Alternative agriculture

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Alternative agriculture

Innovations for growing and cultivating diverse ways of knowing

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Introduction

This chapter provides an overview of approaches to land stewardship and food production commonly referred to as 'alternative' agriculture. With this designation, the question naturally arises as to which type(s) of agriculture these approaches are contrasted, such that they gain the status 'alternative'? The answer may seem, when first considered, to be self-evident – that is, these are alternatives to the dominant industrial and agribusiness approaches (see Chapters 9, 16 and 31). Whereas this comparison is, in broad terms, the basis for the overview of alternative agriculture that follows, it must be noted from the outset, that the category 'alternative' becomes problematic if it is used to imply a *cohesive* set of agricultural practices that can *collectively* be juxtaposed to the agribusiness and industrial scale methods that came to dominate agricultural landscapes in the 20th century. The reality is somewhat less clear-cut than this. Considering just a handful of examples (biodynamics, organics, and permaculture for instance), noteworthy differences amongst these approaches warrant – it could be argued – further division into sub-categories of 'alternative'. This is to say that, when they are studied in some detail, these alternatives begin to emerge as alternatives to *each other*, as well as to more conventional agricultural practices. The term 'alternative' will, therefore, initially be treated as a convenient umbrella term for the following considerations of agricultural practices that do not follow the often mono-cultural and highly industrialised models previously noted. Once a selection of alternatives has been considered, however, this chapter concludes with a brief discussion that will delve further into the proposal that a distinction between the approaches outlined next may well be justified, and will begin to outline possible directions for such distinctions to be made.

One further consideration should be stated at the outset of this chapter. Whereas agribusiness and industrial scale farming techniques have become, in some parts of the world, the 'norm' for agriculture (the 'alternatives' explored in this chapter thus being contrasted to these), in several areas of the globe, practices referred to as traditional farming, akin to 'organic' farming, and forest gardening have been the 'norm' for centuries (Barker, 2007). Many of these pre-industrial forms of agriculture remain the primary approach to food production for large numbers of people to this day (Morton, 2007) and are evident alternatives to industrial intensive agriculture, though they do not necessarily sit within the context of any one of the alternative approaches that will be addressed later.

With these initial reflections in mind, this chapter focuses on a selection of some of the most evident alternatives to industrial agriculture that emerged in the 20th century and that continue to develop in the early decades of the 21st.

Approach taken

A number of entry points can be taken to a study of different examples of alternative agriculture. Such a study could begin from the outset with a comparison of their different perspectives on technical or practical considerations (such as methods of fertilisation, pest management, animal husbandry) and these could be juxtaposed to practices more prevalent in industrial agriculture. Alternatively, an overview could be provided of the current presence in the global food market for alternative agriculture, or of acreage of land under cultivation within a given set of practices (e.g. acreage under organic cultivation, or biodynamic cultivation). Such an entry point would reveal the fact that agriculture in the early 21st century, particularly in the industrial countries of the northern hemisphere, is still dominated by monocultures sustained by large amounts of synthetic fertilisers, pesticides, and a petroleum-based energy economy (Barker, 2007; Chapter 16) – but these are not the stepping off points for this chapter.

Rather than begin with specifics of technique or current impact, the entry point to this chapter is to outline different forms of alternative agriculture as they developed *in time*. This historical or developmental perspective is taken in order to situate different 'alternatives' in relation to agricultural practices that were current at the time they were instigated, and to which they were frequently a response. New initiatives in agriculture have often been sparked by events unfolding in the wake of earlier innovations, and where these were instances of disease, environmental degradation, soil loss, crop failure, or other crises in the agricultural realm, innovative solutions were sought and developed.

It will become evident through the examples that follow that quite different responses have emerged to the challenges ascribed to industrial agriculture practices. These are, on the one hand, evident as novel methods or techniques that give alternative approaches their distinctive character. An initial focus on these practical features of different approaches to alternative agriculture will be taken. Underlying these practical interventions, however, are less evident (and often less discussed) *ways of knowing* that informed the innovation of the alternative approaches in question. This aspect of alternative agriculture will be touched upon briefly in the final section of this chapter.

Setting the scene

As has been noted in other chapters in this volume, the early years of the 20th century witnessed a number of developments in agriculture that furthered a trend where small- to medium-scale, mixed farms were being supplanted by industrial scale monocultures (Chapters 9, 12, 16, 25 and 31).

In 1910 the Haber-Bosch process was developed for producing ammonia, an artificial nitrogenous fertiliser, and in 1913, BASF's plant in Germany opened with a capacity to produce 30 tonnes per day (Modak, 2002; Smil, 2001). The development of synthetic fertilisers heralded dramatic changes for global agriculture, as they soon came to replace the long-established practice of fertilising with manures and using rotations that included cover crops to restore and/or maintain soil fertility (Conford, 2001; Kuepper, 2010). The development of the tractor, such as the Fordson tractor sold in 1917 and the International Harvester Farmall tractor (released in 1923) would continue to replace draft animals and significant proportions of farm labourers with mechanical power (Dimitri et al., 2005; Duarte and Sakar, 2009; Conford, 2001). From this time onwards the agricultural landscape was evermore shaped by technological and mechanical innovation, and by intervention.

The postwar periods (following both WWI and WWII) witnessed dramatic increases in the use of synthetic chemicals for fertilisers, pesticides, herbicides, and insecticides. Although these (and other) innovations in the agricultural realm contributed to increases in yield and moderated crop loss to pests, concerns of possible detrimental effects to these new developments in agricultural practice began to be raised by farmers in central Europe in the second decade of the 20th century. It was, in fact, just as aerial applications of pesticides were beginning (the first was in August 1921 in the US – the application of lead arsenate to kill catalpa sphinx caterpillars (Abrol and Shankar, 2012)) that the first widely recognised alternative approach to agriculture addressed in this chapter was initiated.

Biological-dynamic agriculture: 1924–present

In 1923, while innovations in industrial scale agriculture were – in many respects – still very much in their infancy, a group of farmers in middle Europe approached the philosopher and social reformer Dr. Rudolf Steiner (1861–1925) with a request that he speak on the subject of the renewal of agriculture (Hurter, 2014). They were seeking advice, amongst a variety of concerns, on how to restore and increase *vitality* in soil and crop at a time when the intensive use of synthetic chemicals in agriculture had barely begun. The farmers who brought their concerns to Dr. Steiner were already noticing marked decline in seed viability and an increase in diseases such as foot-and-mouth (Pfeiffer, 1947/2004). They had already noticed the deterioration of plant and animal health due to chemical fertilisation. In developmental terms, it is remarkable that concerns were already being raised by farmers at this time, some 40 years prior to such concerns being brought starkly to the public eye in publications such as Rachel Carson's *Silent Spring* (1962). The response to these farmers' concerns (and persistent requests for advice on these matters) was a series of eight lectures, given in Koberwitz, Silesia (now Poland) that initiated what today goes by the name of *biodynamic* agriculture. The lectures were given between the 7th and the 16th of June, 1924, and have been published under the titles *Agriculture* (Steiner, 1993) and *The Agriculture Course* (Steiner, 2004).

Following on from this course of lectures, individuals set out to put Steiner's recommendations into immediate practice and a 'biological-dynamic experimental circle' (Paull, 2011; Conford, 2001) was formed to begin to undertake formal research into the proposals given in the lectures and discussions. The experimental circle was comprised of farmers, scientists, vets, and other individuals inspired by the initial indications given in Steiner's lectures (Paull, 2011).

The 'biological-dynamic' approach, based on Steiner's indications for considering the spiritual foundations of agriculture, came in time to be known as *biodynamics* and it goes under that name to this day. As of 2011, biodynamic techniques were used on 142,482 hectares in 47 countries (Paull, 2011) and at the time of writing (spring 2017) biodynamics has a global presence as an alternative approach to agriculture, with associations and members in a growing number of countries (Hurter, 2014). Biodynamics places emphasis on the following key concepts and practices.

The farm should be conceived of as an 'organism', 'individuality', or 'self-contained entity' (Steiner, 1993) with, as much as is practically possible, the needs of the various members of the farm organism being met from within the farm itself (nutrient needs, re-incorporation of waste products into the fertility cycle, careful conservation of energy and nutrient flows). This principle is proposed in order to develop resilience and long-term sustainability for the whole farm (Masson, 2012; Thornton Smith, 2009; Hurter, 2014).

Biodynamics takes a 'qualitative-ecological' (Koepf, 1989) approach to agriculture, in contradistinction to the quantitative-reductive approach of many industrial methods. This means that attention is placed by biodynamic practitioners on supporting "earthly and cosmic forces that form life" (Koepf, 1989), a notion that deeply challenges much of the theory and practice that gave rise to industrial agriculture and that continues to inform its application to this day. Biodynamic practice, in fact, hinges on the notion of *vitality* and on supporting/enhancing *life processes* in soil, plant, animal, and human. This emphasis on engaging with, and therefore *understanding*, living processes leads to questions of *ways of knowing* that will be discussed further in the final section of this chapter.

Already in 1924 Steiner drew attention to the importance of soil fertility and proposed that a healthy soil (implying soil *life*) was the basis for healthy plants and animals and, ultimately, was the basis for healthy food for human consumption (Steiner, 1993; Pfeiffer, 1947/2004). This emphasis on cultivating soil health could perhaps be seen as an example of what was also developing as *humus farming* (Kuepper, 2010) in the early 20th century. In biodynamics, however, supporting the development of the humus fraction in soil is furthered by the use of specific *preparations* whose production methods were first described in the lectures given in Koberwitz in 1924.

It is precisely the production and use of these herbal 'preparations' (coupled with the adherence to astronomical planting calendars) that has led several critics of biodynamics to dismiss it as an approach founded on pseudoscience and/or 'magical thinking' (Holger, 1994; Chalker-Scott, 2004). Newcomers to biodynamics will certainly be struck by the field and compost preparations and their method of production, and they can be all too quickly dismissed as 'muck and magic' if taken only at face value. An alternative would be to take these preparations (and the planting calendar used by biodynamic practitioners) as a stimulus for a study of paradigmatic differences in agricultural practices (Lorand, 1996) and to research not only *what* a given approach entails as practices but *how* these arose from an epistemological and ontological perspective (Code, 2014). The preparations are, in this light, one aspect of an approach to agriculture (i.e. biological-dynamic) that arises from a very different worldview and understanding of the organisms, beings and processes in nature than is evident in either conventional agriculture or, in fact, in other 'alternatives' to conventional agriculture (Code, 2014; Thornton Smith, 2009).

Formal research has been undertaken in biodynamics since its inception and although much of this research has been undertaken on the European continent, and is therefore not published in the English language, a body of research and literature available to English speaking audiences continues to be developed (see www.considera.org/reslit.html). An overview of research findings arising from studies of biodynamic cultivation methods (including the use of preparations) which have appeared in a central European context – either at universities, in collaboration with universities, or in scientific journals – is given by Fritz in the 2014 publication *Agriculture for the Future* (ed. by Hurter). Much of the research referred to in this overview was undertaken by professors, by PhD candidates, or by other qualified researchers. The publication *Agriculture for the Future* (2014) also provides an overview of current biodynamic agricultural activities (applied biodynamics, research, social development, and worldwide initiatives) globally.

Biodynamic produce and processes can be certified under the Demeter trademark. Demeter is an international body that defines and oversees standards for biodynamic products. Information about Demeter International can be found here: www.demeter.net.

Organic agriculture: 1930s–present

What are the origins of *organic* agriculture? These are, in many respects, more difficult to localise in a specific moment in time or place than are those of biodynamics. This difficulty is due to the fact that all agriculture prior to the development of synthetic fertilisers, pesticides and the intensive use of petroleum-derived products in agriculture could be considered to be 'organic' in a broad sense of the term. 'Organic', in this less formal sense, can perhaps be understood to mean 'natural' or 'traditional'. Ever since the early 20th century, however, the term 'organic' has become a much more specific identifier or rubric for a particular alternative agricultural method and practice. Philip Conford writes in *The Origins of the Organic Movement*:

> If organic *methods* have existed for centuries, the organic *movement* could begin only once an alternative to them existed. This did not happen until the nineteenth century brought the industrial production of artificial fertilizers and the rapid spread of urbanization.
>
> *(2001: 17)*

Credit is given for popularising (and formalising) this alternative to conventional methods in the UK to Sir Albert Howard (1873–1947) and to Lady Eve Balfour (1898–1990), and in the US, to J.I. Rodale (1898–1971) (Kuepper, 2010; Gillman, 2008; Conford, 2001). The term *organic farming* features in the title of Howard's seminal 1947 book *The Soil and Health: A Study of Organic Agriculture*, but its first use to designate an identified approach to agriculture appears some seven years earlier. Its first appearance in print (where it is contrasted to 'chemical farming') is in a book titled *Look to the Land*, published in 1940 by Oxford University agriculturalist Lord Northbourne (Paull, 2006). Northbourne was deeply inspired by the agriculture lectures given by Steiner as well as by a meeting with Pfeiffer, when the latter came to the UK on Nourthbourne's invitation, and he proposes in his book a number of tenets drawn from the Agriculture lectures – including the notion of treating the farm as an organism or 'living whole' (Paull, 2006).

Sir Albert Howard and his wife Gabrielle drew inspiration from the 'traditional' agricultural methods that they witnessed being practiced in India in the early 1900s (Conford, 2001). They eventually sought to bring a rigorous research approach to natural farming practices (they were both accomplished botanists and scientists) at a time when these had largely been focused on the more chemical intensive approaches. The Howards sought to place 'organics' on a scientific footing, as a fully viable alternative to food production in the 20th century (and, presumably, beyond).

Other early contributors sought to establish organic agriculture on the basis of research and comparative trials (usually comparisons with conventional approaches to food production). Lady Eve Balfour launched the Haughley Experiment in the UK in 1939, comparing organic and conventional farming methods in side-by-side trials (Gillman, 2008). Balfour's subsequent publication of *The Living Soil* contributed to the formation of the Soil Association in the UK – as she did herself, by serving as its first president.

In the US, J.I. Rodale promoted organic agricultural methods and established the Rodale Institute and the Rodale Press to research and promote organic agriculture to the general public (Conford, 2001).

Many other individuals contributed significantly to the development of organic agriculture as a formal alternative to conventional practices, but space does not permit giving due credit to them all (see Conford's *The Origins of the Organic Movement*).

Over time, the distinguishing features of organic agriculture came to include, amongst other tenets and practices, the following (from Gillman, 2008):

- The maintenance and enhancement of soil fertility through crop rotation, the planting of cover crops and green manures, the planting of legumes to fix nitrogen in the soil, and the production and application of compost made from natural materials.
- The development of polycultures (mixed plant communities) rather than monocultures (single crop production) in order to support beneficial insects, soil microorganisms and species diversity.
- Weed management through biological, mechanical and physical means that include regular crop rotation, mowing and tilling, flame weeding, the use of weed suppressing species, mulching and grazing.
- Control of insect pests, fungus and bacteria carried out through interventions such as the introduction of predatory beneficial insects, crop rotation, companion planting, insect traps, physical barriers, biologic pesticides and herbicides.
- Livestock grazed or fed on organically produced fodder, feed (grain, tubers, hay/silage) and pasture.

Where biodynamics can be identified with its references to *vitality* and supporting *life processes* in the agricultural individuality or organism, literature on organic agriculture reveals frequent references to the term *natural*. A recurring articulation of the aims of organic agriculture is that of respecting and harnessing "*natural processes* to build positive health across the ecology of the farm" (cited in numerous publications). Farmer and author Wendell Berry articulates his definition of organic agriculture as follows:

> An organic farm, properly speaking, is not one that uses certain methods and substances and avoids others; it is a farm whose structure is formed in imitation of the structure of a natural system that has the integrity, the independence and the benign dependence of an organism.
>
> *(2009: 143–144)*

The meaning and usage of term *natural* is not as self-evident or straightforward as one might think (Soper, 1995), and just as the concept *vitality* raises questions in biodynamics (in terms of its meaning, assessment, and measure) so too does the term *natural* in the realm of environmental studies, agroecology, and agriculture (also see Chapter 17). In the latter half of the 20th century, organic agriculture increasingly adopted descriptors from the burgeoning discipline of ecology and has been officially described in these terms by its largest international body of standardisation, IFOAM (International Federation of Organic Agriculture Movements):

> Organic systems should fit the cycles and ecological balances in nature. Organic management must be adapted to local conditions, ecology, culture, and scale. It is essential to maintain and improve environmental quality and conserve resources by reuse, recycling, and the efficient management of materials and energy. Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats, and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air, and water.
>
> *(IFOAM, 2009: 7)*

Research into organic agriculture is quite extensive and is varied in type and results; space does not permit a comprehensive description of these. There are a number of organisations worldwide currently active in carrying out research into organic agriculture.

Organic agriculture is not without its critics. Criticisms are brought to bear on several aspects of organics. These might be with regards to claims that organic food is healthier than food produced through conventional means (Dangour et al., 2010), and opinions for and against these claims continue to develop (Woese et al., 1997). Criticism is also brought to bear on the proposals that organic agriculture is more environmentally friendly and sustainable then conventional farming (Trewas, 2001).

Counterarguments to many of these criticisms have been published by IFOAM, and can be sourced freely on www.ifoam.org; they are made available under the title *Criticisms and Frequent Misconceptions about Organic Agriculture: The Counter-Arguments* (IFOAM, 2008).

Proponents of organic agriculture at times raise criticisms of various aspects of its development, such as those articulated by Michael Pollan in his *The Omnivore's Dilemma* (2006) wherein the mega-scale of some organic producers is likened to industrial types of production whose intensive (albeit 'organic') operations call in to question the farm organism ideals of its early founders.

Standards for organic agriculture were produced in various countries throughout the latter half of the 20th century and in 1972, the International Federation of Organic Agriculture Movements (IFOAM) was founded in Versailles, France.

Permaculture: 1978–present

Along with the questions raised by Carson in *Silent Spring* regarding the detrimental effects of synthetic chemicals used in agriculture, the 20th century witnessed a wide variety of environmental crises that could be linked either directly or indirectly to the methods inherent in highly mechanised, monocultural, and chemically intensive farming practices. The Dust Bowl in the US in the 1920s and 1930s could be cited as an early AuQ7 and dramatic example of these (Hyams, 1976), where loss of topsoil due to the combined factors of tillage methods, climate events, and loss of native plant communities created an ecological and cultural disaster on a national scale. Critics of industrial agriculture drew attention (and continue to do so) to a host of other issues, including the heavy reliance on non-renewable resources, the energy intensive and polluting nature of agricultural machinery and practices, the loss of biodiversity which Carson's book highlighted, and the seemingly endless need to develop new chemical concoctions to address the phenomena of resistance that emerged in insect and plant populations (see Chapter 16). These aspects of conventional agriculture led its critics to posit that the very practices developed to increase agricultural production and provide food for a growing global population would be the very interventions that would ultimately lead to catastrophic ecological collapses that would, in turn, lead to cultural crises on a global scale. One response to the perspective that modern agriculture ultimately threatened the sustainability of both the environment and human culture was the proposal that a system of agriculture be developed that was both a 'permanent agriculture' and one that supported a 'permanent culture' – *permaculture* (Mollison and Holmgren, 1978, 1979; Mollison, 1988, 1991).

Permaculture is described as a systematic method, a "philosophy of working with rather than against nature" (Mollison, 1991: 1), a movement, and a worldview (Ferguson and Lovell, 2013). The philosophy of 'working with rather than against nature' arose for Mollison and Holmgren, the co-founders of Permaculture, as a direct response to the many ways in which 20th century agriculture apparently invested significant resources in 'fighting' or 'combating' natural processes. Rather then investing huge resources in trying to model agricultural production after industrial factories, that is, as 'single product systems' (Mollison, 1991), Mollison and Holmgren advocated the development of agricultural systems modelled on natural ecosystems (Mollison and Holmgren, 1978, 1979; Mollison, 1988, 1991; Mars, 2003). Antecedents and/or inspirations for Mollison and Holmgren's initiative in developing Permaculture include the works of J.R. Smith (*Tree Crops: A Permanent Agriculture*, 1988), P.A. Yeomans (*Water for Every Farm*, 1964/2008), and M. Fukuoka (*One Straw Revolution*, 1978). AuQ8

In their extensive review of Permaculture publications representing over three decades of developments in this area, authors Ferguson and Lovell distil out of the body of literature on Permaculture the following aim or objective for this approach to alternative agriculture:

> With systematic site design, emphasising diversity at multiple scales, integrated water management, and access to global germplasm, (permaculturalists) can increase the productivity demonstrated by heritage agroecosystems – especially labor productivity – while retaining their most desirable attributes of sustainability and multifunctionality.
>
> *(Ferguson and Lovell, 2013: 270)*

Central to Permaculture are the notions of *design* and *systems*. Some key aspects of Permaculture include:

- An articulation and adherence to *three core tenets*: Care for the Earth, Care for the People, and Return of Surplus (at times articulated as Fare Share) (Mollison, 1988; Holmgren, 2000).
- An articulation of *design principles* to follow in the development of Permaculture systems. Holmgren describes 12 of these in his *Permaculture: Principles and Pathways Beyond Sustainability* (2013).
- The use of *layers* in design. Modelled after mature ecosystems, which develop different layers (such as canopy, understory, ground cover) and complex inter-species relationships, Permaculture systems strive to maximise the layers in the system (Mollison, 1988).
- Designed systems are conceived of in terms of *zones* that take into account the interactions in the system between the human environment and activity and the different species that dwell in that system (Burnett, 2001). Zones range from 0 to 5, where 0 is the house or home centre and 5 is wilderness or wild space with little to no human intervention.

Permaculture practitioners may involve any number of several ecologically inspired practices in the design and development of systems. Some of these include agroforestry (Bell, 2004; Whitefield, 1993; Jacke and Toensmeier, 2005), natural building, rainwater harvesting, intensive grazing, and keyline design (Mollison, 1988; Yeomans, 1964/2008).

Critical considerations of Permaculture arise from proponents of its approach as well as from those not working with its philosophy and practices. Ferguson and Lovell (2013) point to the fact that relatively little formal research has been undertaken into Permaculture with regard to productivity and realisation of its claims for self-sustaining, productive food systems. They propose, based on their review of Permaculture literature, that:

> The potential of permaculture to contribute broadly to agroecological transition is limited by several factors. Of primary importance is the general isolation of permaculture from science, both in terms of a lack of scholarly research about permaculture and neglect within the permaculture literature of contemporary scientific perspectives. This deficit is compounded by over-reaching and oversimplifying claims made by movement adherents and the absence of any systematic multisite assessment of permaculture's impacts. Additionally, the difficulty of providing a clear and distinguishing description of permaculture can cause confusion and hinder rigorous and systematic discussion.
>
> *(2013: 2)*

Robert Scott, in his article *A Critical Review of Permaculture in the Unites States* (unpublished) asks the question as to why Permaculture in the United States seems to generate a large number of graduates from design courses and publications, but relatively few examples of established and productive Permaculture sites. He asks,

> Given that permaculture grew out of an alternative approach to agriculture and the design of human settlements, it seems reasonable to ask: why does the permaculture movement in the United States appear to have a stronger tendency toward education than agriculture?
>
> *(Scott, 2010)*

Other criticisms about Permaculture raise questions about its potential to realise the claims made by its early proponents with regard to the productive capacity of its 'forest garden' foodscapes and other 'idealised' design proposals that are put forth in the literature (see for instance Williams et al., 2001; Romanowski, 2007).

Although these criticisms are raised, and often by proponents of Permaculture themselves, this alternative to conventional industrial agriculture continues to grow worldwide and attract interest both at grassroots level and more formally in a range of sustainable agriculture circles.

There are no standards for Permaculture produce in the way that these were developed for biodynamic produce (Demeter) and organic produce (organic certified).

Discussion

The following statement appears in the UNCTAD (United Nations Conference on Trade and Development) Trade and Environment Review (2013) titled *Wake Up Before It Is Too Late*:

> The world needs a paradigm shift in agricultural development: from a 'green revolution' to an 'ecological intensification' approach. This implies a rapid and significant shift from conventional, mono-cultural based and high-external-input-dependent industrial production towards mosaics of sustainable, regenerative production systems that also considerably improve the productivity of small-scale farms. We need to see a move from a linear to a holistic approach in agricultural management, which recognizes that a farmer is not only a producer of agricultural goods, but also a manager of an agro-ecological system that provides quite a number of public goods and services (e.g. water, soil, landscape, energy, biodiversity, and recreation). The required transformation is much more profound than simply tweaking the existing industrial agricultural systems.
>
> *(2013: 2)*

The small selection of alternative approaches to the industrial model of agriculture that have been outlined in this chapter are presented as possible contributions to the paradigm shift" – the move from "linear to holistic approaches" – which the UNCTAD report advocates. The methods they employ and approaches they take offer (though not without contention or their share of critics) a "radical transformation of agriculture . . . one guided by the notion that ecological change in agriculture cannot be promoted without comparable changes in the social, political, cultural and economic arenas that also conform agriculture" (UNCTAD, 2013: 27).

The notion of a 'paradigm' shift implies transformation on quite fundamental levels, that is, not merely in practical approaches or applied techniques. These must be seen as the outer manifestation of changes in actual worldview or orientation – in ways of knowing and perceiving. It could be argued that a study and engagement with alternative approaches to agriculture that doesn't address fundamental questions regarding *ways of knowing* falls into the danger of merely presenting practical 'tweaks' to existing agricultural methods while failing to address the deeper ways of knowing that inform these. It must also be considered that for an adequate evaluation (or well-founded criticism) of different alternatives to 'chemical agriculture' this dimension must also be made explicit, otherwise these alternatives will likely only be assessed from the perspective of the current paradigm, which will then fail to comprehend the new theories and practices that they represent (Code, 2014).

The sciences that so deeply influenced the rise of industrial agriculture often applied methods of analytical reduction to the complexity of natural phenomena in order to gain clarity about their constituent parts and the relation of these each to the other. Liebig's identification of nitrogen, potassium, and phosphorus as essential elements in plant nutrition can be seen as a classic example of this approach. Liebig saw

> his agricultural work as proof of chemistry's ability to transform an empirical activity into a science. Botanists and physiologists had neglected plant chemistry, but the processes of transformation were purely chemical and could not be understood without laboratory experiments.
>
> *(Conford, 2001: 17)*

Since the 18th century, this reductive and analytical approach to science has come to inform more and more aspects of the natural sciences (and eventually the social sciences as well), and has greatly influenced developments in agriculture – but it is not without its critics. An exhaustive list of contributors to this discussion would be beyond the bounds of this chapter and its primary focus, though readers will find an entry into this significant area of study through the works of Chalmers (1990, 1999), Barfield (1988), Bateson (1972,1979), Burt (2003), Steiner (1983,1985), Capra (2014), and Brady (2008) – to name but a few. It could be proposed, however, that one of the primary differences between "conventional, mono-cultural based and high-external-input-dependent industrial production" (UNCTAD, 2013: 27) and the alternatives outlined in this chapter is the way in which the relationship between the 'parts' and the 'whole' of the farm (or organisms within the farm) are conceived. Grasping the relationship between 'part' and 'whole' is anyway a challenge for cognition (Bortoft, 1996), let alone for attempts to intervene with living systems, and a key challenge for agriculture (and for science) is how this challenge is addressed.

In *A Guide for the Perplexed* (1995), E.F. Schumacher invites a well considered and highly lucid consideration of the differences between ways of knowing *adequate* to comprehending the mineral, plant, animal and human aspects of nature and concludes the following:

> Physics and chemistry deal with the lowest level, 'mineral'. At this level . . . life, consciousness, and self-awareness – do not exist (or, in any case, are totally inoperative and therefore cannot be noticed). Physics and chemistry can tell us nothing, absolutely nothing about them. These sciences possess no concepts relating to such powers and are incapable of describing their effects.
>
> *(1995: 29)*

Schumacher proposes that different types of science, different ways of knowing, need to be developed in order that our comprehension be *adequate* to the fullness of the phenomena in question. Rather than reject physics, chemistry or other sciences wholesale (as they are evidently suited to the study of the inorganic realm), Schumacher advocates greater attention to the boundaries of *any* way of knowing such that these remain appropriate and best suited to the phenomena under investigation. He highlights the tendency for ways of knowing suited to one realm of phenomena (for example the mineral realm) to be unquestioningly applied to the study of *all* phenomena with this quote from the psychologist Victor Frankl:

> The present danger does not really lie in the loss of universality on the part of the scientist, but rather in his pretense and claim of totality. . . . What we have to deplore therefore is not so much that *scientists are specializing*, but rather the fact that *specialists are generalizing*.
>
> *(Schumacher, 1995: 15)*

In an agricultural context, it can be inferred that Schumacher would invite caution if attempts to manage the complexity of mineral, plant, animal, and human interactions that constitute a 'farm' (or farm organism, from a biodynamic perspective) were to be undertaken only on the basis of knowledge and practice derived from attention to inorganic realms.

This perspective has been proposed by a number of scientists, and one who warrants particular attention in light of the focus on *vitality* and *life processes* in biodynamics is J.W. von Goethe. A comprehensive and contemporary articulation of Goethean science is provided by physicist and philosopher of science Henri Bortoft, whose book *The Wholeness of Nature* (1996) makes a very strong case for its cultivation, particularly where science seeks to understand the living world. Rudolf Steiner referred to Goethe as "the Copernicus and the Kepler of the organic world" (Conford, 2001: 67; Zajonc and Seamon, 1998). Steiner himself spent nearly a decade editing and commenting on Goethe's method and it can be inferred from his concerted attention to Goethe's work that elements of this way of knowing contributed to his own later work, including his insights into agriculture. Several contemporary studies, in fact, explicitly take a Goethean scientific approach as the basis for an investigation of aspects of a biodynamic approach to agriculture (Bockemuhl, 2006; Code, 2014).

It has been noted that where biodynamics places emphasis on life processes, and thereby presents the challenge that we develop sciences adequate to investigating the phenomena of life, permaculture places a good deal of attention on developing a systems approach to designing productive landscapes. Reference to systems is also evident in the UNCTAD report, wherein we find mention of 'agricultural systems' and 'regenerative production systems'. Systems theory and systems science evidently represent a further area of study and consideration in terms of paradigmatic shifts in ways of knowing that can then inform shifts in ways of doing such as are needed for a 'transformed' agriculture. Publications that engage with and articulate aspects of systems theory and its application in diverse fields continues to grow (see for instance Bateson, 1972; Capra, 1997/2014; Bertanalffy, 1968; Checkland, 1999; Luhmann, 2013). The degree to which permaculture has been informed by systems theory is discussed by several authors (Rothe, 2014; Smith et al., 2007). Systems theory seeks to address the complexity of living organisms and their interactions, and strives to overcome the one-sided emphasis on the individual elements of a system (its parts) by maintaining an awareness of the self-organising wholeness of the organisation being investigated.

Conclusion

To have given space to considerations of *ways of knowing* in an overview of alternatives to industrial agriculture is to acknowledge, after Parker Palmer, that "every way of knowing becomes a way of living" (1993). To contextualise this statement further for the themes this chapter addresses, it could be re-phrased as 'every way of knowing becomes a way of growing'. Proposals for paradigm shifts or fundamental transformations in the way we grow lead to the insight that these can only come about if we also address the ways that we 'know'. A twofold development is thus offered in any of the approaches to agriculture outlined in this chapter. On the one hand this is a question of grasping (and perhaps not initially understanding) new techniques and methods of working with the land and its co-inhabitants. On the other hand practitioners of alternative approaches to agriculture are invited to pay due attention to the cultivation of consciousness as well as to the creation of compost.

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