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POST-INDUSTRIAL AGRICULTURE: COMPETING PROPOSALS FOR THE TRANSFORMATION OF AGRICULTURE

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INDUSTRIAL AGRICULTURE – AN OBSOLESCENT MODEL

For many years, scientists have been sounding the alarm that the global ecosystem is in a precarious state and possibly on the verge of abrupt changes due to anthropogenic pressures (e.g. Rockström et al, 2009; IPCC, 2013). *"Further pressure on the earth system could destabilize critical biophysical systems and trigger abrupt or irreversible environmental changes that would be deleterious or even catastrophic for human well-being."* (Rockström et al, 2009) This might leave planet Earth in a "*much less hospitable state*" for human populations (Steffen, 2015).

Scientists have identified nine key processes that regulate the stability and resilience of the global ecosystem. For each process they have quantified a safe operating space for humanity, the boundaries of which should not be transgressed (Rockström et al, 2009). The science shows us that in four of these nine processes, those boundaries have already been crossed as a result of human activity. They are climate change, loss of biosphere integrity (i.e. biodiversity), land-system change and altered biogeochemical cycles (phosphorus and nitrogen) (Steffen et al, 2015).

One of the main drivers of the anthropogenic pressures is industrial agriculture. This has been modelled on the extractive industries, reducing agriculture to a single function: the production of raw materials. In this model maize or soybeans, for example, are no different from oil or minerals mined from beneath the soil. The products of these long, open and linear industrial processing chains can be food, although that is actually just a minor outcome. Mostly, the raw materials are used as feed, fibres and, increasingly, fuel. As with all commodities, they are globally traded and transported. Hence the fact that in all industrialized countries (and in those striving to industrialize), policies have been put in place to reward the consolidation of farms into larger units and enterprises producing as much of these primary raw materials as possible.

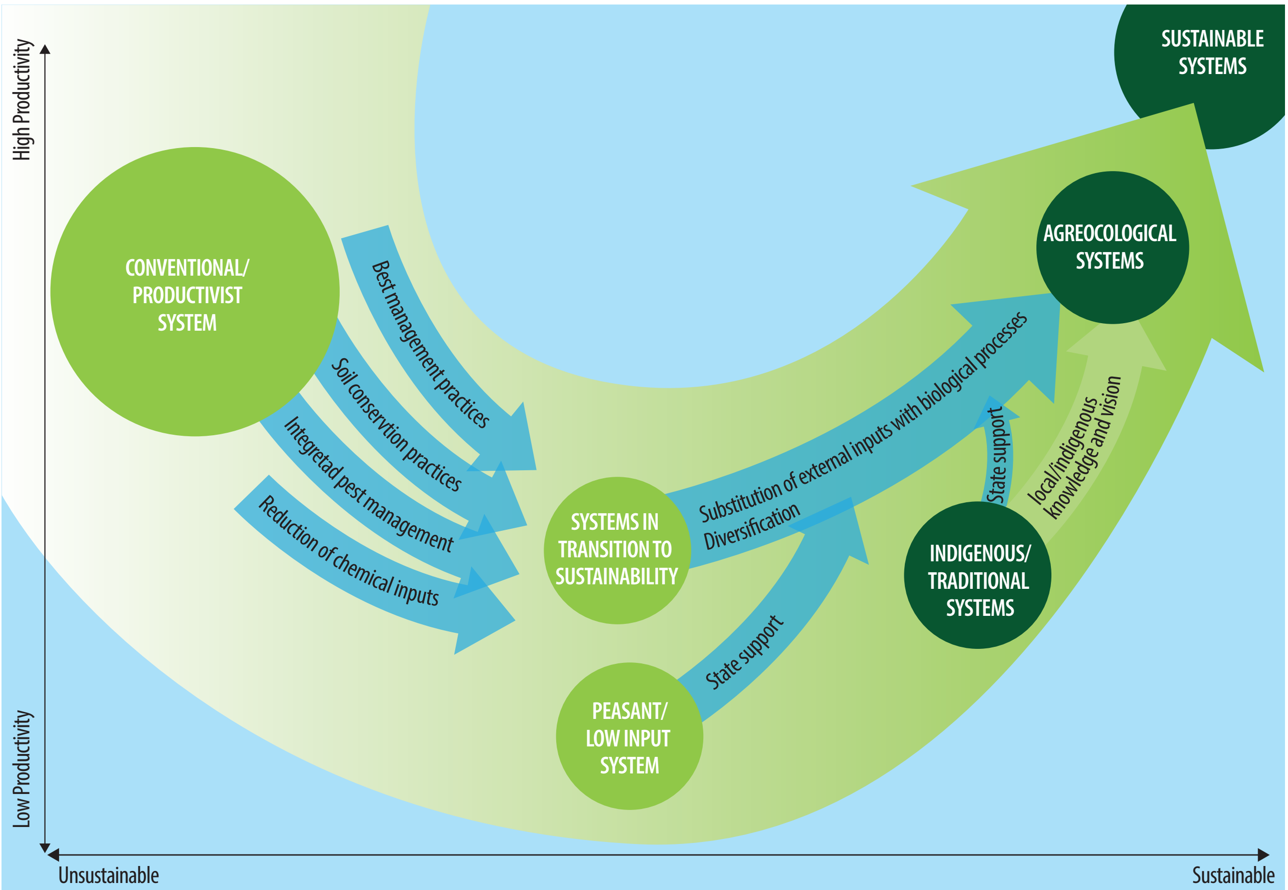
These industrial agricultural systems rely on external inputs such as fossil fuels, synthetic pesticides and fertilizers. The crops, in turn, have been bred primarily, if not exclusively, for increased yields, with little consideration given to their adaptation to local conditions or resistance against pests and diseases. For several decades now, it has been tried to speed the development of such high yield varieties up by using genetic engineering techniques. However, despite substantial investments, no significant achievements have been made (Jacobsen et al, 2013). Conventional breeding still achieves these goals much more quickly, and with fewer associated safety and proprietary issues (e.g. Gilbert, 2014). Furthermore, old problems remain, such as the spiralling need for inputs of toxic agro-chemicals due to the ever faster evolution of resistance to these agro-toxins in weeds, pests and diseases (Heap 2014; Pimentel and Peshin, 2014).

As the current form of industrial agriculture is highly unsustainable (for both environmental and human health reasons), and as it is failing to feed the world, it is clearly an obsolescent model past its sell-by date. This point was expressed in the International Assessment of Agricultural Science and Technology for Development (IAASTD) with the words, 'Business as usual is not an option anymore'. UNCTAD put it even more dramatically in the title of its Trade and Environment Review 2013: 'Wake up Before it is Too Late: Make Agriculture Truly Sustainable Now for Food Security in a Changing Climate'.

Thus there is broad agreement that, in order to achieve food security, it is just as important to change damaging systems of industrial agriculture into sustainable systems, as it is to convert local, traditional forms of agriculture in developing countries – which for various reasons are often characterised by low and highly fluctuating productivity – to more reliable and productive systems. In the IAASTD (2009), this vision of the transition process towards agroecology is outlined in the Latin American and Caribbean Summary for Decision Makers (figure 1).

There are competing concepts and narratives describing 1) how to achieve such a transition, 2) what kind of trajectory should be followed, and 3) what exactly qualifies as a sufficiently sustainable agricultural system.

Figure 1. Transition to productive and sustainable systems from various exit systems (from IAASTD 2009 - Latin America and Caribbean Summary for Decision Makers)



COMPETING CONCEPTS OF CHANGE

The various concepts debated today typically illustrate a dichotomy. One set of proposed narratives remains true to the current productivist economic (figure 2). These narratives viewed technology and science as the primary drivers of change. They still see increased productivity in terms of yields as the key target and guarantor of food security. The other set of narratives follows a trajectory of diversification along with decentralized and localized agroecological approaches oriented toward the environment and humanity. Technologies are important, but they are seen as secondary tools alongside many other non-technological methods that help achieve the main goals of the agroecological system, which consist of more than just productivity (IAASTD Global Report, 2009. e.g. chapter 3).

In its 3rd Foresight Exercise (2011), the Standing Committee on Agricultural Research to the European Commission (SCAR) contrasted these two approaches, coining the names 'Productivity Narrative' and the 'Sufficiency Narrative' to classify them. As early as in 2004, Lyson (2004) synthesized the competing paradigms of industrial vs. alternative, non-industrial agriculture into six major dimensions: 1) centralization vs. decentralization, 2) dependence vs. independence, 3) competition vs. community, 4) domination of nature vs. harmony with nature, 5) specialization vs. diversity, and 6) exploitation vs. restraint. We briefly contrast the main differences between the productivist and the agroecological approaches to change in agriculture (table 1, figure 2).

THE PRODUCTIVIST APPROACH

In the productivist approach, scientific advances should deliver high yielding varieties that can be used in automated precision technologies to boost productivity. The approach should overcome resource scarcities and environmental problems through massive investments in research and development in order to identify precision engineering methods (SCAR 2011) with which to maximize efficiency.

The efficient use of external inputs should derive from high-tech solutions that deliver not only the required inputs but also the necessary machinery (e.g. GPS directed robots). Most importantly, they also provide the essential know-how in form of proprietary software (Grefe, 2015). In this vision, farmers would run farms remotely using a computer from the comfort of their homes; sustainable efficiency gains would be complemented by new proprietary biotechnologies such as genetic engineering (Conway and Wilson, 2012). Externally applied chemical pesticides would be replaced by pesticidal chemicals produced within the plants themselves (e.g. crop plants expressing bacterial toxins like Cry proteins from Bacillus thuringiensis). Furthermore, proponents hope that precision gene editing using refined genetic engineering techniques like CRISPR, TALENs and ZFNs[6] (Sander and Joung, 2014) can endow plants with traits enabling them to grow in difficult environments like saline or drought-prone areas. However, we expect that crops developed with these new genetic engineering techniques will suffer the same limitations as the older forms of transgenesis because, again, only simple, single-gene traits can be manipulated which can be overcome just as easily. More complex traits, like those allowing plants to grow in difficult environments, require the engineering of complex physiological mechanisms controlled by many genes embedded in sophisticated genetic networks and modulated by environmental cues. As there is currently insufficient understanding of ecological genetics and the engineering techniques required for such sophisticated interventions, we expect that such products will not emerge for quite some time, if ever. Precision does not equate to control or to efficiency if the functioning of the object being engineered is less precisely understood than the level of precision at which the tool can operate.

Figure 2. Conceptual comparison of a range of proposed changes (paradigms and narratives) towards sustainable agricultural systems.

PRODUCTIVITY PARADIGM / NARRATIVE		AGROECOLOGY PARADIGM / NARRATIVE	
Exit systems: Conventional, high-input, chemical intensive, high yields			**Traditional, low-input, low-yields**
Conversion - maximize efficiency through precision technologies: • Large industrial operations • Linear, open extraction chains • Integration with high-tech robotics, remote control, IT, software • Biotechnologies • Conventional production – less(?) chemical inputs, more efficient low-volume chemicals	Conversion - maximize efficiency through precision technologies: • Large industrial operations • Conform with current economic paradigm • Perhaps shorter extraction chains? • Appropriation of organic-inspired production methods and supporting technologies • Biotechnologies PLUS GE • No/little chemical inputs?	Transformation to agroecological systems: • Family farm, small to mid size • Transform current economic paradigm, local-global agency • Short chains, closed cycles • Organic production methods and supporting technologies • Biotechnologies except GE • No chemical input	Conversion to more productive systems: • Family farms • Transform and create local economies • Short chains, closed cycles • Organic or other agroecological production methods and supporting technologies • Biotechnologies except GE • No chemical inputs
Modified conventional	**Ecologically inspired conventional**	**Agroecological**	**Agroecological**
Business-as-usual LIGHT **Little-medium change – still towards ruin**		**Transformation** **Much change – away from ruin**	

THE AGROECOLOGICAL APPROACH

In this approach, scientific advances help in developing agro-ecosystems that are both productive and respectful of ecosystems, and which save resources. This is achieved through behavioural change and the use of agroecological practices tailored to the local conditions. Table 1 contrasts some of the differences between the productivist and agroecological paradigms, while agroecological methods are presented and discussed in more detail in other chapters of this brochure.

Here, we argue that the full benefits of these agroecological practices, many of which have been shown to achieve output levels approaching those of conventional systems (most recently, the Rodale Institute Report, 2015), cannot currently be realized in most countries' economic, policy and institutional contexts. As long as the environmental and human health costs of toxic pollution, soil degradation and biodiversity loss are viewed as acceptable collateral damage – as externalities – to be paid for by everyone, either financially or in physical terms, little will change and any improvements will come too slowly. Such health and environmental costs are illustrated, for example, by the horrendous human costs of industrial GM crop production in Argentina[7] and the colony collapse disorder among bees (Buenos Aires Herald, 2015; USDA, 2015).

The mainstream thinking on food security is still focused on – some say obsessed with – extracting higher yields in large-scale agricultural production systems. The industry's claims include 'grow more from less' or 'more crop per drop'[8] (Syngenta), 'a race against time' (Bayer Crop Science), and 'improving agriculture' (Monsanto). This thinking ignores the fact that the main cause of most food crises in the past – certainly of the last one in 2008 – was high prices making food unaffordable for the poor and vulnerable. Prices have risen due to high oil prices, an increase in demand for both biofuels and animal feed, and speculation by hedge funds. The important questions to ask are not only about the quantity of food produced, but rather: How is food produced and by whom? How it is stored, traded and distributed? And how much is simply wasted along the value chain?

As yields in organic production are often lower than conventional production, its contribution to food security is often under-valued. While organic farming in developed countries is seen as a strategy to reduce over-production while maintaining the same level of income for farmers, in developing countries organic production is seen as a way of producing more food to generate higher incomes (El-Hage Scialabba et al, 2014).

Incomes improve not only because of the higher product prices for organic, but also through the development of new supply chains and improved or privileged access to markets. This connects the organic movement to the old concept of food security. The World Food Summit in 1996 defined food security as a state 'when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.' This concept reflects a much more holistic perspective that transcends the narrow framing of productivity parameters used for mono-crops. It builds on three pillars: food availability, food access and food uses (WHO Food Security[9]). This entails a multiple focus on regional value chains, storage, trade and food processing, in order to provide access to food for all, to improve food quality and – as the outcome combined of all these aspects – to improve the overall economic situation in rural and urban areas.

In the context of agroecology, the idea of food security is often used interchangeably with the term 'food sovereignty'. This is when the people who produce, distribute and consume food also determine and control the mechanisms and policies of its production and distribution. In this way they retain control over decision making related to what they eat, and can pursue demand-driven food production (food preferences: what do people want to eat) rather than submit to supply-driven choices (what do people get to eat?). The side effect of using the term 'food sovereignty' is that the debate about concepts of agroecology focuses less on the yields of production systems than on self-determination and control of the food choices on offer. Vivero Pol (2015) takes things a step further and suggests that we need to get away from considering food as a commodity, but to see it rather as a common good like biodiversity, and ties

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[6] Clustered, regularly interspaced, short palindromic repeat (CRISPR), zinc finger nucleases (ZFNs) and transcription activator–like effector nucleases (TALENs)
[7] http://mrofoundation.org/pablo-ernesto-piovano/
[8] http://www.syngentafoundation.org/db/1/898.pdf

this to the need for a food system constructed from grassroots urban and rural initiatives. De Schutter and Vanloqueren (2011) state that 'the belief that larger farms are more productive continues to be disseminated by influential authors.

This is a mistake. Large, mechanized, monocropping operations are more competitive than small farms for the reasons explained above, but competitiveness and productivity are different things.'

Despite its benefits, the transition towards agroecology is happening too slowly. De Schutter and Vanloqueren (2009) summarize the obstacles to the further spread of agroecology:

- Exclusion of small-scale farmers, the primary practitioners of agroecology and the main beneficiaries of its expanded use, from policy decisions.

- Absence of security of land tenure for a large proportion of small-scale farmers.

- Insufficient research investments in agroecology.

- Perception or portrayal of agroecology as a return to a romanticized past that is incompatible with mechanization and agricultural efficiency, and as a model of agriculture that relies on human power for cultivation, plant protection and harvesting.

- Inadequate costing of the environmental and social externalities of industrial farming in the agro-food pricing systems (the 'real' price of cheap food).

- Lack of investors interested in agroecology.

Just as the industrial, mechanized systems of monoculture could only be installed with massive public investments, so too is there a need for concerted and organized efforts on the part of all the relevant sections of society in order to bring about the urgently needed transformation of the existing agro-food systems. As Horlings and Madsen (2011) concluded, for agroecological approaches to contribute effectively to a 'real green revolution' requires:

> ...a more radical move towards a new type of regionally embedded agri-food eco-economy. This is one which includes re-thinking market mechanisms and organisations, an altered institutional context, and is interwoven with active farmers and consumers' participation. It also requires a re-direction of science investments to take account of translating often isolated cases of good practice into mainstream agri-food movements.

As all paradigm shifts and transformation processes require a renegotiation and redistribution of roles, capital and power, this process is likely to be difficult and messy. However, as Felix zu Löwenstein (2011) stated in his recent book, The Food Crash, 'either we will feed ourselves organically in the near future or we will not eat at all anymore.'

[9] http://www.who.int/trade/glossary/story028/en/

Table 2: Differences between industrial and agroecological food production.

	PRODUCTIVITY PARADIGM	AGROECOLOGY PARADIGM
KEY DRIVERS OF SUSTAINABILITY Primary	**Technologies**, techno-scientific methods	**Sociopolitical and ecological changes:** Education, training, policy, institutions, research
KEY DRIVERS OF SUSTAINABILITY Secondary	**Sociopolitical and ecological changes:** Education, training, policy, institutions, research to enable implementation and adoption of technologies and techno-scientific methods	**Technologies**, techno-scientific methods to achieve socio-political and ecological changes
FUNCTION OF AGRICULTURE	**Single function:** commodities, raw materials for sale and centralized, integrated industrial value chains, export, global trade	**Multi-functional:** food, feed, medicine, fuel, building material for local markets, decentralized value-chains
ADJUSTMENTS IN ECONOMIC FRAMEWORK	**Not essential**, small adjustments within existing frameworks. Harnessed to allow for removal of barriers to trade, globalized trade, access to formal markets and dissolution of informal markets, infrastructure in as far as it enables access to formal markets, **hierarchical structures** (top-down)	**Essential**, institutional, changes required to policy and subsidies to allow implementation of socio-political and ecological changes, **builds on sharing** and democratic **participation**
SOCIOPOLITICAL/ECONOMIC ASPECTS	Farmers turn **entrepreneurs**, consolidation to big(ger) farming operations and **building businesses** competing in national or international markets, generate income and **create wage labour jobs**	**Family farmers** integrated in and part of **building local communities & economies**, create opportunities for **diverse on-farm and off-farm employment possibilities**, contributing to sustainable and resilient local food secure communities

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