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Seeds in the Anthropocene: A Critical Lens on Ecology, Empire, and Epistemic Resistance

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Abstract. In the Anthropocene, the global ecological crisis is not only environmental but also epistemological and political. This paper examines seeds as critical analytical sites where ecological disruption, colonial history, and knowledge contestation converge. Through historical and ethnographic examples, it traces the shifting meanings and functions of seeds—from ecological collaborators in multispecies networks to instruments of imperial extraction and capitalist commodification. The analysis reveals how modern seed regimes, shaped by genetic science and property law, have contributed to the erosion of agrobiodiversity and the enclosure of local knowledge systems. However, the paper also identifies a countercurrent: grassroots "reflective seed practices"—such as Indigenous stewardship and community seed saving—are challenging dominant regimes by reviving relational, situated, and non-commodified forms of knowledge and care. These practices are not romantic returns to the past but adaptive responses to planetary instability, grounded in performative and plural ecologies. The paper argues that seeds are not merely affected by the Anthropocene but illuminate its deepest structures. By reading seeds as agents of political economy and epistemic resistance, the study contributes to a rethinking of ecological futures beyond technoscientific fixes, emphasizing relational ethics, cognitive justice, and grassroots transformation.

Keywords: Anthropocene, seeds, epistemic resistance, agroecology, coloniality

1. Introduction

In the face of escalating ecological instability, the Anthropocene is widely recognized as an era of climate disruption, biodiversity loss, and planetary boundary transgressions. Yet this epoch also signifies a deeper crisis—one of knowledge, power, and governance. Beyond material degradation, it demands that we confront the epistemological and political foundations of our relationship with nature [1-3]. Amid these overlapping crises, seeds offer a critical analytical lens. As biological entities and cultural symbols, they reveal how societies construct relationships with land, life, and the future. Seeds are not passive units of reproduction; they are deeply embedded in historical, ecological, and socio-political contexts. From early foraging societies and multispecies dispersal systems to colonial plant transfers and modern biotechnological control, seeds have always been implicated in broader regimes of knowledge and value. How we treat seeds—as commons or commodities, as knowledge or property—shapes not only agricultural systems but also legal,

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economic, and epistemic infrastructures. This paper asks two central questions: How do seeds help us diagnose the ecological, political, and epistemic crises of the Anthropocene? And how might they enable us to imagine more just, plural, and situated ecological futures? Through an interdisciplinary inquiry that draws on historical accounts, political ecology, and case studies of grassroots seed practices, the paper aims to situate seeds as active sites of contestation and possibility. Rather than relying solely on top-down scientific or policy-driven solutions, it explores how seeds can anchor relational, place-based alternatives that respond to planetary crisis from the ground up.

2. Before the Anthropocene: seeds as ecological collaborators

Before the onset of the Anthropocene—an epoch marked by the recognition that humankind has become a global geological force—seeds were not merely passive tools of cultivation but active ecological agents embedded in multispecies dispersal networks [4]. Fullilove has described seeds as "technologies of time," capable of storing evolutionary memory while pointing toward future ecological possibilities [5]. Far from inert matter, seeds travel across space and time through wind, water, animals, and humans.

In early foraging societies, humans often acted as unintentional vectors for seed dispersal. As they migrated, gathered, or interacted with animals, seeds adhered to their tools, clothing, or digestive systems. These incidental interactions accelerated plant gene flow and biogeographical expansion across landscapes. Ellen, in his comparative work on English allotments and Indonesian swidden communities, emphasizes that seed dispersal often occurs through informal, social, and kin-based networks—both deliberately and inadvertently [6]. The Near East provides a compelling illustration of this dynamic. Zeder documents how, beginning around 11,500 BP, human groups across the Fertile Crescent engaged in repeated harvesting and localized sowing of wild cereals such as barley and einkorn wheat [7]. These practices gradually led to domestication, not as a singular, linear process in the southern Levant, but as a mosaic of parallel and interacting developments across multiple regions. This perspective foregrounds the distributed, relational nature of seed–human coevolution.

Seeds are more than reproductive units; they are carriers of meaning. Some of the earliest known cultural artifacts attest to this symbolic role. For example, the National Museum of Damascus houses grains of rice and wheat inscribed with proto-symbols—possibly among the world's earliest alphabetic forms [5]. These grains do not merely represent early forms of writing; they mark a broader civilizational shift: the moment when human societies began not only to domesticate plants biologically but also to inscribe them with cultural significance. Seeds thus became vessels of memory, governance, and cognition—embedded in both agricultural practice and symbolic systems.

To understand seeds fully, we must move beyond anthropocentric paradigms. Latour's Actor-Network Theory offers a useful framework to view seeds not as passive matter, but as agents within distributed ecological assemblages. Their dispersal is shaped not only by human intention but also by wind currents, animal activities, and hydrological patterns [8]. In this relational ontology, seeds actively participate in shaping ecological and cultural landscapes. Their agency is not granted by humans; rather, it emerges from their embeddedness in a more-than-human world. As Ellen argues, the movement of seeds and vegetative propagules in both industrial and non-industrial settings is rarely governed solely by institutional systems or market forces [6]. Instead, it often relies on familial ties, seasonal rhythms, and experiential knowledge. This underscores the importance of social storage systems in maintaining agrobiodiversity. Seeds are not always under "human control," but rather act as an intermediary in ecological negotiation.

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In sum, prior to the Anthropocene, seeds should be understood not merely as biological inputs but as temporal, cultural, and ecological collaborators. Their capacity to mediate between past and future, human and non-human, and symbol and sustenance positions them as vital actors in the co-production of ecological order. This distributed agency, however, would later be systematically undermined as seeds became entangled in colonial extractivism and capitalist commodification.

3. Political economy in the Anthropocene: colonization and commercialization of seeds

If seeds were once vessels of hope for early human societies navigating ecological uncertainty, they became, during the era of imperial expansion, powerful tools of global power projection, resource extraction, and scientific domination. From the seventeenth century onward, as European empires built vast colonial networks, the collection, transfer, and regulation of seeds and vegetative propagules were increasingly systematized, woven into the scientific, military, and commercial apparatus of imperial governance [9]. Botanical gardens such as Kew Gardens in London and the Jardin des Plantes in Paris emerged as command centers of what scholars term “botanical imperialism.” These institutions coordinated plant hunters across the colonies, orchestrating the extraction of economically valuable species and transforming seeds into nodes of global resource redistribution [10].

However, this biocolonial enterprise extended far beyond the material realm. Experiential, community-based knowledge systems surrounding seed saving, crop selection, and ecological adaptation—carefully cultivated over generations—were often appropriated into Western scientific taxonomies and imperial property regimes. Simultaneously, Indigenous knowledge was marginalized as anecdotal or unscientific, rendered invisible within dominant epistemologies of empire. Such processes constituted not merely a territorial enclosure but a cognitive one. Seeds thus became imperial instruments—at once symbolic and material— employed to reconfigure both ecological orders and geopolitical hierarchies.

Crucially, the domestication of plants—long assumed to be a linear and unidirectional achievement of early agricultural “centers”—is increasingly understood as a distributed and negotiated process, involving multiple sites and diverse socio-cultural actors [11]. This challenges the Eurocentric notion of progress and reveals how seed knowledge is not the product of isolated innovation but of collective experimentation embedded in ecological, spiritual, and relational worlds. The translation of these shared practices into private property via patents fundamentally disrupts their communal logic.

As the twentieth century unfolded, the logic of imperial extraction was not dismantled but reconfigured. Under the banner of scientific progress and modernization, seeds became central to a new techno-utopian project: industrialized agriculture. The Green Revolution, launched in the mid-twentieth century, is often credited with averting famine through increased yields. However, it simultaneously entrenched a scientific-industrial paradigm that marginalized agroecological diversity and dispossessed smallholders. Yield became the dominant metric of success, while knowledge systems rooted in place, tradition, and ecological balance were rendered obsolete [12,13].

One of the key institutional shifts in this transformation was the formalization of seed patents. As early as the nineteenth century, the U.S. Patent Office and Department of Agriculture initiated large-scale seed collection and distribution programs. These bureaucratic efforts translated biological commons into privatized assets, masking persistent global inequalities in access to and control over plant genetic resources [5]. Moreover, these public institutions fostered a research culture that

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framed agricultural “improvement” as neutral and technical, while ignoring the inherently political nature of plant collecting and breeding.

This shift was further cemented through the discourse and practices of genetics. As both a discipline and metaphor, genetics emphasized laboratory manipulation over embodied cultivation, reframing seeds as programmable code rather than living cultural entities. Within this epistemic framework, seeds are not situated within landscapes of meaning, memory, or autonomy, but within systems of yield optimization and genetic control. Such framing reinforces what scholars have called “yield fetishism”—a regime that abstracts productivity from ecological integrity and social equity. This narrative renders smallholders and traditional farming systems invisible and legitimizes their displacement in the name of scientific efficiency [5].

In the Anthropocene, where ecological breakdown is often reframed as a technical challenge, the authority of genetic science is further amplified. Gene banks and biotechnological interventions are promoted as instruments of salvation, yet they reproduce the same extractive and exclusionary logics that contributed to environmental degradation in the first place. As Fullilove observes, this results in a profound paradox: while scientific knowledge is mobilized to “protect biodiversity,” it simultaneously abstracts seeds from the socio-ecological worlds that sustain them [5].

Meanwhile, the Anthropocene is witnessing a systemic failure of core ecosystem functions. The collapse of seed dispersal networks is a classic sign of this unraveling. As Pérez-Méndez et al. demonstrate through the case of the Canary Islands, the extinction of large frugivorous lizards has caused a dramatic reduction in seed dispersal distances for endemic plants [14]. Once seeds were able to travel tens of meters, facilitating genetic exchange across populations. Now, with only small-bodied lizards remaining, dispersal is confined to within a few meters, resulting in genetically fragmented plant populations with reduced adaptive capacity. This case exemplifies how the loss of key dispersers due to defaunation—a hallmark of the Anthropocene—can sever ecological linkages that took millennia to evolve.

This pattern echoes and shows that global seed disperser populations are declining at an alarming rate, particularly large-bodied vertebrates that are disproportionately responsible for long-distance dispersal [15]. This trend is driven by habitat destruction, hunting, climate change, and biological invasions, all of which are intensified by human land use and economic expansion. The result is a global erosion of ecological connectivity: plant regeneration slows, genetic diversity declines, and species distributions become increasingly static and fragmented. Seed dispersal is not just a biological event—it is an ecological infrastructure that enables resilience, adaptation, and regeneration. Its loss signals a deeper unraveling of ecological function in the Anthropocene. What appears to be a localized disappearance of birds, bats, or reptiles is, in fact, a systemic warning: the ecological scaffolding that supports life is quietly collapsing.

4. Reflective seed practices in the Anthropocene

In the ecological crisis of the Anthropocene, seeds are no longer merely the material basis of agricultural production. They have become starting points for political, cultural, and decolonial transformations. Bennett et al. proposed the idea of “Seeds of a Good Anthropocene” to highlight how grassroots innovations can offer hopeful visions for sustainable futures, rather than simply patching up the status quo [16]. These “seeds” include local food systems, traditional agricultural knowledge, and community-based seed-saving initiatives. They not only contest mainstream agriculture's singular view of nature but also challenge hegemonic knowledge systems and property regimes.

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The "seeds' substrate" is a new concept introduced by Gianelli et al. to describe how such practices coalesce, scale, and provide fertile ground for transformation. They argue that systemic change depends not only on the potential of individual seeds but also on the networks, support structures, and value communities they are embedded in. In a case study of Uruguay's small-scale fisheries, they found that multiple seed initiatives were connected through non-competitive resource sharing, cooperation, and emotional support, which enhanced the system's overall resilience and regenerative capacity [17].

This evolutionary trajectory resonates with Kumar's notion of the "decolonial history of science" [18]. He argues that modern science—particularly in the field of seeds—often conceals the complexity and legitimacy of local knowledge. Reconstructing a historically and culturally embedded understanding of science is essential to dismantling the structural exclusions built upon the myth of "technical neutrality." The transformative potential of these practices lies not only in resisting commodification, but also in indicating a "re-localized" politics of knowledge. Seeds are re-situated within local ecological rhythms, cultural practices, and intergenerational relationships, becoming shared but non-commodified commons. As Fullilove notes, it is precisely through these challenges to property regimes, technoscientific neutrality, and modernist narratives that seeds emerge as "critical matter" in the Anthropocene: sites of contestation as well as platforms for resistance and collective regeneration [5].

However, revitalizing local knowledge does not imply sanctifying or romanticizing it [5]. Fullilove cautions that local knowledge is not a closed or static repository of tradition, but rather a form of situated, adaptive practice shaped by shifting histories, institutions, technologies, and ecologies. To treat it as an untouched and pristine truth is itself a misreading—one that risks obscuring the internal negotiations, ruptures, and reconstructions through which it is continuously remade. In her field notes from a seed collecting expedition near Mount Ararat, Fullilove recounts an encounter with a Yazidi pastoralist who, without formal education or institutional affiliation, expertly identified the flowering patterns and insect habitats critical to local dye production [5]. His ecological knowledge was not preserved in oral tradition alone, nor was it linked to some "authentic" cultural identity—it emerged from daily mobility, labor, and acute observation. This case illustrates how local knowledge is enacted through practice, not inherited as essence, and how it is deeply entangled with material survival and environmental stewardship. In the context of seed politics, such romanticization becomes especially dangerous. It risks turning farmers' knowledge into a cultural token—displayed but not empowered—thereby stripping communities of their agency in shaping ecological governance. A genuinely decolonial seed practice must operate on two fronts: first, dismantling the monopolistic narratives of modernist agricultural science, and second, refusing to ossify local knowledge as heritage. Instead, it must foreground its performativity, fluidity, and capacity for transformation, keeping space open for a plural ecology of knowledges.

Thus, reflexive seed practices are not merely technical innovations in agriculture—they are processes of cultural recovery, knowledge redistribution, and social reorganization. They serve as critical entry points toward a more just future in the Anthropocene.

5. Conclusion

Seeds are more than biological entities; they are sites where ecological, political, and cultural tensions converge. In tracing their shifting roles across time—from ecological collaborators in pre-industrial societies to objects of commodification and control in the modern era—we find that seeds reflect the broader transformations in how humans relate to nature, knowledge, and each other. Their

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histories mirror not only the evolution of agriculture but also the consolidation of power and the marginalization of alternative ways of knowing.

This paper has shown that seeds have never been merely passive inputs in food systems. They have served as mediators between species, carriers of memory, and instruments of both care and domination. The transformation of seeds under colonialism, capitalism, and technoscience reveals how ecological processes become entangled with legal and economic structures. At the same time, contemporary seed-saving movements, local stewardship, and community-based practices remind us that seeds still hold the potential to resist enclosure and cultivate alternative futures.

In the context of the Anthropocene, where ecological systems are under severe stress, seeds challenge us to rethink the foundations of sustainability. They invite us to imagine relationships based not on extraction and control, but on reciprocity, plurality, and shared vulnerability. Rather than viewing seeds as resources to be optimized, we might come to see them as companions in a more grounded and just ecological future. The task ahead is not only technical or scientific but also relational and ethical—a matter of reweaving our connections to life, place, and each other.

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