Complex Agricultural Thinking: Toward Systemic, Resilient, and Regenerative Agriculture

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1. Introduction

Agriculture, as a fundamental human activity, has historically been a cultural and ecological construct that articulates multiple dimensions of existence: nutrition, the reproduction of life, the relationship with nature, the organization of work, and the configuration of territories. However, since modernity, especially since the Industrial Revolution and the Green Revolution, agriculture has been increasingly reduced to a technocratic and productivist logic, which privileges economic performance and technical efficiency over the biological, cultural, and social complexity of agricultural systems. This logic, has led to a radical disconnection between humans and the land, promoting forms of production, that deplete soils, pollute water bodies, destroy biodiversity, and weaken rural community structures.

In the face of this systemic crisis of industrial agriculture, complex agricultural thinking, emerges as an epistemological and practical proposal that seeks to re-enchant agriculture from a holistic, relational, and regenerative perspective. Inspired by complexity theory (Morin, 2001), political ecology, traditional knowledge, and agroecological approaches, these thinking questions cartesian dualisms (nature/culture, subject/object, mind/body) and proposes an understanding of agriculture as a living, interdependent, adaptive, and co-evolving system. Thus, agriculture, is not seen solely as a means of production, but as a way of inhabiting the world, of recreating connections with the land, with other living beings, and with future generations, in a commitment to solidarity and an intergenerational ethic.

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This essay, aims to delve into the theoretical foundations, practical expressions, and challenges of complex agricultural thought. To this end, it analyzes five central themes: the critique of modern agricultural reductionism; agroecology as a complex praxis; the role of peasant knowledge and interculturality; regenerative agriculture as a systemic horizon; and the institutional and cultural obstacles to its implementation. Finally, it presents a critical synthesis that invites us to rethink agriculture from an ethic of complexity, care, and interdependence.

1. From agricultural reductionism to the complexity paradigm

Modernity reduced agriculture to a technical-productive issue, based on efficiency, control, and yield maximization. This approach, inherited from Cartesian mechanism and scientific positivism, fragmented agroecosystems into isolated components, soil, plant, pest, and input, and promoted a model of external intervention that disrupted ecological balances. As Altieri and Nicholls (2008), point out, the Green Revolution, by introducing uniform technological packages, led to a homogenization of landscapes, diets, and agrarian cultures, at the expense of biodiversity and ancestral peasant practices.

In contrast, complex agricultural thinking is based on complex systems theory, which conceives living systems as nonlinear networks of interrelated elements with emergent properties and adaptive behaviors (Capra & Luisi, 2014). From this perspective, an agroecosystem cannot be understood in terms of its isolated parts, but rather in terms of the interactions, scale relationships, feedback loops, and cycles that run through it. Complex agriculture therefore requires moving beyond the linear view of cause and effect and adopting a contextual, dynamic, interdisciplinary, and even, transdisciplinary perspective.

Edgar Morin (2005), argues that complexity is not opposed to clarity, but rather to reductive simplification. This means, that complex agriculture is not confusing or disordered, but deeply articulated with the rhythms of life, with the multiple interactions between soils, climate, plants, animals, cultures, and local economies. Thus, complex thinking proposes a return to agriculture as an art of observation, adaptation, and care.

2. Agroecology: Science, Practice, and Movement from Complexity

Agroecology, has been one of the main strands from which complex agricultural thought has been articulated. Far from being a mere alternative technique, agroecology represents a transdisciplinary science, a regenerative practice, and a social movement that fights for food sovereignty, environmental justice, and the recognition of peasant knowledge (Wezel et al., 2009). It is an approach that combines ecological, agronomic, social, and cultural knowledge, based on the principle that agricultural systems must function as diverse, resilient, and balanced ecosystems.

Gliessman (2015), identifies five levels of agroecological transition, ranging from the improvement of agricultural practices to the transformation of the food system. This gradual approach, reflects the inherent complexity of change: it is not enough to simply replace chemical inputs with organic inputs; it is necessary to rethink the power relations, markets, public policies, and cultural values that shape agriculture.

In this sense, agroecology fully fits into the complex paradigm, recognizing that there are no single solutions or universal recipes, but rather situated, participatory, and adaptive processes. Each territory requires a specific design, the result of dialogue between diverse knowledge sources, local experimentation, and connection with the biocultural environment. This implies, a break with the technology transfer approach inherent to technocracy and a step toward the co-creation of knowledge (Altieri & Toledo, 2011).

3. Interculturality, Peasant Knowledge, and Agroecological Worldviews

One of the most significant contributions of complex agricultural thought, is the recognition of the epistemic value of peasant, Indigenous, and Afro-descendant knowledge. Far from being considered archaic or pre-scientific, this knowledge embodies relational worldviews that understand agriculture as a spiritual, ethical, and ecological practice. In many indigenous cultures, the earth is not a commodity, but a mother, a living being with rights, with whom a relationship of reciprocity is established (Toledo & Barrera-Bassols, 2009).

Boaventura de Sousa Santos (2010), proposes an ecology of knowledge, which allows for the articulation of diverse knowledge without prioritizing it, promoting intercultural dialogue. In this context, complex agricultural thought becomes a platform for the epistemic decolonization of agriculture, challenging the hegemony of Western scientific knowledge and revaluing traditional practices such as polyculture, rotation, the use of medicinal plants, agricultural rituals, and oral tradition as valid forms of knowledge.

The incorporation of this knowledge, is not only a matter of cultural justice, but also a strategy for resilience. Traditional agricultural systems have survived for centuries in adverse conditions thanks to their capacity for adaptation, diversification, and symbiosis with the environment. Complex agroecology, does not limit itself to integrating this knowledge, but recognizes in it an alternative, profoundly ecological and spiritual rationality.

4. Regenerative Agriculture: A Praxis Emerging from Complexity

Regenerative agriculture, as a contemporary evolution of agroecological approaches, proposes an even more proactive vision, in the sense that it not only seeks to minimize environmental impacts, but also, to actively restore degraded ecological and social systems. This includes, soil regeneration, carbon sequestration, watershed restoration, reconnection with local knowledge, and the healing of human connections with nature (Rhodes, 2017).

From the perspective of complex adaptive systems theory, regenerative agriculture can be understood as a design and management practice, based on observation, experimentation, and continuous feedback. Instead of imposing rigid structures, dynamic relationships are cultivated, allowing systems to evolve, diversify, and self-organize.

This demands a new sensitivity, a willingness to learn from the land, to interpret the signs of the landscape, and to develop agriculture as a living process, not a standardized production system. Regeneration, is not a goal, but a continuous practice of listening, caring, and adapting.

5. Obstacles and Challenges for Complex Agricultural Thinking

Despite its growing relevance, complex agricultural thinking faces significant barriers. In the political sphere, national and international agricultural policies continue to be guided by criteria of productivity, competitiveness, and export, marginalizing agroecological and community-based approaches. In the academic sphere, disciplinary fragmentation prevents a holistic approach to agriculture. In the economic sphere, the power of agribusiness corporations imposes intensive models dependent on external inputs and disconnected from local realities (Shiva, 2016).

Cultural resistance persists, as modernity has instilled an idea of progress associated with the domination of nature, monoculture, technological advancement, and individualism. Transforming this mentality, requires a pedagogy of complexity that trains new generations of farmers, technicians, consumers, and politicians capable of thinking systemically, acting ethically, and inhabiting the world from a place of interdependence.

6. Conclusions

Complex agricultural thinking, represents an epistemological break with the dominant agricultural paradigm and a civilizing commitment to another way of inhabiting the earth. Its strength lies in its ability to articulate multiple dimensions of agricultural life: ecological, cultural, economic, political, and spiritual. Far from offering simplistic solutions, it proposes an open, critical, situated, and relational way of thinking, capable of engaging with uncertainty and diversity.

This approach invites us, to relearn agriculture as an art of care, as a fabric of living relationships, as a regenerative practice that links the local with the global, the ancestral with the emerging, and the human with the nonhuman. In the face of a world in crisis, complex agricultural thinking offers a hopeful horizon, oriented toward building sustainable, fair, and resilient food systems, based on a deep understanding of life in its complexity.

The challenge, is not only technical or scientific; it is also ethical, political, and cultural. It requires a will to change, epistemic humility, commitment to the land and

those who cultivate it, and, above all, it requires imagining and practicing a new pact with life, based on the recognition that, ultimately, we are land that cultivates and is cultivated.

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