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SPECIAL SECTION

INTERSTICES OF CARE: RE-IMAGINING THE GEOGRAPHIES OF CARE

Plants: Crop diversity pre-breeding technologies as agrarian care co-opted?

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Within the realm of international agricultural biodiversity conservation, there has been a surge of funding for "pre-breeding" of plant genetic resources for food and agriculture. Molecular high-throughput analysis, among other techniques, attempts to discern, document, and digitise the genomic traits of farmer/landrace varieties and crop wild relatives stored in gene banks to render them legible fodder for professional breeding. But pre-breeding necessitates thorough phenotypic evaluation and characterisation to understand the physiological attributes, heritable traits, and responses of a plant through its life cycle, under various growing and climactic conditions. This paper explores the irony that a range of surveillance technologies have been developed and deployed to mimic the agrarian work and skills of observing plants and attending to how they are faring, what they like and do not like over many seasons and contexts. These calls and technologies acknowledge the need for heedful attention to crops, even as they further displace actual farmers and their longstanding modes of selecting and saving open-pollinated seeds each harvest. Here, attending to crops entails remembering and communicating collectively gathered information of and from the plant. Such agrarian expertise of caring for plants has been systematically devalued and de-intellectualised, with gendered implications. Drawing on feminist geographies and political ecology, a landscape of care framework discloses the matrix of human and beyond-human care at work in cultivating agricultural biodiversity. Rather than ushering in a new valuation of this expertise, new pre-breeding technologies and trainings continue to ignore on-farm, plant-based care work and the farmers who do it. Calling out this contradiction could help re-centre such agrarian care skills as the crux to effective agricultural biodiversity utilisation. The proliferation of pre-breeding technologies could signify the co-optation of agrarian care skills or the opportunity to re-centre and revalue them.

KEYWORDS

agricultural biodiversity, feminist political ecology, geographies of care, plant genetic resources for food and agriculture, pre-breeding, science and technology studies

1 | INTRODUCTION

Within the realm of international agricultural biodiversity conservation, there has been a resounding call, a surge of funding, and spate of new technologies developed for "pre-breeding" plant genetic resources for food and agriculture (PGRFA).

Pre-breeding entails growing out, evaluating, and characterising the open-pollinated and landrace seed varieties and crop wild relatives stored in gene banks, to render them more genetically manageable for professional breeders. Since the mid-20th century Green Revolution, professional breeders have drawn from a narrow selection of gene bank holdings of PGRFA to produce high-yield commodity crop cultivars for wide, largely commercial, dissemination. Yet, as climate change becomes more severe and erratic, genetically homogenous agriculture becomes more precarious. Commercial breeders scramble to find new traits, even as the logistical challenges of these searches remain labour, knowledge, and time intensive (Kumar & Shukla, 2014). Hence, the new pre-breeding technologies, designed to "unlock" the "untapped potential" held in gene banks (Food & Agricultural Organization, 2015, pp. 5, 7). Although not described as such, this phenomenon is permeated with care to the degree that it comprises a veritable landscape of care (Milligan & Wiles, 2010). As the product and process of agrarian practices, agricultural biodiversity exists as complex, living matrix of human and non-human reciprocal nurturance through nourishment (Graddy-Lovelace, 2019). As agrobiodiversity declines, conservation efforts target heretofore neglected species, varieties, and wild relatives, and work to bring them into existing breeding pipelines through advanced pre-breeding technologies. Pre-breeding as currently defined in policy and training documents includes farmers only as end-users of commercial seed products. Yet, even these interventions can be understood as technological renditions of the agrarian care work of plant observation and also as potential co-optations of this on-farm care work and those who do it. Applying the lens of care both elucidates key power dynamics at work, and it sheds light on how care works in 21st century contexts. This article deploys discourse analysis contextualised with combined critical literature reviews of feminist geographies of care, feminist political ecology, and research on pre-breeding technologies. Empirically, I draw upon three sets of discourse: pre-breeding e-course material, global PGRFA policy, and data from qualitative research with in situ agrobiodiversity initiatives in the Peruvian Andes. By comparing these texts, I demonstrate the hidden, fraught care landscape at work in this new focus on pre-breeding technologies and the risks and opportunities therein.

2 | NEEDING PRE-BREEDING

2.1 | The big call

Conservationists and breeders bemoan the genetic erosion – and bottleneck – that has arisen after generations of monocropped, single-season cultivars have been bred, commercialised, distributed, and grown across the world.[1] The UN Food & Agricultural Organization (FAO) estimates that there are over 7.2 million accessions conserved in over 1,300 gene banks throughout the world (FAO, 2015), but their value withers when locked up. Pre-breeding encompasses all activities designed to identify desirable characteristics and genes from non-adapted germplasm and transfer these traits into "an intermediate set of materials" that breeders "can manipulate" (Food & Agricultural Organization [FAO], 2015). The world's major "high-yielding" varieties have "narrow genetic pedigrees," as commercial breeders have used "the same very few number of parents" to breed new varieties of major staple crops (Bhatti et al., 2015, p. 350). This limited genetic base, however, is no match for climate variability, driving breeders farther afield for crop wild relatives (Khoury et al., 2010).[2] Historically not worth the effort, pre-breeding has become critical amidst the agroecological vulnerabilities of monocropping. Pre-breeding converts wildness into legibility, taming and upgrading the "non-elite," "unimproved" landraces, while capturing their high levels of hardiness. Commercial breeders dread the unruliness of such "exotic" germplasm, but they need its novel, robust, adaptive traits now more than ever (Montenegro, 2016).

"Pre-breeding," as a distinct skill-set, was first defined in 1996 by the International Association of Plant Breeders (ASSINSEL, 154). In 2006, the FAO launched the well-funded Global Partnership Initiative for Plant Breeding Capacity Building (GIPB) and began administering grants and training in 2013. Pre-breeding topped the 2010 World Economic Forum agenda (WEF, 2010), and the 2012 Rio+20 meeting called for public–private partnerships to deliver "top-quality prebred genetic materials" to commercial breeders. The Food & Agricultural Organization (FAO), 2011 Global Plan of Action on PGRFA upheld pre-breeding as a Priority Activity: "Identifying traits in exotic materials and moving those genes into material more readily accessed by breeders" (4.6.1).[3]

Although scientists have framed pre-breeding as "pre-domesticating" (Falk, 2016), the call and subsequent public–private funding partnerships position pre-breeding as *pre-commercial* breeding, geared towards the needs of a highly consolidated agro-industrial market. Here the "pre-" prefix means both temporally before commercialisation and pro-actively assisting it. The online GIPB pre-breeding course justifies its own content and context within dominant political economies of agribusiness accumulation: "Private plant breeders are generally under pressure to fulfil short term goals and develop products that will generate profits…close cooperation between public and private institutions can be especially helpful in

pre-breeding programmes" (GIPB, 2011). Most pre-breeding remains funded by agroindustry-affiliated philanthropy, if not private industries themselves (ITPGRFA, 2013).

2.2 | Back to the field

Pre-breeding results from and expands a set of spatial tensions. Current framings of, and investments in, pre-breeding support ex situ conservation, yet requires field-based (*in situ*) phenotyping. Genetic and genomic characterisations strive to discern, document, and digitise which chromosomes will confer which traits. To counter a plant disease for instance, a pre-breeder characterises the epidemiology of the pathogen in question, screens for this trait among gene bank collections, characterises it in various samples, develops molecular markers for promising traits, and back-crosses to find a variety fit for commercialisation and distribution. At key stages, she draws upon data from field notes on trait expression and plant performance. Laboratory-based genotypic and genomic aspects of breeding have long garnered institutional support, but increasingly pre-breeding necessitates thorough *phenotypic* evaluation and characterisation. A plant's phenotype encompasses its physiological attributes and heritable traits: the structural, behavioural, and morphological features of a plant through its life cycle amidst myriad geophysical, biotic, and abiotic pressures. The molecular scale of reference therefore needs in-field corroboration, visible to the naked eye because the farm is where a plant's "phenomic" (Houle et al., 2010) spectrum of traits express themselves in their multifaceted manifestations. Recent research, however, laments the lack of proper phenotyping as the limiting factor in genomics (Araus & Cairns, 2014).

Pre-breeding acknowledges that phenotyping needs to happen before, during, and after genotyping. "No matter how fascinating the discoveries in the field of molecular biology are, in the end it is the phenotype that matters" plant scientists Pieruschka and Poorter admit (Pieruschka & Poorter, 2012, p. 813). Re-prioritising the phenotype re-centres the scale of reference of the plant itself, and thus the hand and the eye of those tending the plant. This entails returning to place and place-based knowledge, but "thinking place relationally" (Massey, 2004). The GIPB e-course admits as much: "The pre-breeder, although interested mainly in the genotype of the unadapted germplasm identified as a potential gene source, will have to pay careful attention to environmental components of variation" (2011). Evaluating a plant's performance requires attending to its stress levels, its well-being or lack thereof over successive generations and growing conditions. The GIPB reiterates the central importance of heredity, which requires accumulative attention: the breeder's memory and knowledge of a plant's memory, its reproductive system and inter-species variability.

Foregrounding pre-breeding therefore widens geographic scope even as it prioritises place-specific information. International PGRFA research centres around the world are in current consensus as to its import. It broadens the genetic base of crop production by expanding the area of potential crosses (Cooper et al., 2001), as it is the geographic features of each place that shape heritable traits and genetic memory. This global portfolio of local contexts accounts for phenotyping's high labour expenses; thorough pre-breeding would entail eco-geographical land characterisation maps of core collections to document millions of distinct ecosystems influencing individual trait expressions in combinations, across the world, amidst variably, rapidly changing climates. So much place-based work to do. How will it be done?

3 | AGRARIAN CARE SKILLS OF AGROBIODIVERSITY

3.1 | Caring for/through plants

Though the term "pre-breeding" and its funding surge are recent and focused around major gene banks, the realm of work comprising this activity is ancient, persisting in gardens and farms around the world. For millennia, farmers have selected, saved, and bred seeds based on agronomic performance, culinary preference, cultural significance, and nutrition. Colonialist agriculture instituted more extractive production methods, as did further waves and iterations of agro-industrialisation. By the 20th century, the agrarian care work of cultivating on-farm agricultural biodiversity persisted in pockets and margins of the Global North and in large swaths of the Global South. In a variable ecology, a farmer watches the field attentively to find a cultivar that handles drought well, that matures before frosts set in, that withstands a prevalent fungus. This work requires integrative ecological and agronomic expertise because it attends so meticulously to how individual trait expression signifies overall plant health, indicating overall crop population resilience. It merges praxis-based versions of botany, soil science, pollinator biology, hydrology, and meteorology, in successions of trial, error, success, communication, and more trial. Here, experiments depend upon temporally and spatially multi-scalar attentiveness to the conditions of a plant's thriving—and what constitutes thriving. The interstitial aspect of this inter-local, inter-generational expertise is dialogic farmer-to-farmer communication, itself foundational to farmer seed networks (Coomes et al., 2015).

This on-site attending can be understood through the lens of tending: effective breeding requires care for the plants at hand and for the broader development of robust, resilient crops. As a whole, these networks weave together to comprise a landscape of care, literally grounded in care in, for, and through agrarian landscapes. Here, following feminist political ecology, feminist geographies of care can be expanded to beyond-human realms (Puig de la Bellacasa, 2015), with people caring for food-plants so as to fulfil broader responsibilities of care and nourishment of others. Arguably, calling on-farm seed saving "care" risks further delegitimising the intellectual skillsets involved, which have been feminised in their devaluation as not productivist enough. But feminist geographies assert the honesty of investigating care (Lawson, 2007; Smith, 2016), particularly as a fulcrum of power relations and asymmetries (Raghuram et al., 2009) amidst increasing human-technological intimacies and interdependencies (Puig de la Bellacasa, 2011). Tracing the carescapes at work in pre-breeding entails recognising the carework comprising in-field agricultural biodiversity and its intellectual dimensions. From the agronomic perspective, growers have cultivated agrobiodiversity through careful attention to well-being and lack thereof. At the heart of this attending to plants is *tending* to them. Driving careful observation is care itself.

3.2 | Crianza

The affective aspect of environmental care labour makes it effective (Singh, 2015)—a point emphasised by farmers in the Peruvian Andes, a world-renowned Center for Crop Diversity and Origin,[4] who often describe seed selection for agricultural biodiversity by explicitly using language of mutual nurturance. Focus groups with farmers, as well as public materials, describe the central biocultural principle of reciprocal care: in Quechua, *uywayku* (nurturance) comes to comprise *anyi* (reciprocity). This has been translated into Spanish as "*criar y dejarse criar,*" meaning to raise/rear and allow oneself to be raised/reared (Apfel-Marglin, 1998). Agrobiodiversity necessitates *tending* to seeds and plants with expertise – expressed by farmers as both tenderness and knowledgeability – and then remembering and communicating that information *of and from the plant* across time, for future seasons, and across space, for different places.

Feminist geographer Puig de la Bellacasa notes that "engaging with care requires a speculative commitment to neglected things" (Puig de la Bellacasa, 2011, p. 85), in this case the small-scale, semi-subsistence farmers or home-gardeners hard at work selecting, saving, and sowing biodiverse seed. Most farmers draw upon both informal and formal seed networks, saving seed while also purchasing seed bred from gene banks (Coomes et al., 2015; Jarvis et al., 2011) and general throughlines exist: in situ (on-farm) agrobiodiversity expertise may be lauded, but it is rarely supported (Graddy, 2013). From epistemological and financial perspectives, on-farm agrarian care skills have long been devalued as less important than laboratory-based professional breeding. Agrarian theorist Berry evocatively defends the intellectuality of on-farm breeding:

> The good farmer, like an artist, performs within a pattern; he must do one thing while remembering many others. He must be thoughtful of relationships and connections, always aware of the reciprocity of dependence and influence between part and whole. His work may be physical, but its integrity is made by thought. We will not understand what we mean when we say that he works with his hands, if we do not understand that he works also with his mind. (Berry, 1981, p. 28)

Milligan and Wiles (2010, p. 737) emphasise the "reciprocal dependence in which both recipients and providers are involved in the coproduction of care." In the agricultural context, humans and plants (and ultimately livestock, soil biota, pollinators, fungi) comprise the web of multidirectional flows and connections of mutual nourishment held together with care and/or the implications of its lack. A feminist theory of care "troubles the autonomy of the individual" (Olson, 2016) to foreground empathy "arising from face-to-face encounters in particular situations" (Lejano & Funderburg, 2016, p. 1098). On-farm seed selection necessitates this relational, contextual attentiveness beyond the human realm. The theoretical framework of carescapes also encompasses macroeconomics, governance, and social arrangements (Milligan & Wiles, 2010). Carescapes of farms, gardens, and plants – and in the case of professional pre-breeding, experimental test plots, laboratories, and chromosomal sequences – interweave with broader political and economic carescapes of agrarian change and crisis, politics, and possibility.

4 | RENDERED TECHNOLOGICAL

4.1 | Caring through technologies and data

While pre-breeding is slow and expensive, requiring long term investment (Bhatti et al., 2015), technologically enhanced pre-breeding is like "fishing the gene pool with dynamite" (Dempewolfe, 2013, p. 35). The new batch of pre-breeding

technologies includes expensive "high-throughput" phenotyping platforms for rapid data collection, robotics, and precision remote sensing (Araus & Cairns, 2014). But the meticulously controlled environment of these high-technological facilities backfires in the case of identifying traits resilient to variable conditions. The need for non-invasive, non-destructive investigations of plant phenotypic features (Fiorani & Schurr, 2013) has prompted a range of proximal sensing. To streamline field screening for desirable traits, the Focused Identification of Germplasm Strategy scans and merges climate-level habitat characterisations and correlates them to crop trait scores: "environmental parameters describing plant germplasm collection sites are used as selection criteria to improve the probability of uncovering useful variation" (Khazaei et al., 2013).

Geo-spatial, aerial, and high-resolution satellite mapping need prior on-site observation of environmental contexts. Virtually rotated 3-D plant phenotyping assess plant morphology, while optical sensors, as used in precision agriculture, employ hyper-spectral or thermal imaging from "phenomobiles," "phenotowers," and drones for plant architecture (e.g., Rist et al., 2018). But they measure only one site in the famously heterogeneous topology of soil, leading experts to admit that "[c]rop performance provides the best indicator of field variability" (Araus & Cairns, 2014, p. 58). In this proliferation of technologies and genomic sequencing information, a whole other realm of bioinformatics and communication is needed to synthesise and deploy the data deluge.

Technologies themselves could be used to supplement, expedite, and connect farmers' field observations, seed selection, and participatory plant breeding. Yet, the current treadmill of capital-intensive technologies mimic and threaten to displace human agrarian care skills. The subject of pre-breeding requires the feminist analysis of care along with a science and technology studies perspective (Martin et al., 2015), because 21st century care increasingly combines the human and technological. Although useful, these technological advances emerge from and, thus far, perpetuate an epistemology – and political economy – that devalues agrarian care skills. If technologies supplant humans, then conditions of the mutuality of care are undermined; the networks of reciprocity and responsibility that comprise care risk becoming tangled and curtailed. Technologies are being designed and deployed to simulate these embodied and situated, "emplaced" (Singh, 2015) practices. Yet, if these technological interventions thwart the affective relations of care between humans and plants, the *effectiveness* of the broader landscape of care is threatened, its ability to nourish and upkeep the conditions for mutual nourishment.

4.2 | Capturing capacity

One way this happens is in the GIPB e-course and grants which aim to "build pre-breeding capacity in developing countries" (2011). Intending to empower through technology transfer, however, the GIPB model further delegitimises on-farm breeding skills, even as it inadvertently acknowledges their importance. When the GIPB e-course lauds multidisciplinarity and communication as the two "main pillars of pre-breeding," it is admitting the intellectual breadth of agrarian farmer-breeder knowledge. The GIPB e-course lists those working within the realm of pre-breeding – "germplasm curators and plant breeders and their assistants, and extension agents, seeds specialists, field technicians and relevant research administrators and managers" – but omits farmers and gardeners. Its flyer strives to expand its relevance – "the ultimate goal is to ensure that a critical mass of plant breeders, leaders, managers and technicians, donors and partners are linked together through an effective global network to cope in unison with the challenges of crop production and sustainable use of PGRFA" – but this just deepens the omission. Farmers appear in the current pre-breeding boom as end-users, rather than as (re)generators of genetic diversity. In-field breeding knowledge has been systematically de-scientised – as unskilled labour – but is now being unwittingly re-scientised as technology and as "capacity" held by professional breeders and gene bank institutions. The Global Plan of Action on PGRFA echoed and amplified lamentations on the global lack of pre-breeding skills: "human resource capacity is still far from adequate at virtually all levels and in all disciplines related to PGRFA conservation and use" (FAO, 2011, p. 80). One of the "causative factors" of narrowing genetic base for major food crops consumed globally "is inadequately skilled human resources…the single most critical factor imperilling efforts to enhance the resilience of cropping systems worldwide. Pre-breeding…can reverse this trend" (Mba et al., 2013, p. 21). PGRFA conservation has entailed Global South "capacity building" for a generation, with over 300 professional PGRFA conservation specialists trained between 1989 and 2012 in southern Africa alone (Munyenyembe & Qhobela, 2014). But with pre-breeding described as the transfer of traits from gene banks to "an intermediate set of materials that breeders can use further in producing new varieties for farmers" (Kumar & Shukla, 2014, p. 199), in situ farm breeding withers for lack of acknowledgement and thus support.

Techno-managerial, developmentalist calls for pre-breeding fail to acknowledge farmers and their intellectual heritage of crop diversity as "capacity." In her analysis of soil degradation, Puig de la Bellacasa shows how "[p]roductionism transforms care from a co-constructed interdependent relation into mere control of the object of care" (Puig de la Bellacasa,

2015, p. 700). Likewise, productivist breeding overlooks the interdependent reciprocal care between crops and their cultivators, reducing the complexity of agrarian care skills into discrete tasks of surveillance and classification. Fraser's claim that the current "crisis of care" represents an "acute expression of the social reproductive contradictions of financialised capitalism" (Fraser, 2016, p. 99) pertains. Here, the need for agrarian care skills is inadvertently acknowledged, even as the political-economic conditions for them are undermined.

This displacement has gendered implications. According to 2014 UN FAO and World Bank sources, there are 564 million women farmers around the world, although this is likely an undercount. Farmers, particularly women farmers, have been selecting seeds to save and breed for millennia. In Centres of Crop Origin and Diversity, seed selection entails knowledge of wild crop relatives and cross-pollination. Yet, despite rhetoric of gender equity in agriculture, disparities remain regarding land tenure and the feminisation of agrarian exploitation and crisis (Deschutter, 2013). Geographers have chronicled how women's agricultural labour has been appropriated even as it is de-intellectualised as domesticated (England, 2010) and mere "tinkering" (Mol et al., 2010). Agrobiodiversity embodies this, as demonstrated by Howard in Bangladesh, where biodiverse agriculture: "involves a highly demanding and holistic level of technical environmental knowledge and skills related to plants that can require at least a third of a lifetime to accrue, as well as frequent innovation. …Women's subsistence work related to plants is *intended* to remain in the shadows" (Howard, 2003, p. 6). Within this broader context of gender inequity in agriculture, feminist agrarian scholars warn of the tendency to hierarchise technologies overloaded with clout over feminised realms of agrarian care.

5 | OPPORTUNITIES

5.1 | Care remunerated?

Feminist geographers contend that the analytical lens of care, "which is so critical to our very ability *to live*, is also vital to questions of morality and subsequently politics" (Smith, 2016, p. 1228). As such care becomes not just an object and lens of study, but the fulcrum for an alternative ethical standpoint (Blazek et al., 2015; Popke, 2006; Tronto, 1993). The intellectual marginalisation of care exacerbates existing axes of discrimination, thereby demanding intersectional (Hankivsky, 2014) and postcolonial (Raghuram et al., 2009) analyses. This phenomenon unfolds in the realm of agricultural biodiversity, which can be understood as a landscape of care at large, and as micro-landscapes of care in settings across the Global South and in margins across the Global North. Disclosing the carescape of pre-breeding technologies shows the exclusion at work in these investments and how they perpetuate historical appropriation and displacement.

This partial recognition of the value of in-field phenotypic analysis in pre-breeding brings possibility. The sheer scale of multifaceted and multi-local pre-breeding needs has led to calls for low-tech complements to high-tech interventions (Araus & Cairns, 2014). The USDA concurs: as "the most important challenge now in terms of time, cost, and complexity is to phenotype the collections," they call for "low-cost phenotyping platforms that can be accurately replicated and dispersed" (Byrne et al., 2018, p. 10). Farmers and gardeners might want to be trained and remunerated in this line of suddenly revalued, re-scientised work, if it acknowledged their pre-existing expertise. This could entail increased support for participatory plant breeding (Ceccerelli, 2015) and Payments for Agrobiodiversity Services (Krishna et al., 2013).

Although critiqued as commodification of life-forms, payment for ecosystem services can also, according to feminist geographers of care "create an opportunity to valorise the role of human relationships of management and care along with the diverse and amorphous ways in which they are embedded in communicative reciprocity with non-human nature" (Jackson & Palmer, 2015, p. 139). Focusing on care unpacks the extension of market economics and neoliberal logics into lived, personal relations and domains (Lawson, 2007). Recognising pre-breeding technologies as both a growing part of agrobiodiversity's landscape of care and as a potential unravelling of its affectiveness/effectiveness clarifies key points: it highlights the long-disregarded agrarian care skills at work in breeding and how this work and these skills are obscured when agricultural biodiversity is rendered germplasm. The landscape of care lens also shows how even high-technological interventions still aim to accomplish attentive plant observation and intimate knowledge and memory: care work, rendered scientific and technical. Applying a landscape of care lens comes, however, with both insights and further risks. Feminist geographers warn against the objectification of care, the non-remuneration of ubiquitous, crucial care work (Claassen, 2011; Cox, 2013) as well as simplistic understandings of care-based employment, which fail to account for the multiple, relational dependencies and contingencies that make up life and thus livelihoods (Hanrahan, 2015).

6 | CONCLUSION

A range of pre-breeding technologies are being developed to examine, survey, and explain plants' structure, performance, and resistance to environmental stresses over time and across fields, while another set of bioinformatic technologies aim to analyse and synthesise this field-based data. This paper explores the contradiction of this call, its funding, and its technologies, which all result from a recognition that the dialogic expertise of knowing how a plant is faring under various growing and climactic conditions is fundamental to breeding, to agriculture, and to human life. But this recognition is itself unrecognised in pre-breeding trainings and agendas, as are the farmers who have been "pre-breeding" long before it was called that.

On-farm crop diversity expertise is honed by paying attention to a field of plants, attending to their needs, in short, caring for them. This realm of agrarian skill highlights the intellectual, place-based, and beyond-human dimensions of care work more broadly. Continuing historical power dynamics of appropriation and the de-valuation and de-intellectualisation of agrarian care skills persist, now alongside a mechanisation and re-scientisation of in situ breeding. Pre-breeding technologies admit, and yet still fail to acknowledge, the tending at the heart of attending: that meticulous, multifaceted, accumulative attention to a plant's well-being requires care. Agrobiodiversity exists as landscapes of care, and the rise of pre-breeding technologies weaves its way in. On one hand, they are merely extensions of the agrarian care skills that comprise these matrices of human–non-human nurturance; conversely, if they further displace actual farmers doing the work of seed saving and on-farm breeding, they thwart the networks of affective/effective nourishment and threaten the efficacy of the carescapes themselves. Nevertheless, calling out this contradiction through the lens of care could help re-centre and revalue such agrarian care skills towards effective and equitable agricultural biodiversity cultivation.

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DATA ACCESSIBILITY

No new datasets were generated for this article.

ENDNOTES

[1] Intellectual property regimes, from plant variety protection to utility patents, prohibit on-farm saving of modern seed varieties, thereby legally rendering them single-season.

[2] Crop wild relatives are weedy plants in the same taxon as major crops.

[3] The Consultative Group for International Agricultural Research (CGIAR) system took up the cause with gusto, as did the International Treaty for PGRFA's funding arm: the Global Crop Diversity Trust.

[4] These are regions of the world where major crops were first domesticated and which persist as crop diversity hotspots.

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