have concerns of overlapping portfolio holdings, particularly Chem-China's subsidiary, Adama Agricultural Solutions, whose herbicides, insecticides, and fertilizers compete with Syngenta's product-line. Finally, and perhaps most notably, Monsanto, the world's largest seed producer has agreed to a sixty-six billion dollar buyout by Bayer, the largest agro-chemical producer (Gregston 2016). As with Dow(USA)-Dupont(Germany) and ChemChina(China)-Syngenta(Switzerland) mergers, the Monsanto(USA)-Bayer(Germany) merger as yet awaits trade regulation approval. However, this reflects a continuing trend towards larger concentrations of seed production-lines on an increasingly transnational and even global scale in which the six largest agrochemical *or* seed companies potentially become the three largest agrochemical *and* seed producing companies.

Until 1990, agrochemical research and development were conducted by separate corpora-tions. In this time, the prevailing market strategy was for larger agrochemical companies to di-vest from less profitable, and perceived-as-unrelated seed-genetic companies (Wield et al 2010). During the 1990's, Monsanto successfully pioneered a synergistic market strategy for trans-ge-netic research and agri-chemical development (Wield et al 2010). Here, Monsanto's relatively modest agrochemical holdings consisted almost entirely of glyphosate herbicide Roundup™ (Wield et al 2010). To synergize profitability between seed stock and agrochemical holdings, Monsanto bred Bt (insect-resistant) corn to have greater resilience to glyphosate chemicals

(Wield et al 2010). Monsanto is the first to imagine modifying seed stock to create benefits which are tailored specifically to their particular, owned, patent-protected agro-chemical. To insure profitability over the long-term, Monsanto legal departments apply for and receive utility patents or PVPA certificates for these new genetic variations of (at first corn) but quickly soy, and cotton among others.

This R&D technique was so successful at the market-end, that throughout the 1990's, large agrochemical companies reversed earlier corporate strategies to divest from seed holdings and instead began what is currently the trend towards agro-chemical capital concentration in addition to a synergistic concentration of agro-chemical and seed holdings. This results in increasing concentration, in the last year six of the largest agro-chemical or seed producing companies have developed merger deals which are under current regulation (Syngenta-ChemChina, Dupont-Dow, Monsanto-Bayer). Further consolidating agro-chemical and biological technologies in the agricultural marketplace, and further delimiting the kind of production and exchange network from a which a farmer is constrained to purchase.

Legal Responses To Transgenetic Techniques

The material reorganization of the marketplace which synergizes seed R&D with agro-chemical production has been made practical by specific legal changes in patent law enacted by the 1970 revision of the PPA, as the certificate-granting Plant Variety Protection Act (PVPA). Prior to this time, the PPA remained almost untouched since 1930, where it had been developed to address genetic research in cloning and asexual grafting (Schneider 2016). The PVPA institutes language confirming the legal protect-ability of sexually reproduced seed stock. It secondarily allows for specific certification for these sexually reproduced seeds, which offers mediat-

ing legal stipulations (including an allowance for seed saving) and a shorter cycle of protection than a standard utility patent (Schneider 2016). This is modified by a second legal precedent, set by the Diamond v. Chakrabarty case and its appeals, for protecting bioinformatic inventions (bacteria, seeds, etc) under utility patents, which are farther reaching, and less limited in power than PVPA certificates.

Diamond v. Chakrabarty, represents a landmark decision wherein the supreme court eventually offers a utility patent on the method, substrate, and lab-produced bacteria themselves which Chakrabarty had developed under the employment of General Electric Company. The supreme court allowed the issue of a utility patent to protect intellectual property rights over living organisms developed by new and original genetic and trans-genetic alterations made by Charkrabarty under contract to GE so long as it represented a “significant departure” from the original (Schneider 2016:562-3). Patent law describes any unique “manufacture" or "composition of matter" as available for patent, given it can be described as original, for a majority of the judges a population of genetically modified bacteria represent the first living things to receive patent protection based upon genetic make-up. In J.E.M. Ag Supply Inc v Pioneer Hi-bred International INC, the supreme court upheld Pioneer’s growing number of utility patents taken on their produced seed stock (Schneider 2016). They specifically cite that because the PVPA legislation makes no claim to its exclusivity in legally protecting seed-genetic stock ownership (7 U.S.C.S. § 2321 et seq.) utility patents as well as PVPA certificates. This signified a clarification in the reading of changes made by the certificate program instituted in the PVPA, certification and utility patents represent a both-and legal response to the problem of confirming and policing plant-genetic ownership.

The PVPA should be differentiated from the utility patent. Notably, the PVPA is governed by it's own office which, in theory, delimit the powers of certificate holders to abuse farmers at the expense of the public:

> The Secretary may declare a protected variety open to use on a basis of equitable remuneration to the owner, not less than a reasonable royalty, when the Secretary determines that such declaration is necessary in order to insure an adequate supply of fiber, food, or feed in this country and that the owner is unwilling or unable to supply the public needs for the variety at a price which may reasonably be deemed fair. Such declaration may be, with or without limitation, with or without designation of what the remuneration is to be; and shall be subject to review as under section 71 or 72 [7 USCS § 2461 or 2462] (any finding that the price is not reasonable being reviewable), and shall remain in effect not more than two years. In the event litigation is required to collect such remuneration, a higher rate may be allowed by the court. (7 USCS § 2404)

Here, in cases of public need, as determined by the secretary open distribution of certificate-protected variety may be price-set by the secretary and their community. These delimitations are in addition to other changes. For example, while PVPA holders bear exclusive rights to the sale of the seed, they cannot place strictures on the right of the farmer to save seed adequate to self-seed in subsequent generations. The PVPA certificate cycle is also noticeably shorter than utility patents.

These material difference aside, both PVPA certificate and Utility patents protect ownership based upon a presumption of discursive fixity. That is to say, a clear description of the developed product, proof of its originality, and the process by which it was developed are necesarry for establish patent or PVPA protection. So, while PVPA certificates are more moderate, both suggest attributes about a seed which the material resists. The PVPA, because it does not make a claim to exclusivity, paves the way for legal justification for utility patents on bioinformatics and plant seed stock instead of supplanting it. Within the last fifty years, through utility patent and PVPA certificates the legal precedent for protection of human rights over living organisms has repeatedly been allowed where actual genetic uniformity and stability is not required.

This is not because the courts are dastardly, but rather because legal precedent simply does not align with the governed material. That is to say, the hybrid plants most often protected are genetically unstable in the second generation. In non-hybrid cases there remains genetic variability across generation and conditional/phenotypic variability within the first generation. This is true of all living, sexually reproducing varieties of agricultural plants or useful microorganisms, all of which include demonstrated generational instability in genetic code. The willingness to protect these materials reflects a disconnect in patent-logic and material conditions. Secondarily, this protection suggests ownership as a proprietary function of invention, much in the same that IP law protects software code (a notably contentious battle in its own right, see Eben Moglen's dotCommunist Manifesto whose fourth tenet, second clause, reflects the sentiment of this paper), but not as an ownership over a complex living being, with mutable phenotypic and genotypic lineages and possibilities.

Plastic Seeds, Vital Seeds

How is a seed conceptualized by large production corporations? This as already suggested, is a question for extensive qualitative research in its own right. However, the purpose of this paper is to explore how assemblage thinking informs the imagination of environmental justice scholarship, and specifically, how it could imagine a new way of organizing and governing ownership and social interactions with humans and seeds. Because of this, I offer only a brief discussion about the way seeds are conceptualized currently by corporations, and rely on Carolan's (2010,2011) research to verify these claims. Though much of a company's understanding of their product line is revealed in legal cases governing patent protection, a clearer picture can be drafted by examining the way seeds are described in their advertising materials. Seminis is a

vegetable seed subsidiary from monsanto, and it's dual offering of garden and production seeds result in a product line, which by comparison to other specialized Monsanto seed subsidiaries like Dekalb, use straightforward untechnical language to describe their seed, below is one of their production corn offerings:

> SV9010SA sweet corn hybrid combines great taste with insect control traits. In addition to offering dual modes-of-action for management of select above-ground insect pests, control of select below-ground insect pests and crop safety to in-crop applications of Roundup WeatherMAX® and Roundup PowerMAX®3 agricultural herbicides, SV9010SA sweet corn hybrid also contains the Rp1D and RpG genes, which provide high resistance to prevalent races of common rust. This bicolor has high yield potential superior eating quality and excellent shipability. (Seminis 2016)

The seed is described immediately as hybrid, and this is followed by description of response traits. The seed is described relationally, and plastically, it's transgenetic pre-disposition operate effectively in these specific ecologic conditions. Where Roundup Powermax®3 is used, and select pests are problematic, this seed will grow effectively. This hints at the semiotic positioning necessary to commodify a thing with such complex assemblage relations.

The distributed agency (Bennet 2010) of a seed is highlighted by its varying growth interactions with different ecologic inputs. Hybrid seeds, particularly, reflect this varying and unpredictable interaction by their eratic phenotypic expression in second generation growth. Admittedly, when describing the seed as active, Seminis writers do use actionary language when describing "dual modes for management" for select pests (Seminis 2016). However, the work of this description remains in specific response to a perceived active input (pests in the field) and therefore remains a distinctly plastic description. Here, plastic is used because the living seed is described as mutable to the specific needs of the farmer as imagined in the lab, just as medical plastics are mutable to specific therapeutic benefits. However, it also emphasizes that the seed and plant are considered, fundamentally, as objects similar to inert matter. A seed's differentia-

tion is described by genetic code(not lineage, heritage, or even phenotype) which is reported in much the same way as a specialized computer programer may describe new software code, in order to gain intellectual property protection rights.

Latour refers to linguistic conceptualizations, semiotics, as form of bridge-building (1998). The legal framework for protecting ownership over seed-stock attempts to reach the materiality being protected and owned. It represents an attempt by human actants in the larger ecologic *assemblage of assemblages* (Delanda 2016) to comprehend and govern other actants, as well as to *enrol* them into a new legal assemblage (Callon in Gibson and Gray 2014). The ability to govern effectively varies directly with the precision by which that semiotic bridge reflects, describes, and integrates humans into the assemblages owned commodities operate with/in. Justice does not occur simply by freeing information, or by freeing members of a community. However, just solutions are hindered, if not precluded when governing systems imagine the governed members inaccurately. Bad fiscal policy may still occur with good data on community demography, but bad demography hinders, if not precludes a governing body from generating quality, helpful fiscal policies. Seed law currently fails to govern the actual material because it describes a static object, described by genetic code, and secondarily by static phenotypic traits, instead of a variable, living organism, an object not simply with distributive agency but individual agentic potential. While Deibel's (2013) protected commons imagines a possible more-just future, it fails to account for actionary stances of corporations and populations whose procedures may *enrol* actants into governing relations which preclude fair action for other human actants in the assemblage. Put another way, to tell a driver he must drive below sixty mph is fair governance, but to tell a pilot to fly below 60 mph, is to ignore the difference in material organization between

these two technologies. It precludes reasonable action by those in closest relation with the object and therefore produces injustice.

I am not contending that trans-genetic seeds are an intrinsic evil. Real solutions to eco-logic issues may, at times, benefit from techno-scientific plant development techniques (see perennial crop development efforts by The Land Institute, near Salina, KS), though evidence suggest these efforts will not originate with conventional bio-technical corporations. I am also not suggesting that trans-genetic seeds represent a true, inert, plasticity, rather, they represent a kind of expansive mobility. Seeds can be manipulated for specific traits in the first generation. Research in, and beyond, this area cannot justly be outlawed. However, in a true commons, seeds are imagined as collaborators with farmers, gardeners, seed sellers, seed exchangers, re-search laboratories, and seed producers. These human collaborators would not have exclusive rights over the genetic code, and participants therefore could not be legally coerced into external systems of re-purchase, or contractual exclusivity to specific corporation's stock and product. At once, this would accelerate and disperse trans-genetic research as well as devalue the synergistic model utilized by companies like Monsanto whose profitability lie in a diversified portfolio of proprietary agricultural technologies. A corporation, could, admittedly continue imagining the seed as plastic, as mutable and stable, but such imagination would not necessitate a governed system privileging that one (mis)conception. Seeds already *mean* a variety of things to a variety of actants, this would be recognized and encouraged.

This imagining is over-simplistic, but it is the *kind* of future assemblage scholarship could imagine. Assemblage thinking does not lead down a single corridor, into a clear solution for any kind of legal problem, it opens a door into a plane of networking actions and relations (Deleuze and Guattari 1987). This think-piece does not represent a totalizing theoretical frame-

work or methodology which solves problems of seeds. However, in this instance it does lead a to a discursive space which suggests that freeing components of an assemblage would *allow for* but not necessarily create, the possibility for just environmental futures with regard to seed exchange. This extrapolates to a new question in environmental justice scholarship: how do systems of governance effect just regulation for a variety of materialities? And secondarily, how do we equivocate justly between human and non-human actants? One implication drawn from these questions, is the presumption that regardless of the answer, material objects and organisms *matter,* pun intended. A first step to enabling justice is to enable participants to interact freely and organically, we might say, to interact ecologically. By refusing to grant patents, and therefore ownership over genetic lineages in seed and plant material, one is not deregulating human control but rather placing a tighter stricture on human control in order to enable more equitable collaboration between human and seed actants.

To put it another way, it is a kind of material enfranchisement. Assemblage thinking reminds us that the self, what we imagine as human, is not always the most important actor (Bennet 2010). Collaboration between humans and non humans does not produce justice. It allows for justice in an ecologic and environmental sense to occur. Deibel's proposed commons is well meaning, and moves towards justice for humans, but assemblage thinking recognizes all social problems are distinctly relational (Latour 1998, Pellizzoni 2014, Delanda 2016) and the relationships extend to human and non-humans alike. When imagining a just ecologic future, we are necessarily dealing with a supra-human issue. As a problem, it belongs to all members of the ecologic assemblage-of-assemblages (Delanda 2006).

To bring this around to the stated issue, imagining a more just future, and informed by assemblage theorists and Carolan's examination on seed governance through patent law and

Deibel's (2013) software inspired protected commons. An assemblage approach imagines a future wherein seeds are not equivocated with human actants but are recognized as actants with agentic capacity and are therefore carefully considered and included when imagining more just futures for whole agro-ecologies.

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