Original Article

Subjectivity and plant domestication: Decoding the agency of vegetable food crops

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Abstract Seeds of domesticated plants are a literature, a hard drive and a coded record of past information. Historically speaking, breeding is a special kind of alteration that has made domesticated plants among the most ancient of technical products. In this process of domesticating plants, kinship can be profoundly disrupted and transformed into intellectual property, only to escape, and revert to illicit relationships that are formed in the same agricultural fields that are attempting to tame them. Attention has turned in some quarters to challenging the notions of subjectivity of traditionally ignored subjects. In this paper I want to bring domesticated vegetables to the table. Domesticated plants created by selectionist plant breeding are testimonies to the benefits of cross-species cooperation that have been occurring for generations. Exploring the status of plants as subjects suggests that the controversies surrounding breeding practices need to be reconsidered.
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Introduction

Domesticated plants created from established plant lineages are a testimony of the benefits of cross-species cooperation that have been occurring for generations. This work has been done in the fields and in the laboratory by careful scientific work. In order to understand domesticated plants, and the processes by which domestication is constantly produced and maintained, I propose to analyze domesticated vegetables using a co-constituted lens that will highlight the human–plant material semiotic relational nodes (Haraway, 1991). By thinking about domestication as a node of intersection for ever-emergent functional relationships between humans and certain types of plants, we can consider a number of questions: What kinds of subjectivity are possible for the plants? Should we consider the subjectivity of plants as individual specimens or as varietal groups? If the latter is the case, what are the implications of ascribing subjectivity to plants in varietal or breeding line groups rather than as distinct individuals? Given the plant's inability to use human language, how can the mark of their agency be noted and communicated and thus transform the plant(s) from object into subject? And finally, what implications do plant subjectivity have for understanding newer forms of plant breeding, specifically genetic engineering and terminator gene technology?

Domestication

Domestication is conventionally defined as the process of making plants or animals useful for human consumption, usually by selective breeding over time (Smith, 1995). The word 'domestication' has its etymological roots in the Latin *domus* or home, implying that domestication is literally the bringing of that which is 'wild' or utterly non-human into the territory of the home. Home designates a place that belongs to humans, to subjects and what is outside the home is an object, wild. The recent literature in geography has problematized this dichotomy arguing that conceptualizing the wild as a distinct territory separate and pristine from human environs endangers the very survival of animals so designated and does not reflect the exercise of social configuration by humans in regard to those animals (Whatmore and Thorne, 1998; Hinchliffe *et al*, 2005). We have learned not to treat our wilderness as an object and are now considering its subjectivity in our conservation policies.

Another traditional interpretation of domestication argues that there is considerable evidence that animals choose humans as much as the reverse (Budiansky, 1992). It is not accidental that much of this discussion of wilderness, what constitutes wild versus domesticated, and what motivates domestication, focuses on animals. Animals, after all, can move in a manner that seems to reflect volition. Many mammals, in particular, are large, armed with claws and teeth, and potentially dangerous if a process of accommodation does not occur as an essential first step in domestication. The mutual adjustments necessary to reach acceptable co-existence, include an exertion of will on the human side, and acquiescence on the animal side. Taming, training, control and the subjugation of the subject fill the animal domestication literature. This reminds us that domestication of animals has typically been understood as a formation of subject status under the reign of dominance by humans over animals. Key exceptions are Haraway's recent work on dogs and Pepperburg's work with parrots as well as Despret's analysis of animal breeding in Europe (Pepperberg, 1995, 2008; Haraway, 2003; Despret, 2008).

The co-evolution of plants has taken a different path because over the evolution of agricultural production and especially since the rise in importance of grain crops, production agriculture takes place in designated locations – fields. Fields, like homes, are protected spaces, guarded and demarcated as places with specific purposes. Unlike human homes, however, fields need to be kept clear of too much human interaction. Walking, driving, sleeping or resting on a field compacts the soil and disturbs the crops, making that field less hospitable for plant roots. Thus plants are not co-habitants of the same buildings as humans, but have their own unique space near humans. In those fields, plants are provided with support of kinds that they would not get if planted elsewhere: more regular water, customized nutrients, protection from animals, insect pests and perhaps some protection from disease.

When plants physically resist our attempts to move them they use slow-moving techniques such as thorns, toxic sap or failure to thrive. They generally represent limited physical threat to humans, unlike animals. Therefore the focus of plant breeding is very different. Animal domestication and breeding frequently aims to deliberately inhibit maturation beyond the juvenile stage (Trut, 1999) in order to tame the animal. Tameness *per se* is not the concern of plant breeders, they generally focus on more varied goals like resistance to a specific disease or the capacity to produce fruit all at once. On the one hand, plants seem far more malleable, after all they cannot run away. However, when we consider the interaction between farmers and their plants where the farmer's goal is to produce a usable crop with certain predictable characteristics, we can see examples of plant influences on humans. A farmer who wants early tomatoes, for example, will need to provide warmed greenhouses for seedlings and enriched soil to support early growth. A seesaw interaction exists between what farmers must do to achieve their aims and what plants can and will do in support of those mutual goals.

Domestication has been both an historical event, and an ongoing process. Historically, plant domestication is said to have begun some 10 000 years ago and to have lead to the transition from nomadic to settled agricultural communities. Historians and a whole genre of popular books have traced out the repercussions of specific food crops on the rise and fall of major empires and the environmental devastation of whole sections of the globe (Hobhouse, 1985; Mintz, 1986; Fussell, 1992; Evans, 1993; Diamond, 1997; Beinart and Middleton, 2004). At the same time domestication is an ongoing process. Maintaining domesticated crops in forms that make them effective requires yearly attention (Joshi *et al*, 2001). Plant breeding in the twenty-first century is generally described in terms of enhancing or improving the diversity, yield or viability of agricultural crops. In addition, plant breeding also keeps domesticated crops from degrading back into forms that might serve the needs of plant reproduction but not satisfy human concerns as well (Mayo, 1987; Jain and Kharkwal, 2004; Morris and Bellon, 2004). In other words, the array of domesticated crops that currently exist represents a snapshot of a particular set of relations among plant genetic materials, farmer's fields, irrigation schemes that feed those fields with water, levees that protect them from floods, weather conditions, and nutrients as well as countless other mechanical, human, plant and soil factors that produce this year's crop.

The term 'domestication' is a leaky one. For example, in some communities, plants that self-seed in certain marginal lands are used as food crops. Those plants may not require the intensive attention of an industrial potato field, yet even in that case, there can be a gesture of accommodation that makes it possible for those particular plants to grow in a particular location and be harvested. Allowing plants to grow along a roadway rather than insisting on mowing them (Boutin *et al*, 2008) or avoiding disturbing wetlands that harbor plants that require those conditions are two *de facto* methods by which humans perform acts of accommodation, and perhaps gestures of semi-domestication, toward otherwise independent plants.

Thus it is important to remember that the domestication of plants has been understood as a negotiation in which a central portion of the process consists of coming to understand what a given plant or population of plants may choose to offer up. In many ways this negotiation model, because it recognizes that plants do 'choose,' represents a significant improvement over its theoretical predecessor that assumed that the plant world was simply available to service human needs and desires. The service model confines plants to the role of inanimate objects, like minerals or metals. The negotiation model, by contrast, recognizes that plants are the point of origin for plant–human interaction, and respects that both are altered and shaped in their relationality. It therefore becomes theoretically possible to imagine that plants have agency, express preferences, and/or autonomy. Or in other words, that plants are subjects or have subjectivity.

Becoming domesticated has ensured the survival of certain species but it does come with a price exacted from humans in the form of care requirements (Stoskopf, 1993; Pollan, 2001; Jain and Kharkwal, 2004; Morris and Bellon, 2004). Recognizing subjectivity does come with a price for both parties. Negotiators recognize that plants hold some of the chips, in the sense that humans can be held accountable by the material world if they are careless and fail to provide the conditions for plants to flourish. If plants fail to fulfill human needs they will not be replanted or nurtured.

The negotiation model opens the door to consider the possibility of plant agency emerging into subject status. Determining the correct language to characterize domesticated plants that impose conditions on how they may be used is not a simple matter. Plant communication does not involve speech, for example. As Vinciane Despret has pointed out, philosophers and animal behaviorists have missed animal speech because both groups have presumed that cross-species interaction must happen in circumstances determined by human interests (Despret, 2008). For plants, where speech is not an option the tendency is even greater to ignore the question, under what circumstances and in what ways might plants have an interest in asserting their subject status? Without that perspective, that subjects must be interested in order to reach across the species barrier, the discussion about plant subjectivity becomes mired in the assertion that plants exercise agency without intentionality. It is here that re-configuring our thinking about the human–plant relationship benefits from an examination of Haraway's, Callon's and Despret's explorations of human–non-human interactions in detail in order to understand the process of decoding the resistances inherent in the material world.

Subjugation and/or domestication

There are some parallels between the ongoing processes of domestication and the phenomena of domestication of scallops in France in the 1970s described by Michael Callon (Callon, 1999). His project focused on the creation of scallop farming as an example of translation work in which a few researchers become the determining voices who define the appropriate engagements between human and non-human actors (Callon, 1999). Callon describes this process as competitive where the dominate actors recruit others to their perspective by weakening ties between those others and competing frameworks advanced by yet other actors. Haraway's material-semiotic nodes, by contrast, acknowledge the creation and inequities in power relations within a network, and these in turn emphasize her interest in forging inclusive alliances rather than positing a battle for hearts, minds, scallop larvae or squash germplasm (Haraway, 1999). Despret adds a crucial insight when she references the need for interest and attunement as prerequisites for intersubjectivity or cross-species communication. Attunement being the process of acknowledging the interest of the other. What is interesting for my purposes is that all three account for the process of defining terms and applying labels to human–non-human cooperative ventures that includes both the spoken and the material participants. They make a place for the non-human living world to act as something more than a canvas onto which human needs and desires can be projected. Moreover, especially Despret's work demonstrates that agency is a too limited term to describe human–non-human intersubjective relations, a position that an analysis of plant breeding confirms.

Plant breeding, as opposed to germplasm collection, avails itself of the reproductive cycle of plants to perform interventions that will alter the nature of the following generations. Moreover, because traditional selectionist plant breeding involves directing the course of sexual recombination, a certain degree of plant agency can be expressed with every new generation of crosses. Genetic engineering has its own uncertainties brought about by the lack of control that breeders have over the DNA insertion process and the lack of knowledge they may have about the contextual impact of a given gene placement. Whereas the goal of Callon's scientists was to preserve and enhance the scallops already being fished, the breeders' goal is to direct plants toward certain aims. At the same time, at least among some skilled selectionist breeders, there is the intention to observe and engage with plant responses as they emerge from the breeding process.

Without human maintenance and sustenance, domesticated plants do not maintain their distinct varietal identities. Indeed the sheer effort devoted to keeping commercial domesticated varieties stable year after year is perhaps one of the most compelling proofs of the impulse Haraway tracks toward the dissolution of boundaries between distinct biological entities. Without maintenance, commercial varieties will drift from their defined set of traits toward characteristics that may ensure plant survival while undermining the usefulness of the variety for growers and gardeners. An example of this is noted in the Sugarsnap snap pea product description of the 2009 Fedco seed catalog where the company makes the following observation:

> We were appalled to hear reports of 20–30% off-types in our commercial Sugarsnap seed. Since Sygenta's PVP [Plant Variety Protection] ran out they are no longer producing it, and the strain has been deteriorating … . Because we have lost faith in the purity of commercial Sugarsnap seed, we are offering only organically grown seed. Although our grower started with the same contaminated commercial stock, he observed the off-types and rogued heavily in the field. This lot will still contain a diminished percentage of off-types. We will continue to work to clean up this critically important variety. (Lawn, 2009, p. 25)

Fedco is a small worker-owned cooperative that supplies primarily organic growers and gardeners in the Northeast. It is one of the few companies that sell open gene pools and highly variable varieties that allow grassroots breeders to make their own selections. As such, the company has a uniquely proactive role in expanding the opportunities for plant subjectivity to be acknowledged and used by plant-interested humans. Nonetheless, in this instance, the issue at hand is the need to suppress the desire of the Sugarsnap snap pea to merge with other pea types and thus dilute its reliability as a producer of a certain kind of edible podded pea. The 'deterioration' that the catalog is describing is the same mechanism by which innovation takes place, namely, the free crossing of mutually compatible pea types with each other. The term 'off-types' signals that the communication from the plant side is unwelcome. Sugarsnap is a finished variety, which means that its use value to humans is in part based on the consistency with which it produces near-identical plants from each seed, which will react to disease and agronomic conditions in predictable ways. The bundle of genetic structures, that is Sugarsnap, had been afforded plant variety protection for the standard 18 years, which gave the owner of that protection right, Syngenta, exclusive marketing rights (Strachan, 1992). Now that the protection has expired and anyone can grow Sugarsnap for seed, Sygenta no longer represses Sugarsnap's creative impulses. The response from the seed trade to Sugarsnap's initiative is decisive and negative. Those non-standard members of any given Sugarsnap seed crop are to be systematically 'cleaned up' and 'rogued (weeded out) heavily.'

The case of the impure Sugarsnap demonstrates that in regard to finished varieties, the dynamics of plant–human relationships parallel those of microbiology described by Latour in his famous work on Pasteur (Latour, 1999). Three steps are involved in Pasteur's process according to Latour: capturing the other entities' interest, using variation in scale to move the leverage point from the farm into the laboratory, and finally, dissolving the inside–outside distinction between the laboratory and the rest of society by reorganizing society to mimic laboratory conditions and thus replicate laboratory successes in suppressing a disease, in Pasteur's case, anthrax (Latour, 1999).

Traditional selectionist plant breeding of finished varieties for commercial production performs each of those three functions as well. Initially germplasm with potentially useful traits and human desires for plants with given trait expression are collected by the breeder. Germplasm is a technical term for a collection of DNA that constitute the genetic resources of a given plant, variety or breeding line. Horticultural crops like vegetables frequently store this genetic material in seeds, although some common vegetables like potatoes are replicated from tubers or rhizomes. In experimental fields, greenhouses and sometimes laboratories, germplasm is isolated into breeding lines, recombined in various ways to optimize outcomes and then stabilized, a term that refers to the narrowing of the genetic imprint of a variety such that it can be reliably and specifically described, protected legally and replicated. From there, the seed is grown out and distributed back into a world of seed catalogs and end users who expect from finished varieties the results promised by the breeders' field trials.

Unlike Pasteur, however, plant breeders do not have as their goal the elimination of a disease-causing microbe. Instead their aim must be to both coax from plant germplasm results that are desired and understood and also at the same time and especially in the early development phases, plant breeders must hone what Barbara McClintock called, a feeling for the organism (Keller, 1983). The process that Latour describes is one in which humans act upon microbes. Negotiations may occur but they are compromises born of necessity rather than the acknowledgment of a useful contribution of the other to a mutual project. As we will see from the descriptions of an experienced plant breeder, plant creativity and plant innovation spark ideas that can re-frame the course of agricultural practice and food consumption. The translation from field to society then becomes the promulgation of a vision for plant life that is significantly produced by the plants themselves. What looks like negotiation at first blush proves to be a variant of that dynamic in which the locus of power must be shared.

How Plant Breeders Talk to Plants

To understand how plants communicate within the breeding process it is beneficial to speak to those on the front lines – professional breeders. Joe[1] is the lead technical staff on a project that produced an award-winning squash variety. Traditional plant breeding involves taking two individual plants and fertilizing the female flowers of one with the pollen of the other. The resulting vegetables produce seed that, when it is grown out, is called the F-1 generation. The self-pollinated next generation is called the F-2. Within each generation there is uncertainty about the results and, as Joe explains, breeders have to be prepared to change course in mid-project to accommodate the constraints of the plants.

> The way we came up with Harlequin, which is an acorn delicata hybrid, was we made the initial cross to get powdery mildew resistance into delicata – and the hybrid was absolutely beautiful. We wanted to develop an OP [Open pollinated variety] that looked like that hybrid, but our problem was everything segregated back to one type or the other; you couldn't stabilize something that looked like that hybrid in an open-pollinated [variety].
>
> Ruth: Why not?
>
> We didn't get the color combination that we wanted. We either had dark delicatas or light colored acorns, or we didn't get that beautiful dark green-white mix that we were looking for. So, and one of the offshoots of that was a bush delicata with powdery mildew, and we said, well, hey, why don't we try that hybrid again, and we tried it again between our newly developed bush delicata and our powdery mildew resistant bush acorn, and the hybrid was gorgeous … the offshoot of that was a powdery mildew tolerant bush delicata, and we got an All American Award.

Joe is describing what he said repeatedly was a regular occurrence in plant breeding. Until the variety has been bred to the point where it is consistently stable for certain traits, the breeding process can and will produce unexpected results that a wise breeder will notice and capitalize upon. The research project just described began with a specific goal, to create an open pollinated acorn delicata squash that was powdery mildew-resistant. This goal was not achieved.

It happens that the second generation, the so-called F-2, re-segregates in a way that one cannot produce the desired color combination and the disease resistance at the same time. The idea that a certain form of squash should show a certain set color pattern is highly socially constructed. This is so much so that another breeder informant told me squash coloration preferences among consumers could vary dramatically within a 50-mile radius in the continental United States.

The plants' response to Joe's breeding interventions demonstrate their unwillingness to assume the position of an open pollinated acorn delicata with powdery mildew resistance. The rejection of the human goal, however, did not simply result in failure but rather in a counteroffer from the plant side. Instead of an open pollinated variety, the result was a hybrid. Instead of an acorn delicata, the result was a delicata with a bush habit. Latour talks about these sorts of necessary failures in his discussion of laboratory functions. Indeed, one of the strengths of the laboratory and practicing scientists is that scientists accumulate negative outcomes until such time as a successful outcome can be assured.

> Certainty does not increase in a laboratory because people in it are more honest, more rigorous, or more 'falsificationist.' It is simply that they can make as many mistakes as they wish or simply more mistakes than the others 'outside' who cannot master the changes of scale. … If a great many trials are recorded and it is possible to make a sum of their inscriptions, that sum will always be more certain if it decreases the possibility of a competitor raising a statement as plausible as the one you are defending. That is enough. When one sums up a series of mistakes, one is stronger than anyone who has been allowed fewer mistakes. (Latour, 1999, p. 271)

If we contrast the function of failure in Joe's squash case with Latour, we see that the term has a slightly different meaning closer to that described by Despret's description of attunement. In the case of anthrax or related kinds of laboratory experimentation such as described by Latour, there exists a singular goal and a definition of failure. Tests can be designed against which data and evidence can be run, resulting in either confirmation of one's hypothesis or indications that one must try again. Latour's point here is to highlight the value of repeated failure and false leads as a mode of eliminating unacceptable outcomes and confirming the validity of positive solutions. A series of failed outcomes direct research toward an increasingly narrow selection of possible viable solutions under this model. In Joe's case, an hypothesis can fail and yet not count as a failure. The result of some failures is not a narrowing of options, an elimination of possible correct answers, but an expansion of outcomes. The impact of this difference means that every experimental outcome presents Joe with several options: success as desired, failure of desired goals, or, failure of desired goals and assertion of new possibilities. This third option deprives Joe of some of the mechanisms for determining certainty in his outcomes that would be available to a scientist of Pasteur's sort. It also means that an additional decision must be made when a failure of intended results is registered: Do I keep the failed outcome or not, is this failure perhaps an All American winner in disguise? This is the kind of reinterpretation of misunderstandings that led Irene Pepperberg to discover speech in parrots. Despret makes a related argument when she argues that speech between species requires an interest in misunderstandings. Pepperberg demonstrated empirically that her gray parrot Alex was capable of generating his own words that reflected a logical, although not correct, use of English. Before her work, animal speech had been assessed simply in terms of the animals' ability to mimic human language. Joe's case, the pushback from the squash plant, was accompanied by an expression of interest on different terms. Key to the success of the exchange was Joe's capacity to value something other than his own notion of a desirable outcome and to demonstrate an openness toward the interests of the plant.

A prize-winning hybrid did result from knowledge gained from watching the failure of the initial project Joe described. The key here is that it is the skill and curiosity of the breeder interacting with the limitations set by the plants that create new entities. But more is happening here than a one-to-one negotiation process. As Bowker and Star have suggested, standardized classification and codification predetermine the terms within which recombination can occur (Bowker and Star, 2002). In this case, the codification includes the breeder's standards, what constitutes an acorn versus a delicata squash, for example. Similarly, the plants produced their acceptable combinations, in this case expressed as things the breeder did not want, dark delicatas or light colored acorns. When bred to produce a dark green-white mix, the plants in question re-segregate themselves into alignments consistent with their own predilections.

I would, therefore, contend that the insistent re-segregation on the part of certain squashes to produce dark delicatas or light colored acorns falls squarely into the realm of a social communication emanating from a non-human. That is, the plants' expression of agency leaves its mark, in this case on its own blended body, communicating to the breeder its color preferences. Those preferences are both expressed and understood within a technologically defined environment in which plant breeding lines are maintained and genealogies combed for optimal participants. In this way plant breeding is literally kinship work in the sense that Braidotti has described Haraway's intentions:

> … Haraway stresses a number of crucial features. The first is power as a dynamic web of interconnections, as a principle of radical non-purity. The second, is the refusal to fall into the pitfall of the classical nature/culture divide; there is no natural *telos* or order, as distinct from technological mediation. In order to restructure our collective relationship to the new nature/culture compound of contemporary techno-sciences,

> Haraway calls for a renewed kinship system, radicalized by concretely affectionate ties to the non-human 'others.' (Braidotti, 2006, p. 199)

In the case of the squash example, we can see the dynamic web of interconnectedness at work. The key parties are several parent breeding lines, the breeder and the end users whose desires for certain kinds of squash determine what shapes and colors will sell. The breeder uses technical and aesthetic standards to guide the way he does his work and the baselines against which he judges the outcomes. As I will discuss below, the plant participates not only as its singular individual self, but also in the outcome of a genealogy of squashes, a specific pattern of cucurbits winnowed down, and expanded pre-determined categories with a functional goal that is a matter of appearance as well as other physical traits. The process of breeding is governed by technologies old and new, from gel caps that keep stray pollen from fertilizing where it should not, to the expertise of the breeder who picks flowers to cross-pollinate. At its most basic, breeding is kinship formation driven by attunement or affection. A successful cross produces a single new fruit, a successful breeding project produces a new variety. A new variety wins awards, is licensed to a seed company, is grown out in bulk by seed farmers and is sold to vegetable farmers who then sell a new squash to the consuming public. If the degree to which a new variety differs from pre-set norms is relatively minor, the kinships established may be modest but this need not be the case. A major crop improvement, such as a radical increase in cold tolerance, or iron-clad resistance to a fatal disease, can radically restructure the interlocking chain of events that is the food system.

The orderly process of two-party negotiations envisioned by the co-evolution model is one in which humans act upon plants to contain and guide them. This conception of order yields to a more complex interaction. The shift in the function of failure demonstrates a messier, less orderly, but it seems more empirically accurate, version of how breeding unfolds and viable varieties are produced with plant contributions. As we have seen earlier from the Sugarsnap example, the recombination of even stable varieties can be undermined by genetic drift, mutation, failure to isolate breeding stock in the fields and a host of other factors (Parlevliet, 2007). The default mode for plants is not stasis, it is self-alteration. That means that the essential contributions of humans is limiting and choosing plant initiatives, not making those initiatives in the first place.

Before I leave this issue of breeding as kinship creation and plant agency in the breeding process, I would like to return to our expert breeder and the question of chance. When I suggested to this breeder that plants participate in the breeding process, he responded affirmatively with this particularly telling example:

> Oh yeah … you have to keep an eye open, and a lot of times what is going to catch your eye is the oddball, that always happens. If you've got one

> oddball plant, and every time you go out to the field, you keep gravitating back towards that oddball plant, you're wondering, what in the world is this, why did it do that. Well, I myself would keep seed of it just because it's an oddball and we're going to find a use for it.

Joe is describing his plant kin calling out to him as a sympathetic listener, one of those few humans who can hear plants as they innovate. Pragmatically speaking, the oddballs produced by breeding activities over a period of years form a unique and valuable resource for future breeding but only if they can be recognized as such. In other conversations this individual described how one year's oddball might be next year's salvation as humans needs and desires change. It is also the case that the unexpected products of a given breeding experiment may give the breeder ideas for a new project. He gave the following example:

> We've got these note cards, we've got summaries, who knows, we can go back and say, hmm, years ago, we had a little tiny dwarf pumpkin plant, it only made one fruit, and finally you get somebody that says, hey, I'm looking for a bush pumpkin, just an ornamental so somebody can grow a pumpkin in a five-gallon bucket. Guess what I have? … we thought it was ugly at the time, but somebody else may come along and say I want to grow pumpkins in bucket, as ridiculous as that sounds.

Joe is describing behavior that is the reverse of the Sugarsnap seed grower who uproots 'off-types.' Instead he sees oddballs as potential future participants in an array of pumpkin varieties that may have relevance at some juncture. To be fair, Joe can do this because it is his job to breed, whereas the Sugarsnap seed producer is needed to deliver consistent seed for sale. Under other circumstances the seed grower might too have saved and experimented with oddballs whose strengths might form the basis of a new variety. The reaction to plant innovation, the willingness to consider a given oddball for inclusion in a larger network of plant–human kin labeled as domesticated vegetables, in short, the human response to an expression of plant subjectivity depends on the expectations and context of the plant–human relationship. Within the experimental field, plant innovation is sometimes welcome, and failures can become good friends. By contrast, when the products of the experimental fields reach market and are designated as varieties, rather than varying gene pools, the tolerance for deviation is curtailed.

This particular breeder was unusually creative about marketing uses for strange offshoots of breeding projects, but his point was shared by all of the breeders, on-farm and off. The breeding process is anything but formulaic or human-centered. Moreover, because plant genetics are complex and not entirely understood, every breeding program produces volumes of plant feedback in the form of a variety of results other than one's specific breeding goal. On the one hand, the lack of precision and predictiveness makes traditional plant breeding slow and sometimes frustrating. On the other, the process creates a plethora of results that are useful in their own right. Plant breeding is not efficient from a human industrial perspective, but it is a means by which plants can influence human activities. Plant breeding functions as a location for joint brainstorming between humans and plants, assuming that the humans involved have the patience to participate.

Varietal subjectivity

If we accept that plants participate in the process of their own change and that breeders and seed companies embrace or bemoan those plant initiatives depending on the circumstances, one further important issue remains. As I indicated earlier, the exact status of plant subjectivity fits poorly with the terminology we have to describe it. Part of the problem is the question, can we think of the enhanced agency, intersubjectivity or subjectivity of domesticated plants as inherent in individual specimens or is the salient unit of subjective expression a population? If the main means by which plants express their subjecthood is, as I have argued, mediated through the breeding process, then it is difficult to imagine any single plant as an individual subject. If we return to Joe's observations about the stray miniature pumpkin, it is true that outlier individual plants play a key role in some kinds of plant breeding changes. The miniature pumpkin was probably a result of a mutation or a particularly restrictive growing environment to which one particular plant responded uniquely. The vast majority of breeding shifts, however, are incremental. They occur over the course of generations as a result of variations that can be encouraged in one direction or another. If the goal is to produce plants with resistance to a certain disease, one might plant a population that expresses tolerance toward that disease and expose them to high levels of infection. Those plants that survive the increased exposure are then crossed with each other and then backcrossed to stabilize the trait. Not only does this kind of population-based approach allow traits to emerge efficiently, but it also allows breeders to give full consideration to diverging traits. For example, I interviewed a broccoli breeder who had noticed that his populations were beginning to produce two kinds of heads both of which he considered desirable. Part of the population produced single large heads but as a result the stem was tough and woody so that it would be strong enough to hold up the large head. A second group evidenced small side shoots but no single head. The lack was compensated for by long, tender stems that could be used for soups in a way that tough shoots cannot. The development of these two broccoli versions are an example of the ways in which it may be more fruitful to consider plant subjectivity as a group endeavor.

The danger with displacing subjectivity onto a variety or a breeding line is that one might argue that the phenomenon is simply random variation rather than actual subjectivity. Reducing plant innovation that takes place at the population level to a mere display of variation neglects two factors in my view. First, population shifts are not simply random. Indeed adaptation by a population to changes in an environment are less random than mutation of a single plant, which takes place at the level of the individual specimen and thus might feel more intuitively like human subjectivity. In other words, plants adapt to environmental changes in ways that serve their survival needs that, in turn, are not random.

Secondly, domesticated plant populations are always already combinations of plant–human intentions and interactions. Unlike the French scallops in Callon's example, domesticated plants have been acting as biological machines, converting sun to food at the behest of humans and their own ancestors for thousands of years. The scallops had been fished for a few years and were being asked to shift to a farming environment for essentially the first time. Any individual act of breeding, by contrast, uses germplasm that has generally been altered and directed toward functional aims for many generations. When a breeder avails herself of a breeding line she is revisiting the site of earlier engagements. Thus, unless one is using anything but utterly undomesticated materials one is attaching a new project to the multiple layers of past human–plant co-creation. Conceptually the idea of cucumberness, for example, is a product of countless engagements or struggles between humans and qualifying plants about the criteria that will define what a cucumber may be. Those struggles are attached to a material form that can reliably produce under a negotiated set of conditions an outcome that meets the agreed upon standards. Therefore one can think of a domesticated variety as the embodiment of a circumscribed set of characteristics (cucumberness) connected to a plant structure that replicates itself predictably.

Final Words

My discussion has focused on selectionist plant breeding of vegetable plants used in agriculture and their status as subjects. At the moment, the other major breeding approach, genetic engineering, is used principally in four crops: corn, soybeans, cotton and canola. Genetically modified (GM) versions of other crops exist but are not widely planted on a commercial basis. Another approach to breeding is the creation of Genetic Use Restriction Technology (GURT), the so-called terminator seeds that are currently not commercially in use. Haraway has expressed a passing admiration for genetic engineering as an appropriate means of creating new kinships and disrupting previously unmovable categories (Haraway, 1997). Thom Van Dooren has argued persuasively that even genetically modified organisms contain within them past genealogies that are linear.

> While it is clear that transgenic-genealogies have definite horizontal features not found in traditional genealogies, the vertical lines comprised of ancestral organisms that have brought them to this point in time cannot be ignored. Similarly, the vertical lines of descendants that carry on into the future are not insignificant. While for some transgenic creatures in controlled conditions, successful sexual reproduction will not be possible, the children of *agricultural* biotech have shown us that this is by no means the only possibility (emphasis original). (Van Dooren, 2008, p. 780)

Van Dooren is correctly pointing out that when one uses existing germplasm, one is using the outcomes of distinctive patterns of development. The vertical lines to which he refers are the genealogies that produce a given plant variety. Those complex patterns of provenance are then promulgated into the future when plants reproduce. Transgenetic technology allows for materials that are utterly unrelated to be transferred, flounder genes into tomatoes, for example, and this constitutes a horizontal manipulation across species lines. The vertical patterns or genealogies within transgenics have a tendency to reassert themselves much as their traditionally bred cousins like the Sugarsnap will do. Plant kinship can be profoundly disrupted and transformed into intellectual property, only to escape and revert to illicit relationships formed in agricultural fields. Indeed agricultural use, the planting of many seeds over large stretches of geographically disbursed terrain, makes containment of any genetic containment of a plant variety potentially impossible in the long run.

GURT technology is destructive because it destroys the kinship between crops and growers for the benefit of seed companies. When plants are denied the possibility of ever reproducing, then and only then, is kinship practice ended with terrible results for farmers. Van Dooren explains:

> It is very likely, therefore, that while the mutation of traditional biogenetic plant kinship lines (through the engineering in of seed death) will produce profit through the stabilization of the commodity form in seed, the undermining of inter-generational, inter-species, human/plant kinship relations will produce yet another source of profit, through induced dependence on high-input farming regimes (Van Dooren, 2008, p. 83).

It should be noted that the one possible benefit of GURT is that it prevents geneflow of transgenic material into fields of neighbors who do not desire to grow Genetically modified organisms (GMOs). For those who worry that allowing GMOs undermines non-GMO production in a given region, GURT offers a viable control mechanism.

Van Dooren's point about the profits to be derived from GURT use does not just accrue to indigenous or poor subsistence farming communities. Also marginalized are organic and sustainable agriculturalists in developed nations, who farm outside prime farmlands. For vegetables sold as fresh produce in the United States this means essentially all farmers outside California.

Clearly then, even GMO plants, even GURT GMOs are enmeshed in the history of kinship and collective contributions of plants and their human caretakers. While kinship may be an uncomfortable category in other arenas, for agricultural purposes, documented webs of human–plant relationships, including the restrictions that can then be placed on plant subjectivity, are vital to the well-being of the food system. The restrictions of kinship allow a framework within which plants can articulate and humans can listen to voices that function without language.

Seeds of domesticated plants are a literature, a hard drive, a coded record of past information. Historically speaking, breeding as a special kind of alteration makes domesticated plants among the most ancient of technical products. The domesticated plant possessed of subject status belongs to the ancient centers of origin for food crops (Vavilov, 1992). As I write, it is the season when this year's forgotten tomatoes fall to the ground where they join the lettuce that bolted over the 4th of July and the walking onions that escaped my last desultory attempts at weeding. Those seeds are each like miniature encyclopedias of collective knowledge, articulating themselves and asserting their subjectivities, wherever and whenever they can.

About the Author

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Note

1 Joe is a plant breeder and member of the technical staff at a leading US land-grant university. The comments cited here are taken from a larger qualitative case study of a participatory plant breeding project that sought to breed varieties for the organic and sustainable farming sector.

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