A social perennial vision: Transdisciplinary inquiry for the future of diverse, perennial grain agriculture

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Societal Impact Statement

Plant scientists around the planet are working to develop new perennial grains and learn how to grow them in diverse agroecosystems. Perennial grain agriculture could accomplish long-term sustainability by providing food for humans without degrading the ecosystem processes on which food productivity depends. However, more research is needed to understand how to pursue perennial grain food system transformation that builds justice within diverse human societies. We use a case study from Palestine to explore why this research should encompass many academic disciplines and go beyond them to engage communities. By paying attention to deeper agricultural systems of relationship that shape change, researchers may better develop and integrate the knowledge necessary to help realize a “social perennial vision.”

Summary

- Research across plant science domains is foundational to the development of novel grain agroecosystems that feature perenniality and diversity. Because agriculture is social as well as biophysical, research is also needed to address how to make just and fair human community arrangements and socioeconomic relationships within diverse, perennial grain agroecosystems.
- As a first step, we draw on agroecology as well as critical concepts from the social sciences and humanities in order to identify dominant systems of relationship in agriculture, recognize their past and present impacts in the ecosphere, and envision alternatives. To ground our analysis, we use a case study of a research group in Palestine that engages communities in co-producing plant knowledge.
- Our social perennial vision recognizes the effort required by human communities to find ways to endure in agricultural landscapes. Alternative systems of relationship are both necessary and possible to build diverse, perennial grain agroecosystems. The scientific and social knowledge required for positive agricultural transformation may be gained through more integrated research efforts.
- The social perennial vision that we characterize affirms the importance of transdisciplinary inquiry for the development of diverse, perennial grain agriculture. We highlight the ethical and practical values of participatory approaches and accessible tools for future research.
1 | INTRODUCTION

Input-intensive annual grain monocultures require disturbance and thus have come to industrially dominate many of the planet’s agricultural landscapes at the expense of long-term ecosystem health (Crews et al., 2018; Pimentel et al., 2012). Future projections describe the negative impacts on biogeochemical processes if industrial food systems are continued (Carlson et al., 2017; Lassaletta et al., 2016; Mueller et al., 2017; Schütz et al., 2018). In contrast, novel grain agroecosystems that feature perenniality and diversity may both provide food for human societies and mimic the ecological processes provided by intact wild ecosystems (Asbjornsen et al., 2014; Crews et al., 2016; Glover et al., 2010). Plant breeders and ecologists at The Land Institute (Salina, KS, USA), in collaboration with research partners around the world, are developing new perennial grain crops to be grown in diverse systems (see special issue introduced by Crews & Cattani, 2018).

Research across scientific disciplines is foundational to the development of perennial grain agriculture. But agriculture is sociocultural as well as biophysical. Since food production is increasingly seen as an industrial process, it is necessary to remember agriculture’s human dimensions and cultural importance. Agroecosystems include and are influenced by human cultural ecology (Francis et al., 2003), and the agroecosystem concept has been defined by a goal of “increased social value” (Conway, 1987). Generally, scientific research is practiced, supported, and applied by people, whose values and priorities matter at multiple stages of research processes (Elliott, 2017). Humans are land animals who live in relationship with biophysical and ecological processes, and humans are social creatures who live in relationship to each other. Transforming grain agriculture requires attention to and perception of both.

Because perennial grain agriculture is being developed through applied research with the goal of solving sustainability problems and supporting positive transformation, there is scientific, practical, and ethical worth in articulating and analyzing its normative implications and opening them up for discussion. We follow Nielsen et al.’s (2019) understanding of normativity as “a reflexive collaborative process acknowledging, deliberating on, and learning from the evolution of concepts, underlying values and assumptions, and shared understandings that guide our research and how, in the end, to operationalize our findings for more sustainable and just land-use options for current and future generations.” Perennial grain researchers themselves have called for further study of the “interlinked socio-economic and ecological dimensions” of agriculture and “the process of transition itself, the engrained practices and institutions that have a political and economic stake in perpetuating the current agricultural mode, and how they can be confronted” (Crews et al., 2018).

In this article, we follow and build upon Crews et al. (2018) in utilizing Erik Olin Wright’s (2010) three-part framework for “envisioning real utopias” to specifically explore the sociocultural dimensions and human community implications of perennial grain agriculture research. We focus on diverse, perennial grain agriculture because it could provide an alternative to annual, plow-based, industrial grain agricultures that are entwined with relationships of domination.

First, we critically engage normative relationships that help drive annual grain agriculture. We draw on theoretical concepts from the humanities and social sciences to identify relationships of domination that undergird engrained agricultural practices. Our ecospheric analysis highlights the relevance of studying and engaging human social processes, as established in agroecology more broadly (Méndez et al., 2013), for the transformative development of perennial grain agriculture.

Second, we envision alternative normative relationships that could lead to more sustainable grain agriculture and advance research into more perennial and diverse systems. If the ecological future of agriculture is to become perennial and diverse, what is required of humans in social terms? Inspired by diverse knowledge systems, we share a social perennial vision.

Third, through our critique and vision, we provide a case study of a transdisciplinary research group who engages with shifting normative relationships in order to illustrate a possible process for transformation. This case study, situated in Palestine, shows both the challenge and possibility for landscape-scale agricultural intervention that engages human communities in co-producing plant knowledge. We affirm the relevance of transdisciplinary inquiry (Knapp et al., 2019) for the development of perennial grain agriculture in particular and in the context of scientific research that relates people and plants.

2 | RELATIONSHIPS OF DOMINATION IN AGRICULTURE

Agriculture is not merely an environmental problem, by which we mean it is not merely “out there,” in fields that surround humans but are separate from us. Agriculture is a system that has emerged from and within the processes of the ecosphere, Earth’s dynamic mantle of life (Rowe, 2002, 2006). Through agriculture, landscapes are changed to direct more of the energy animating ecosystems to humans as food. On a larger scale, agriculture impacts and redirects Earth system processes, such as energy flow pathways and nutrient cycling. Both local and global impacts of agriculture are mediated through the lively ecospheric nexus of soil. An ecospheric perspective helps us conceive of how agriculture is also “in here” and among humans (Jackson et al., 2018). How we humans feed ourselves is a major factor in how we express...
and reify our relationship to the ecosphere our bodies are constituted by, including our material relationships to non-humans and seemingly non-living matter, and our social relationships to other human beings in communities.

Scholars in the social sciences and humanities have theorized multiple ways of understanding and naming the relationships of domination that underlie deepening social–ecological harm. We consider three systems of relationships in particular that have grown out of agriculture in the ecosphere and help drive a Western extractive agricultural system, now at the scale of a global economy with planetary consequences:

- **Agrilogistics** (Morton, 2016): a mechanical system of thought and action, resulting from a basic division between culture and nature established at one of the origin regions of agriculture, which pulls increasing numbers of humans into an ever-tightening loop of carbon exploitation. The development of annual grain agriculture reliant upon intensive disturbance was a particular fault line in human history (Jackson, 2010; Scott, 2017).

- **Misogyny** (Manne, 2018): the system that reinforces, upholds and enforces patriarchy, and that is dependent upon the reasoning that the humanity of some humans (especially but not limited to women) is contingent upon them primarily giving their time and bodies and attention to the moral support and needs of other humans (especially but not limited to men). Annual plow-based agriculture has historically been linked to the establishment of settlements and private property to organize social and biological reproduction of humans through patriarchal relations (Scott, 2017).

- **Settler colonialism** (Lloyd & Wolfe, 2015; Wolfe, 2006): systems that "destroy in order to replace," that justify domination of the land by claiming they are putting it to more profitable use via the concept of property. Such systems include the logic of elimination, the idea that what pre-exists people on the land must be violently eliminated in order to allow for proper use, and the white supremacist and racist logic of deficiency (Kaye, 2011), the belief that what newcomers encounter in an existing place is inherently deficient and in need of efficient improvement and replacement. Settler colonialism has been underpinned by annual plow-based agricultural production for the profit and sustenance of the settler population at the expense of the native population (Knobloch, 1996). Similarly, native perennial plant communities have been replaced by annual cropping ecosystems at the expense of ecological coherency.

These relationships of domination that have grown out of the history of agriculture, and that shape many human economic and energetic relationships to the land and each other, are increasingly incompatible with the planet’s ability to support good human lives. Since these dominating relationships shape and constrain human ways of making a living, naming them helps deepen and extend agroecological critiques of food systems’ political economies (Méndez et al., 2013).

As a geographical illustration of the impact of relationships of domination in agriculture, consider the landscape of Palestine. The terraced hill region of Palestine—as with Mediterranean climates around the world—is a complex of microclimates, plant communities, and biophysical factors where the rainy season brings plentiful rains and brilliant green hillsides. The powerful summer sun shapes the dry season turning all but the evergreen and sclerophyllous plant life brown. The continuous dry stone wall terraces were built, stone by stone, by humans and they continue to give hope for soil retention.

Since its emergence millions of years ago from the ocean, this landscape was covered by dense forests of oak (Quercus spp.) and terebinth (Pistacia spp.) trees (Zohary et al., 2012). With their powerful processes of photosynthesis and nutrient cycling, with their bodies, and helped by a more hospitable climate shift, these trees built the soils of Palestine and set the stage for a tremendous diversity of annual and perennial plant communities. As humans emerged and moved in and foraged in the area, those forests and associated plant groups became the supermarket of wild grasses, legumes, and other plants that early Neolithic peoples domesticated into crops (Zohary et al., 2012). By extension, Neolithic food systems in turn domesticated humans (Scott, 2017). The gentle climate of Mediterranean Palestine with its moderate sea-based weather and abundant sunshine and rain has been a comfortable locale for humans to inhabit. In Palestine, for example, are the remains of one of the longest-inhabited human settlements in the world (e.g., Jericho).

Palestine is also one of the first places where agrilogistics emerged. Annual disturbance-based grain production has wrought deep wounds to the soils built by the ancient forests of Palestine. Wheat and barley, with the attendant legumes of lentil, chickpea, and vetch, provide valuable grain yields in the near term but live in tillage systems that are not sustainable for the long term (Butzer, 2005). Perennial grain production may include tillage but greatly reduces it. However, Palestine is also home to a deep history of diverse polycultures, with many perennial crops (Tesdell et al., 2020). A complex of domesticated perennial tree crops inhabits the land too, including olive, grape, and almond. Combined with the domestication of grazing animals like sheep and goats, the landscape of Palestine has provided food, fuel, and fiber for many generations of human communities who took those technologies, ideas, and plants around the globe. Similarly, perennial grains may be grown in monocultures yet research in this field features the twin principles of perenniality and diversity and thus the need to design diverse agroecosystems in which to grow perennial grains (Crews et al., 2018).

The persistence of perenniality and diversity has also enabled deep adaptation to biophysical, economic, and political forces over many generations. Olive is a particularly powerful example of a perennial tree crop, grown often in polycultures, that has sustained Palestinians for millennia and that remains the only major agricultural crop today after the collapse of small-scale production of other crops (Assaf, 2010). Olive's persistence is likely due to its hardy perennial nature and the fact that olive orchard production relies on grafts to wild rootstock.
Patriarchal structures, reliant upon misogyny, that have developed within communities in the Palestinian landscape remain entrenched. It is important to recognize the participation and leadership of Palestinian women in struggles for freedom from economic structures of domination that have transformed agrarian relations from small-scale agriculture to wage labor within the Israeli economy. This powerful economic restructuring in the Palestinian West Bank since the 1970s also requires new forms of struggle within colonial and patriarchal relations (Haj, 1992; Hasso, 2001).

Climate crisis adaptation is particularly difficult for people living in a deeply contested landscape where most aspects of life and research, including borders and travel, are controlled by a powerful occupying state. Palestine’s food system is precarious, what remains of a meager political and economic system is deteriorating, and Palestinians find themselves nearly entirely dependent upon an occupying military (El Zein, 2017). Yet at the same time, possibilities for reducing Palestinian food dependency parallel those needed around the world for deep adaptation to climate crisis (Tesdell, 2018).

Relationships of domination—in systems of agrilogistics, misogyny, and settler colonialism—are evident in Palestine and grow from within a context of plow-based annual grain agriculture. Palestinians seek to live in one of the oldest agricultural landscapes in the world—one that bears the scars of millennia of plowing and annual, grain-based agriculture. The provision of annual domesticated crops to the world has come at significant cost. Anthropogenic climate crisis is fruitfully considered from the perspective of the marginalized spaces of the world. Palestinians still live amidst the remnants of the myriad societies that came and went, but now the future of humanity’s common home on Earth is in question. The situation in Palestine reveals the difficulty that peoples who have become economically and agriculturally dependent have in facing that future.

The historical and contemporary impacts of dominant agricultural relationships on the ecosphere in Palestine emphasize the need for human community behavior to transform as part of landscapes and agroecosystems in the search for true sustainability. Community is achieved, and communities are maintained and changed, through culture as much as nature. Agricultural relationships are made by material circumstances, but once made they can have further effects back upon and beyond those structures and systems through processes of cultural evolution (Laland, 2017). Culture includes the out-of-awareness, taken-for-granted, common-sense assumptions of our communities and societies that shape our behavior. The dominant cultural dimensions of agriculture may explain why many people have learned to name their perception of a freshly cleared and plowed field as a beautiful landscape, even without intentionally deciding that; it also explains why it takes work and effort to unlearn such a seemingly “natural” and “normal” perception.

Cultural systems and institutions “provide the tools, techniques, and, to some extent, even the incentive people need to confront the difficulties involved [in community] and deal with them in a productive way” (Jordan, 2003). Making human community arrangements and socioeconomic relationships with diverse, perennial grain agroecosystems that do not simply replicate relationships of domination in agriculture will require effort and is not inevitable. Recognizing the dominant norms, values, and patterns of relationship in the agriculture that currently feed most people—that is, beginning to gain awareness of how they influence human ways of seeing, thinking, feeling, and knowing, so that some things are more or less visible, thinkable, sensible, and knowable—matters because these same norms, values, and patterns shape the very cultural tools and social institutions available to try and enact positive agroecological change.

Reflective awareness is an ongoing critical step in the process of making change. Without reflective awareness, people may struggle to directly confront dominant agricultural relationships and may pursue solutions that inadvertently reinforce or reassert them as “natural” and “normal” perceptions of reality. Attention to underlying norms, values, and patterns as cultural drivers of change in social–ecological systems may help researchers make informed choices and discern collaborative pathways toward effective, ethical solutions (Streit Krug et al., 2017).

3 | A SOCIAL PERENNIAL VISION

If annual plow-based agriculture has provided an ecological, economic, and energetic infrastructure for the development of globalized human society, then we may assume that the reverse could also be true. In other words, we believe that perennial, diverse grain agriculture can provide an ecological, economic, and energetic infrastructure for the development of new human societies. Different agricultural structures certainly influence the shape of communities, and perennial grains can and will be new shapers of human community life. But new grain crops and cropping systems will be two of many variables and forces. While an agriculture that provides food along with sustaining ecosystem processes may make more just and fair systems possible, it does not guarantee them.

How can a plant science-based research community pursue agroecosystem and food system change in ways that will allow perennial grains to build justice within human societies that are expected to exist with less discretionary energy? Before discussing practical research implications, it is necessary to envision alternatives. Perennial polycultures inspire a new possible vision for future human communities living and eating in agroecological alignment with ecospheric processes, but without reflective awareness and intentional effort, those future communities may still resemble currently dominant realities.

An honest yet hopeful future vision is of a hotter, more unpredictable world that is still a planet persisting in lively, beautiful movement; still the ecosphere in which seeds can sprout and roots can grow; still the critical zone for soil retention and formation; and still the creative nexus for the continuance of diverse communities enduring in landscapes—communities whose behavior shows that they have learned and are still learning across generations.

In this context, a social perennial vision for grain agriculture recognizes how food systems that are based upon relationships of domination could transform to feature more mutually beneficial
relationships between peoples, plants, and the planet. Indigenous peoples who have resisted and persisted despite the relationships of domination we outlined above share that beyond the existence and recognition of a relationship, the qualities of a relationship matter (Whyte, 2018). Inspired by the knowledge they share, we imagine that in a social perennial vision, such relational qualities may include:

- **Sufficiency**: In contrast to dominating agrilogistics, relationships of sufficiency question the pure reasoning that efficiently limitless carbon extraction is always the inevitable goal, in order to reflectively grapple with the limited powers of people—through human narratives, emotions, feelings, norms, values, laws, legal orders, beliefs, cosmologies, and more—to shape change, for worse and for better, and decide what is enough to be satisfied.

- **Responsibility**: In contrast to the dominating system of misogyny, relationships of responsibility depend upon the reasoning that all humans need to give their time and bodies and attention to the moral support and needs of all other humans as well as non-human creatures and the places and processes of the ecosphere (Streit Krug, 2020).

- **Co-creativity**: In contrast to dominating settler colonial systems, relationships of co-creativity are remembered or renewed when people seek to learn together with the land rather than destroy a landscape in order to try and improve it.

For just transition and transformation, it makes sense look to who has already been engaged in the experimental struggle to figure out how to live together within ecological limits without exploiting human labor: in other words, to study as best and as fast as we can the lessons from all past and current human attempts to live in good communities. The landscapes most harmed by dominant agricultural relationships can be sites for radical change, and the places where the stakes are highest might offer unique insights. The cracks, shadows, and traces held within landscapes—which include human beings—may help us learn how to make enduring habitats in the ecosphere (Tesdell, 2013).

The knowledge held and lessons shared by Global South practitioners may be especially important to agroecological transformation. In Palestine, the Makaneyyat project demonstrates a social perennial vision for agricultural landscape change through scientific and community-based research and education (Tesdell et al., 2019). Here teams composed of both people and plants are organized to provide more equitable and just arrangements across the landscape. At once broad and specific, the landscape scale provides the appropriate scale of regeneration of food production and human communities with diverse perennial practices.

Makaneyyat’s research team is not alone in their learning, and their teachers are not only humans. Motivated by agroecology, they are learning about the communities of people in relationship and collaboration with other ecospheric forces like rain, climate, soils, rocks, grazing animals, and communities of local forager-farmers. The tremendous potential of these forces is apparent as they work to document the diversity and use many forms of knowledge to gather the plants needed to build the landscape anew.

The wild cousins of famous annual founder crops and many other spring annual spring legumes thrive in the wadis and hillsides of Palestine today. The Makaneyyat team is working to identify, collect, conserve, and propagate this agrobiodiversity (Thrupp, 2000), in the context of relationships of sufficiency. They are doing the same for the hundreds of other species that were not domesticated, still wild, which people in Palestine continue to use as foods, especially during the monsoon season when stores from the previous harvest run thin (Tesdell, 2018). Their research focuses specifically on perennial crops. Some of the species currently in early stages of evaluation include perennial grain candidates including *Hordeum bulbosum*, a wild perennial barley. Such a wild plant is being explored by scientists around the world for barley breeding and improvement but is also beginning to be explored for domestication as a perennial grain (Westerbergh et al., 2018).

The technical knowledge about the Palestinian landscape and its various beings, including the soils and geologic formations, is found in many sources. The Makaneyyat team is collecting this knowledge to make research more accessible and effective. Moreover, they are employing as many sources of knowledge as possible, from global datasets to local observations, with freely accessible and open-source tools. Open-source data management and storage tools are part of a larger effort to develop non-proprietary tools from the open science, open-source software, and open-source seed movements (Kloppenburg, 2010; Moeller & Pedersen, 2018).

In Makaneyyat, knowledge created by PhDs and university educated people is shared in collaboration with knowledge created and practiced by local communities with varying degrees of formal education. Team members Omar Tesdell, Yusra Othman, Mary Deike, Saher Alkhoury, Fouad Muaddi, Hanan Zahran, Sameer Khaishi, Yara Dowani, and others produce this open access scientific knowledge from within communities they inhabit and from within the challenging research context of Palestine (Abbott, 2018). The team is learning to carry out their research in a way that responsibly values and equitably shares human labor and ecospheric care work. In particular, they recognize and credit the knowledge held and shared by Palestinian women farmers (Tesdell et al., 2019).

Makaneyyat builds knowledge through co-creative relationships with people and plants. The wild relatives of many major crops persist on Palestinian landscapes. Many plants that were not selected for domestication millennia ago, many of which some Palestinians still rely upon, could become domesticated crops within new polycultures. Such polycultures of perennial grain and cover crops could emerge within the existing social-perennial infrastructure of olive, almond, grapes, and other fruit and nut crops. It is no coincidence that these tree polycultures remain one of the most powerful agricultural practices in Palestine, drawing families and friends together in community to harvest olives by hand each October and November, even as other practices have faded. Perennial grains could be brought into the existing arboriculture agroecosystems in the hill regions and in the plains regions. Makaneyyat continues to document and conserve...
plants in a social context in order to advance pilot studies for selection and domestication; the group envisions perennial grain agroecosystems in Palestine (Tesdell et al., 2020). Diverse perennial grain agroecosystems could enable long-term adaptation to both climate crisis and economic dependency by making large-scale food production sustainable and possible once more.

4 | IMPLICATIONS FOR RESEARCH

To realize a social perennial vision, the tools, techniques, and motivations provided by various human cultural institutions and communities will need to be critically taken up along with the tools, techniques, and testable modes of inquiry practiced by the scientific community leading research into perennial grain agriculture. It is useful to consider the social dimensions of the problem of agriculture (Jackson, 2010) not only as an alternative to perennial grain development (Smaje, 2015), but also coupled with scientific research seeking to accomplish sustainability (Crews & DeHaan, 2015). In Gliessman’s (2016) five levels of food system change, the long-term and big-picture Level 5 goal of transforming the global food system only becomes possible with the paired accomplishments of Level 3 agroecosystem redesign based on plant science and agroecology and Level 4 establishment of economic (re)connections in agroecological food communities and networks.

The scientific knowledge required to build diverse perennial grain agroecosystems, and the social knowledge required to sustain communities in which humans have just relationships to each other and the ecosphere, can be gained through integrated research efforts. The alternative normative relationships in the social perennial vision we provide lead us to affirm participatory research as a pathway for positive agroecological transition and transformation (Duru et al., 2015; Méndez et al., 2013). The case study of Makaneyyat in Palestine illustrates the beginnings of a very challenging yet exciting transdisciplinary research process (Lang et al., 2012) for community-engaged development of diverse, perennial grain agroecosystems that could inspire other efforts across a range of geographic and social contexts. We call for the further development of perennial grain agriculture research that engages and experiments with the range of transdisciplinary approaches (Knapp et al., 2019).

For research into perennial polycultures to be transformative (rather than conforming to dominant systems of relationship), participation should be fostered across the research and development process, so that knowledge is exchanged and co-created rather than simply passed in one direction from scientists to farmers (Levitt et al., 2014; Ryan et al., 2018). Participants in a 2013 workshop on perennial crops for food security also described (Leakey, 2014) and recommended (Neely et al., 2014) participatory approaches to the development of perennial crops, including public policies in support of perennial agricultural system change, in diverse contexts around the world. Agricultural research into deeper strategies that integrate social factors and values such as gender equity can help build accessibility and resilience in food systems (Schipanski et al., 2016).

A social perennial vision of alternative normative relationships, and a transdisciplinary research agenda with roots in both human learning communities and plant science and agroecology, may help build practical and ethical legitimacy for perennial grain agriculture, that is, its widespread ecological practice as well as social acceptance (Montenegro De Wit & Iles, 2016). Perennial, diverse landscapes and enduring, generative agroecosystems are possible through co-productive research between local communities and technical experts via transparent and open technological tools. By articulating a social perennial vision, we hope to help catalyze new collaborative research processes that result in a future where human communities are sustainably and equitably nourished by diverse, perennial grain agricultures.

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AUTHOR CONTRIBUTIONS

A.S.K. and O.I.T. collaborated throughout the research design, analysis, and writing and revision process of this manuscript.

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