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## AGROECOLOGY FOR NOURISHING THE WORLD AND TRANSFORMING THE AGRI-FOOD SYSTEM

IFOAM EU GROUP

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Picture back cover: Soil erosion in a GM maize field after severe rain, South Africa, 2010

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# TRANSFORM?... OR CONFORM AND ADJUST?

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How can inefficient, poorly managed smallholder systems be transformed into productive agroecological systems? And how can environmentally destructive, energy and chemical-intensive industrial systems be converted into productive agroecological systems? What role does international trade play in today's agro-food systems, and are short supply chains relevant? This brochure provides a platform to a number of experts working in various fields relevant to these issues. It gives them space in which to share their visions and voice their concerns about how we are feeding the people of the world.

The focus is on small-scale farmers who, all over the world, are prone to food insecurity, but who nevertheless feed more than 80% of the world's population. Many of these farmers are located in what we often call the developing world, but we should make no mistake: change is needed in developed and developing countries alike. Food insecurity in today's world results from a globally dysfunctional agro-food system that is failing to meet the needs of many people in both developing and developed countries.

There is an urgent need for a transition from the existing agro-food systems to sustainable agroecological systems. This brochure explains many reasons why change is needed, based on strong science to underpin the arguments. At the same time, the authors highlight the main needs for further research and describe impediments to the progress of agroecology.

The articles examine aspects of agricultural policy, the role of livestock and nutrient cycles, climate change, international trade and certification schemes, the need for innovation and the need to bring consumers closer to producers. In this way, we hope to contribute to a constructive and inspiring debate on this important issue that affects everybody around the globe!

A lot of know-how has been generated on the production side, and many methods for alternative, sustainable forms of agricultural production have been documented. This rich body of expertise continues to grow. The flourishing organic sector, the growing interest in agroforestry and permaculture, the spread of integrated pest management approaches are just a few examples. These developments so far have yet to be matched by a similar degree of support in other fields necessary for their broader adoption. Therefore, to scale up the use of these agroecological production systems, there is a need to develop and improve the means of knowledge transfer that includes the participation of farmers. And it is important to establish regional supply chains, including food storage, processing and trade links.

At both national and international levels, there is an absence of broad-based political support, regulatory frameworks and appropriate economic incentives – or they are just in their infancy. Just as the industrial, mechanized systems of monoculture that transformed post-war global agriculture could only be installed with massive public investments and the concerted efforts of all the relevant segments of society, so too will the next transformation of agriculture require a similar concerted effort for its success – an effort that involves science, research and technology combined with adequate policies and economic incentives.

## THE WAY FORWARD FOR AGROECOLOGY AND THE TRANSFORMATION OF THE GLOBAL INDUSTRIAL AGRO-FOOD SYSTEM

- Funds must be provided and opportunities created for scaling up the best agroecological systems and integrating them into a coherent supply and value chain.

- National and international trade agreements must support the development of regional food systems.

- Training and extension work for agroecological production and fair trade must be integrated into academic and vocational education programmes.

- Significant investment is now needed to research and develop new economic paradigms that penalize business models contributing to environmental degradation, and reward those that protect and promote biodiversity, and eliminate environmental pollution and other harmful practices. While research into agroecology in its broadest sense has delivered results, that research has been largely decoupled from the study of economics.

- Final product prices must reflect the true costs of production by internalizing all the externalities.

- A detailed review is needed of the existing WTO rules, including its trade and agricultural policy measures, in order to strengthen food security, food sovereignty and sustainable rural development. Other relevant agreements should also be examined, such as those on anti-dumping, public procurement and the agreement on services.

- For this reason, we are calling for a billion-euro flagship research programme on agroecology and the transformation of the current agro-food system. The disadvantaged position – even exclusion – of agroecological research from major funding mechanisms must be overcome. Agroecology is an innovative form of food production that offers huge potential, not only to provide better food but also to remedy the environmental destruction that now threatens human societies.

- It is imperative that we break free of our collective dependency on the industrial agro-food systems that is under-serving the people and destroying the environment – it is also achievable, because the necessary agroecological systems do exist and are ready for deployment as soon as we have a conducive institutional and political environment. Missing this opportunity would be unforgiveable to future generations.

# INTRODUCTION

**BERNADETTE OEHEN,**
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Agroecology is an idea inspiring more and more people, but it means different things to different people. Altieri (1983) defined it as the application of ecological principles to agriculture. This definition of agroecology includes farmers and farmers' knowledge, and it sees farmers as stewards of the landscape, of biodiversity and of the diversity of foods. In 2002, Altieri developed his concept further when he proposed that agroecological systems should be based on five ecological principles: 1) recycling biomass and balancing nutrient flows and availability; 2) securing favourable soil conditions for plant growth by enhancing the organic matter; 3) minimizing losses of solar radiation, water and nutrients by managing the microclimate and soil cover, and practising water harvesting; 4) enhancing biological and genetic diversification on cropland; and 5) enhancing beneficial biological interactions and minimizing the use of pesticides.

Some years later, Wezel et al, (2009; 2011) and Gliessmann (2011) stated that agroecology is not only a means of producing food or a scientific discipline, but also a social movement that links producers to consumers, and criticizes the effects of industrialization and the economic framework of the globalized food market. In 2009, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) documented the need for the agroecological transformation of agriculture, food production and consumption and positioned the concept of agroecology in the food policy debate. The report also showed that agroecology is a worldwide process involving conventional, large-scale farmers as well as smallholders, scientists and policymakers, at regional, national and international levels. De Schutter (2010) identifies agroecology as a mode of agricultural development that raises productivity at the field level, reduces rural poverty and contributes to improved nutrition, while helping regions to adapt to climate change. He also points out that the concept of agroecology includes the participation and empowerment of food-insecure groups, because it is impossible to improving their situation without involving them in the process themselves.

De Schutter and Vanloqueren (2011) see agroecology as an effort to mimic ecological processes in agriculture, while increasing productivity and improving efficiency in the use of water, soil, and sunlight as sustainably as possible. Pimbert (2009) goes in the same direction, saying that agroecology is a new form of agricultural production, based on autonomy, prudent use of resources, and cooperation along the agro-food chain. El-Hage Scialabba et al (2014) states that agroecological systems are characterized by the use of a variety of methods, a wide range of crops and, as a new element, different sources of knowledge. And Lampkin et al (2015) sees different agricultural practices and systems as being agroecological in nature. However, according to these authors, they do not count as agroecology unless they integrate multiple practices in order to use synergies at the system level.

To conclude, agroecology is neither a defined system of production nor a production technique. It is a set of principles and practices intended to enhance the sustainability of a farming system, and it is a movement that seeks a new way of food production. Increasingly, agroecology is a science looking at ways of transforming the existing food system, and of further developing agriculture and adapting it to the changing environment – an approach which is vital for food security.

In the literature (Lampkin et al, 2015; Niggli 2015, El-Hage Scialabba et al. 2014) the following production systems are listed as examples of agroecology: integrated pest management (IPM), conservation agriculture (CA), organic farming, mixed crop-livestock/fish systems, agroforestry and permaculture, Low External Input Sustainable Agriculture (LEISA), Low Input Agriculture (LIA).

Among these systems and techniques, only the products of organic farming are subject to worldwide regulation, with laws and private label guidelines. They are traded as such on markets all around the world. The concept of 'organic farming' is rooted in the social movements of the early the 20th century, mainly in the German and English-speaking countries. It combines the visions of social reform movements and pioneer farmers who refused to use artificial fertilizers and synthetic pesticides, but were interested instead in concepts of soil fertility, nutrient cycling involving livestock and composts, food quality, and health. Decades later, IFOAM codified this idea into the four principles of organic agriculture: health, ecology, fairness and care. These principals should serve to further develop organic standards worldwide and are deeply rooted in the organic movement. However, they go far beyond the current legislation on organic farming, such as exists in most European countries, the US or Australia. In these countries, many labelled organic products are available to consumers by way of different supply chains: from farm shops and farmers' markets, to supermarkets and discounters. It cannot be overlooked that large enterprises are also becoming more deeply involved in organic production, not least because of their greater ability to comply with the standards of the retail industry, including organic certification schemes.

Driven by the economic success of organic labels in the food market, there is a risk that certified organic farmers just aim to fulfil the legal requirements. As Lampkin et al (2015) explain, it is debateable whether or not organic farms that achieve certification merely by substituting inputs rather than redesigning their operations, can really be considered agroecological. Even if these farms avoid synthetic fertilizers and pesticides, their dependency on external inputs remains high and the diversity of their crops low.

Meanwhile the organic farmers themselves might feel challenged, both by the conventional sector embracing them, and by the agroecologists bringing new concepts into the discussion of sustainable production, such as biodiversity, food diversity, farm-saved seed, food sovereignty, landscapes and participation (see table 1).

**Table 1: Differences between industrial and agroecological food production.**

| CONVENTIONAL AGRI-FOOD SYSTEMS | AGROECOLOGICALLY BASED AGRI-FOOD SYSTEMS |
|---|---|
| Domestic and export-oriented production of raw materials (feed, fibres, commodities) | Local, regional and national food production and consumption |
| Long supply chains | Short supply chains |
| Feeding the agri-food industries with cheap raw materials | Nourishing households with healthy food |
| Few crop and livestock species | Different varieties of crops and livestock species |
| Large-scale mono-cropping or short crop rotation | Small-scale diversified food systems with long crop rotations and temporary grasslands/fallow lands |
| High dependency on external inputs (hybrid seeds, fertilizer, energy) | Lower dependency on external inputs (farm-saved seeds and own breeding, manure and composts to feed the soil) |
| Top down extension schemes | Participation, farmer field schools, stable schools, innovations platforms |
| Industries are innovators | Farmers led innovations |
| Segregation of the producer from their social background | Integration of the social relationships (farmer to farmer, farmer to consumer) |
| Segregation of agriculture from landscape, biodiversity, single functional | Integration of landscape and biodiversity into agriculture, multifunctional |
| Narrow single field perspective, one size fits all blueprint approach | System view, holistic approach including methods and technologies based on farmers knowledge, traditions |

Nevertheless, when comparing agroecology and organic farming, the overlapping areas are obvious. In contrast to highly industrialized monoculture, organic farming features the integration of legumes and livestock in order to recycle nutrients; it strives to improve the condition of the soil, especially through increased organic matter content and biological activity; it uses crop rotations; and it further reduces the dependency on external, synthetic inputs. All these measures combine to reduce the environmental externalities caused by the use of toxic agro-chemicals to compensate for these lost ecological functions in industrial monocultures (El-Hage Scialabba, 2014).

What could be learnt from agroecological farm practices and how could it be effectuated in the context of organic agriculture? Just as organic farming contributes to agroecology with its production methods that have been tested in different regions of the world, so does agroecology also add new elements to organic production:

- Use of ecosystem services.
- High diversity of crops and varieties.
- Integration of trees, (fodder) shrubs and hedges.
- Focus on food and communities.
- Food system perspective and access to markets.
- Integration of human knowledge and social capital.

In this brochure, we have brought together a number of experts who are well known in their respective fields. They share their visions of how agriculture can be transformed from its current, destructive form, to one that will help reverse the environmental damage done by industrial agriculture, and one which can feed the global population. While there is broad agreement that such a transformation is imperative for our collective human survival, the proposed trajectories of that transformation differ. How should it be achieved? Can it be achieved within the current economic framework – or will the transformation require an entirely new economic paradigm?

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# 1.
# NOURISHING THE WORLD: THE ROLE OF SMALLHOLDERS AND VALUE CHAINS

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If we want to nourish our planet's more than nine billion people by 2050, we need a fundamentally new approach to agriculture and food production. We must change from a productivist and exploitative form of agriculture to a sustainable and regenerative one known as agroecology. Overall, we already produce about twice as many calories as we really need in order to nourish everyone, but we waste or lose about half of them[1] – and there are still 795 million[2] people starving today. Today, smallholders and family farms – 72% of which cultivate less than one hectare of land – still produce about 80% of the food consumed worldwide.[3] To ignore the needs and the capacities of these farmers, especially in developing countries, means putting food security at risk.

The key drivers of the globalized, industrialized food system have been the push for food security and cheap food. It has now been proven that the approach has failed. This was demonstrated by the explosion of food prices in 2008 and since then, by strongly fluctuating food prices. These events are the result of adverse climate developments and weather events, as well as changes in demand and the production of biofuel.

Agriculture should change from being a producer of commodities to being a producer of nutritious food, and it should switch to ecologically adapted and culturally appropriate crops and livestock. In newly industrialized countries, such as Brazil and Argentina, the large-scale production of soybeans and maize, mainly to be exported as feed, incurs huge but externalized costs, including damage to human health and the environment. Since this generates a long-term economic burden, such crops should be replaced by the production of healthy and nutritious food for local and regional consumption. Livestock should be fed what is appropriate for its health, rather than what promotes rapid growth at the expense of environmental and human wellbeing. The problems are seen in the development and spread of confined animal feeding operations (CAFOs), as well as the resistance to antibiotics caused by their wide abuse in the livestock production.

The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) contained a highly detailed analysis of the agricultural food production system over the past 50 years. It concluded that, while there were some benefits in the short term, in general the Green Revolution failed to address the key issues of hunger and poverty, which form an inseparable nexus. As it was based mainly on the increased use of synthetic inputs, upon which the new plant varieties were totally dependent, the increased level of production had disastrous effects on the environment, polluting ground and surface waters. The use and abuse of insecticides and herbicides has resulted in arthropod pests, diseases and weeds developing resistance, thereby leading to the now familiar treadmill.

The push for hybrid seeds and GMOs is eroding biodiversity, although this is a badly needed resource for climate change resilience. The super varieties introduced during the Green Revolution were also very thirsty and hungry: they needed ever more water and nutrients to keep producing the expected yields. Such a trend cannot be sustained, and only serves to strengthen the case for a more natural and regenerative type of agriculture. It is notable that the latest iteration of the Green Revolution, 'climate-smart agriculture' as promoted by the World Bank and a number of other foundations and development partners, simply continues the trend of reductionism and symptom treatment. Meanwhile, the real solution clearly lies in a complex and holistic approach to agriculture and the food system. This can only be achieved through the inclusion of smallholders and family farmers, and by building up local and regional supply chains.

Providing enough food for everyone is not only a question of productivity. It is also about producing the relevant food in the right places (developed and developing countries), by the right people (smallholders and family farmers). It is about growing the right kinds of food (diversified and adapted to local cultural and ecological needs; crops and livestock), using sustainable agronomic practices (ecological, organic, agro-ecological, regenerative). And it is about creating regional supply and value chains.

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[1] Lundqvist et al.: SIWI (2008)
[2] The State of Food Insecurity in the World (SOFI) 2015 (FAO, 2015). (http://www.fao.org/publications/card/en/c/c2cda20d-ebeb-4467-8a94-038087fe0f6e/)
[3] Family Farmers: Feeding the world, caring for the earth (FAO, 2014). (http://www.fao.org/resources/infographics/infographics-details/en/c/270462/ )

A powerful concept for food security is described by the term 'food sovereignty'. Local by definition, food sovereignty is driven by both local production and local consumption. We would not dispute the need for global food reserves to cater for major disasters or wars, but such reserves cannot be the solution to food and nutrition security.

Market access is another crucial factor when it comes to guaranteeing small-scale farmers a decent livelihood and ensuring fair prices for their products. This, in turn, ensures that farming is an attractive option. The UN Secretary General's Zero Hunger Challenge, which promotes affordable food and nutrition for all, is a step in the right direction.[4] The way the system works today, with rich countries over-producing and flooding the markets in developing countries with their highly subsidized products, has a massively disruptive effect and ruins local production and markets.

Rural areas would benefit greatly from the introduction of food storage and processing facilities. For one thing, this would minimize losses while adding value, and would thereby raise incomes in rural areas. This, in turn, would enable rural populations to afford to buy food when the need it.

By applying agro-ecological practices, farmers do more than produce food for the community. They also ensure that biodiversity and associated ecosystem services remain intact, because they use their own seeds and they protect water and the environment from agro-chemical inputs. Agroecology also results in healthy soils, which are maintained or restored with biological methods and contain more carbon per hectare than conventionally managed soils.[5] This is yet another crucial factor that helps protect the world from climate change, at the same time as increasing the resilience of the whole system.

Agroecology and other sustainable agricultural practices are knowledge-intensive and empowering. Farmers have to learn good farming practices and then apply them. The important point is that farmers need access to information on agroecology, to training in regenerative agricultural practices, and to related research results. At the same time, they must become actors themselves in the research, extension and production continuum. Once the know-how has reached the smallholders and family farmers, they can improve not only their own livelihoods, but also those of the people around them by producing enough healthy food for all.

A key element is investment in human capital: it is important to develop capacities and skills, and provide access to the information highway where people can acquire and spread knowledge and innovations. There are, after all, many innovations in the field of sustainable agriculture and food systems.

Many good examples exist of programmes to help farmers acquire skills and technologies, from the FAO's farmer field schools, to the Farmer Communication Programme of the Biovision Foundation in East Africa. The latter complements actual field training with a monthly magazine on organic agricultural practices, as well as weekly radio broadcasts, an SMS service and local knowledge hubs from where extension officers visit farmer groups to support and educate them. There is a huge amount still to do in this respect, given that despite today's major efforts, only a small fraction of the 500 million farming families have yet benefited from such transformative support. Without that assistance, efforts to change the course of agriculture and of food systems, and as such the course for humanity, will progress only slowly.

The responsibility rests mainly with national governments who should support their farmers and farming communities in the transformation to sustainable production. They should do so by investing public funds in research, capacity and institution building in the areas of agro-ecological, organic and regenerative agriculture.

However, one of the most powerful tools that we could deploy to control the devastation caused by industrial agriculture would be true pricing – in other words, the internalization of all externalities into the final price of products. This would effectively render large-scale industrial production uneconomical, given its destructive impacts on soils, water, pollinators, biodiversity and, last but not least, on human health. At the same time, true pricing would give a great advantage to sustainable agricultural practices, which provide services and benefits in all areas of sustainable development. As such they are still true to agriculture's multi-functionality, as is already explained in the IAASTD Report.

[4] UN Zero Hunger Challenge, see: http://www.un.org/en/zerohunger/challenge.shtml
[5] Research Institute of Organic Agriculture (FiBL, www.fibl.org)

# 2.
# 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.

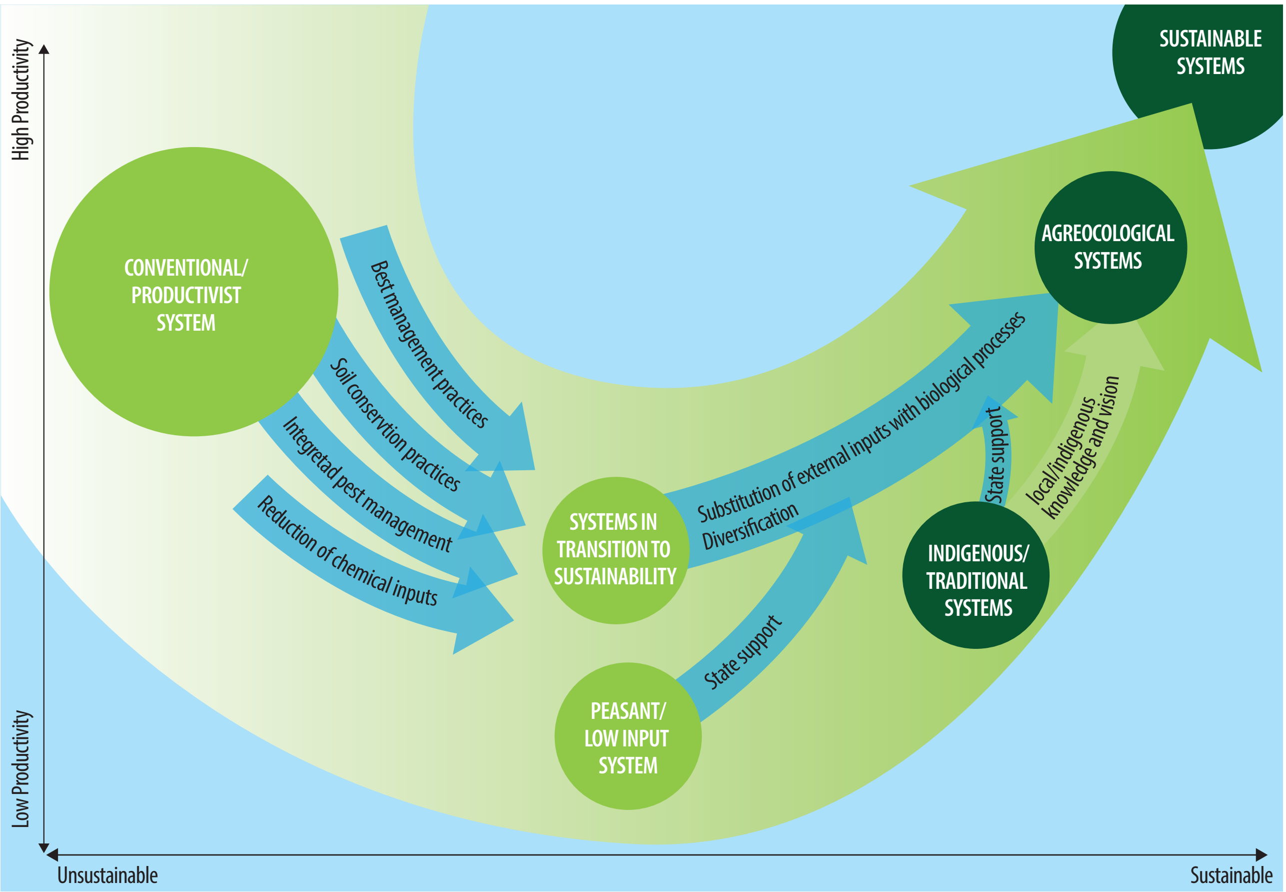
These industrial agricultural systems rely on external inputs such as fossil fuels, synthetic pesticides and fertilizers. The crops, in turn, have been bred primarily, if not exclusively, for increased yields, with little consideration given to their adaptation to local conditions or resistance against 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:<br>• Large industrial operations<br>• Linear, open extraction chains<br>• Integration with high-tech robotics, remote control, IT, software<br>• Biotechnologies<br>• Conventional production – less(?) chemical inputs, more efficient low-volume chemicals | Conversion - maximize efficiency through precision technologies:<br>• Large industrial operations<br>• Conform with current economic paradigm<br>• Perhaps shorter extraction chains?<br>• Appropriation of organic-inspired production methods and supporting technologies<br>• Biotechnologies PLUS GE<br>• No/little chemical inputs? | Transformation to agroecological systems:<br>• Family farm, small to mid size<br>• Transform current economic paradigm, local-global agency<br>• Short chains, closed cycles<br>• Organic production methods and supporting technologies<br>• Biotechnologies except GE<br>• No chemical input | Conversion to more productive systems:<br>• Family farms<br>• Transform and create local economies<br>• Short chains, closed cycles<br>• Organic or other agroecological production methods and supporting technologies<br>• Biotechnologies except GE<br>• No chemical inputs |
| **Modified conventional** | **Ecologically inspired conventional** | **Agroecological** | **Agroecological** |
| **Business-as-usual LIGHT**<br>**Little-medium change – still towards ruin** | | **Transformation**<br>**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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# 3. RECLAIMING FOOD SYSTEMS: LOCAL FOOD SYSTEMS AND ACCESS TO MARKETS LINKED TO TERRITORIES

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## LOCAL FOOD SYSTEMS AND ACCESS TO MARKETS LINKED TO TERRITORIES

Evidence from all continents suggests that agroecological intensification is more successful when it is based on re-localizing food systems and short food supply chains. Local food systems and short food webs help valorize farm-level agroecological methods and their wider environmental benefits.

For example, a growing number of initiatives in the Americas, Europe, Africa and Asia aim to reconnect producers and consumers and re-localize agricultural and food production. These innovative efforts to reorganize food and agriculture include short supply chains, alternative food networks, local farming systems and direct sales. The following forms of economic organization have been particularly effective in providing new market outlets, income and livelihoods for agroecological farming and land use:

*'Local Food Systems'* are those in which the production, processing, trade and consumption of food all occur in a defined, reduced geographical area (about 20 to 100 km radius).

*'Short Food Supply Chains',* on the other hand, describe a situation in which the number of intermediaries is kept to a minimum, the ideal being direct contact between the producer and the consumer.

According to a recent study commissioned by the European Union,[10] short food chains generate many social and economic benefits throughout Europe. They create a sense of community and of 'living together' by building trust and social bonds. They generate jobs and strengthen local economies because a larger share of the added value is retained by producers, with profits being potentially re-distributed to more people.

Taking a global perspective, the majority of the world's 570 million farms are small in scale, and most of them are operated by families.[12] According to the UN Food and Agriculture Organization, smallholders supply 70% of overall food production.[13] This involves some 470 million farmers, artisan fisher folk, pastoralists, landless and indigenous peoples. Smallholders in Africa, Asia and Latin America, as well as in developed countries, often sell their goods and labour, or buy inputs in markets that are in close proximity to their farms. Trade includes non-monetary exchanges, as well as sales to smaller or larger scale informal traders. These markets are part of everyday life and are rooted in the local institutions, culture and values of the local society and environment. They often constitute a complete local food system in which all stages in the food chain, from planting to final consumption, take place locally.

In this context, innovative marketing systems have been emerging in recent decades in some parts of Asia and Latin America, which enhance the economic viability of agroecological farms. These are usually based on voluntary standards and labels such as organic, fair trade, mountain products, farmers labels, geographical indications and quality linked to origin labels. Newer, community-supported models of agriculture have also emerged in which smallholder farmers organize themselves to supply directly to consumers through local food systems and short food webs.[13] Thus, with the construction of novel institutional arrangements that directly involve consumers as active participants, new local market outlets are created for agroecological products. These serve to remunerate, support and scale up agroecological intensification pathways in Africa, Asia and Latin America, as well as in developed countries. These arrangements often reflect a strong commitment to re-localizing food systems and sustainable, territorially based development.[14]

However, it is important not to make facile assumptions about the social, economic and environmental benefits that short food chains and local food systems may deliver for agroecological farming and land use. For example, the evidence on environmental impacts shows that shortening a food chain will not necessarily reduce its carbon footprint. Other factors must be taken into account, including production methods and logistical issues. Indeed, Plassmann & Edwards-Jones[15] have questioned just how 'local' such food actually is, when many of the inputs even for unprocessed seasonal food, such as fuel for farm machinery, are sourced at considerable distances from the farm. Realizing the potential of agroecology therefore calls for wider systemic changes such as those discussed below.

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[13] CFS, 2015. Committee on World Food Security. High Level Forum on Connecting Smallholders to Markets, 25 June 2015, Background document. FAO, Rome
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## A TRANSFORMATIVE AGENDA FOR AGROECOLOGY AND LOCAL FOOD SYSTEMS

Circular agroecological models of production cannot be made to fit in the linear, and increasingly globalised, structure of dominant food systems which assume that the Earth has an endless supply of natural resources at one end, and a limitless capacity to absorb waste and pollution at the other. Nevertheless, recent reductionist attempts to align 'agroecology' with 'sustainable intensification' have sought to incorporate agroecological methods into the linear extraction system of corporate-controlled industrial agriculture (e.g. see Arrignon and Bosc[16] for an analysis of mainstream development of agroecology in France). Agroecological innovations can be designed either to conform with or to radically transform the dominant agri-food regime.[17] The imperative is now for transformation rather than reforms that leave the basic economic, political and technological structure of current food systems unchanged.

An alternative to the current linear paradigm is to develop productive systems that minimise external inputs, pollution and waste (as well as risk, dependency and costs) by adopting a circular metabolism that is inspired by nature. There are two principles here, both or which reflect the natural world. The first is that natural systems are based on cycles, for example the water, nitrogen and carbon cycles. Secondly, there is very little waste in natural ecosystems. The 'waste' from one species is food for another, or it is converted into something useful by natural processes and cycles. These ideas are, of course, central to agroecology and the design of sustainable agriculture. But they now need to be extended and applied to the design of entire food systems as part of a transformative agenda for agroecology and food sovereignty.[18]

Circular systems that mimic natural ecosystems can be developed at different scales, from individual farm plots to entire cities, by using functional biodiversity, the ecological clustering of industries, reuse, recycling and the re-localization of production and consumption within specific territories. Reintegrating food, energy and water systems in locally embedded, circular models is a priority. To date, most sustainable food, water, energy and waste systems have been implemented in isolation. However, greater synergies are possible when ecological agriculture, local food systems, renewable energy systems, and sustainable water and waste management systems are all integrated from the outset and developed simultaneously within a circular economic model. Circular systems do not consume large quantities of fossil fuels and other finite resources; at the same time they maximize the possibilities for recycling and reuse. In the process, greenhouse gas emissions, air and water pollution, and outputs of solid waste are minimized.[19] 'Re-localizing' and 're-integrating' food and energy production with water and waste management in circular systems is also gaining credence as a means of enhancing quality of life for urban dwellers. This improves public health, supports adaptation to climate change and secures more reliable supplies of food and energy. Furthermore, in rural and urban contexts alike, circular systems that reduce people's dependency on external suppliers and distant markets have also been shown to promote local citizens' control over the means of production. As such, it therefore also enhances inclusive governance and direct democracy.[20]

If the full potential of agroecology to transform the dominant agro-food regime into one that offers greater food sovereignty is to be realised, it is important for organized citizens and policymakers around the world to act, in order to redirect investments towards integrated, resilient and locally controlled circular models, and at the same time to remove key obstacles that limit the spread of these systems in rural and urban areas.[21]

## CONCLUSION

Agroecological models of production based on functional biodiversity can benefit society, the economy and the environment in many ways. However, achieving the full potential of these multifunctional benefits largely depends on the spatial scale and structure of the food system and markets in which agroecological farms are embedded. Access to and distance from local markets for purchasing farm inputs and for selling farm produce is particularly important in realizing the potential of agroecological models of production. Similarly, to secure multifunctional benefits from agroecological farming and land use, the extent of the farms' integration in re-localised, circular economic models is also of key importance.

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# 4.
# RECLAIMING FOOD SYSTEMS: AGROECOLOGY AND TRADE

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Agroecological production is viewed as one of the approaches that can help overcome the economic, social and ecological crises now facing the global agri-food system. That system is predominantly controlled and managed by a small number of large, globally active multinational companies. Agroecology is promoted as a means to supply healthier food, improve agricultural sustainability and revitalise local communities, for instance by improving the livelihoods of farmers. From a social and political perspective, agroecology entails decentralized and localized governance and economic life. It adheres to the principle of subsidiarity, it recognises equity and protects diversity, and it helps to break down artificial boundaries and hierarchies in knowledge systems. (Dale et al, 2015: chapter 1)

As a food system with a local focus, agroecology also implies bypassing the long international supply chains that characterize the conventional food system. As emphasized by Hinrichs (2000), direct agricultural markets play a key role in creating spaces where consumers and producers can interact face-to-face. They produce an arena of exchange that is imbued with more social meaning than conventional retail spaces.

However, it is important to ask to what extent such 'localized' agroecological systems might become entangled nevertheless in the structures of conventional food markets. This can happen, above all because of international trade, which means that agroecological systems may not escape the inherent contradictions of conventional food and agricultural markets.[22]

International trade is necessary if the structure and volume of agri-food supply are to match those of consumption. Comparative cost advantages can also be realized through trade, which may improve the livelihoods of the farmers concerned. Furthermore, trade compensates for the instability of local production, which is becoming increasingly likely in times of weather extremes caused by climate change.

Almost 25% of agri-food production in developing countries is traded internationally.[23] However, if one considers the significant share of agricultural production that is not part of the monetary economy in developing countries (where subsistence agriculture often represents half of total food production, or more), the trade intensity of the agri-food sector is likely to be below 10% of total production. Such a low figure might suggest that trade – and the underlying rules of trade – have little significance for national food production and agricultural policy. However, the analysis below shows the opposite.

## WTO RULES AND FOOD SECURITY

World Trade Organisation (WTO) rules, and the related bilateral, regional and multilateral liberalization agreements (outside of WTO) have an impact on agricultural production, trade and consumption. On the one hand this is because they affect trade (WTO disciplines on market access and export competition); on the other, it derives from the WTO provisions on domestic governmental support, which should avoid distorting trade as far as possible.

Agriculture was excluded de facto from the rules set by the General Agreement on Tariffs and Trade (GATT) until the conclusion of the Uruguay Round of Trade Liberalization and the subsequent creation of the WTO in the mid-1990s. The sector was widely seen by developed countries as too economically, socially and politically sensitive to be governed by the GATT rules. Since the conclusion of the Uruguay Round, however, agriculture has been subjected to the WTO rules and, with a few exceptions, is treated like most other industrial sectors, such as the steel and car industries.

The rules in question encourage the specialization of production, as well as concomitant increases in scale to enable the achievement of maximum economies of scale. Mass production of food tends to reduce production costs and increase the availability of food, but it does not necessarily overcome the problem of food accessibility. Low food prices are notably problematic for small-scale farmers, agricultural labourers and pastoralists, who account for 60-80% of those suffering from hunger in the developing world. Therefore, liberalization of agricultural trade on its own is not an effective means of combating hunger and malnutrition. Moreover, as global markets take over from local markets, diversity is being replaced by monocultures. The ensuing loss of ecological functions formerly provided by the biodiversity is compensated through the escalating use of agro-chemicals, which in turn

[22] As highlighted by Böhm et al (2015: chapter 14), while at face value such approaches 'might look alternative (green, more sustainable, more ethical, etc.), the reality is often more complex, with many contradictions at work, precisely because they sit within the inescapable web of socio-economic capitalist relations. We will argue that in many ways these so-called "alternatives" are part and parcel of capital's continuous attempts to find new ways of accumulation and legitimization.'

[23] ((Import + export value) / 2) / value of agricultural GDP, calculated on the basis of UNCTAD (2013).

cause further serious environmental impacts, the costs of which are externalized (i.e. not included in the food prices).

According to the former UN Special Rapporteur on the Right to Food, Professor Olivier de Schutter (2011: 7), the Agreement on Agriculture (AoA), which is the WTO's specific legal framework for agricultural production and trade, does not specify food security as the key or overriding objective. Rather, achieving food security is seen as complicating factor which could distort market mechanisms (and is listed among the so-called non-trade concerns). According to De Schutter, the AoA should redefine non-trade concerns and recognize their importance for achieving effective food security. Nor should it be overlooked that the slow progress in the current multilateral liberalization round of the WTO (the Doha Round) has led to the signing of many bilateral, regional and mega trade liberalization agreements, often with rules that go far beyond those of the WTO and its AoA, including 'behind-the-border' measures on competition policy and investment rules. De facto, the AoA and the other agreements all have a significant bearing on national agricultural and rural development policies. It is important to understand that the structure of trade negotiations normally takes the form of a package deals, with compromises being made in the name of trade liberalization between agricultural and industrial goods as well as services. This may result in key issues influencing food security and sovereignty becoming bargaining chips in the negotiations.

At issue in the Doha Round of WTO negotiations, which started in 2001, and in the deliberations on the other trade liberalization agreements, is nothing less than the challenge of strengthening public investment and flanking measures in support of sustainable agriculture and rural development. These are needed in order to combat hunger, foster rural development and farmers' livelihoods, and to overcome the environmental crisis that plagues agriculture. In view of this, the special circumstances of agriculture (as distinct from industrial sectors) need to be recognized:

- Unlike many other products, food is absolutely essential for human life.

- Soil, the most important production factor in agriculture, is local in nature and highly diverse.

- Specialisation and mass production have bio-physical limits in agriculture because diversified production, the preservation of biodiversity and the recycling of nutrients are essential for the sustainability of the agricultural production system and for enhanced resilience to climate change.

- Farmers are not only food producers and providers of raw materials for industrial uses, but also managers and guardians of an agroecological system whose long-term functioning and environmental health is imperative for sustained productivity.

- Agricultural markets are often very volatile in response to crop failures or bumper harvests.

## HARNESSING AND MODIFYING INTERNATIONAL TRADE RULES IN SUPPORT OF AGROECOLOGICAL PRODUCTION

To foster agroecological production it seems appropriate to address two specific areas:

- Strengthening public support for sustainable agriculture, especially in terms of advisory and extension services, infrastructure and inputs.

- Reducing the excessive dependence on international trade for food security.

## STRENGTHENING PUBLIC SUPPORT FOR SUSTAINABLE AGRICULTURE

It might seem surprising initially that quite a large number of potentially effective measures that could support agroecology, food security and rural livelihoods are already included in clusters of measures exempt from further trade liberalization commitments. These include measures under Article 6.2 (the so-called development box of the AoA) and in Annex 2 of the AoA (known as the green box).

Article 6.2 covers public investment and input-support measures for low-income and resource-poor farmers. This support, however, makes no distinction between conventional and sustainable forms of agricultural production. Public support for large-scale, industrial agriculture will certainly not be covered by Article 6.2, although governments have a certain flexibility to interpret and stretch the limits of such support, unless formally challenged in the WTO.

The public support measures allowed under the 'green box' are very comprehensive and concern the following clusters:

- General support services (e.g. research and development, pest control, advisory and extension services, inspection and control, marketing and infra-structure).

- Public food reserves/stock.

- National food support programmes.

- Direct support payments to producers for:
  - Income support, but decoupled from production volume
  - Compensation for crop failure, or crop failure insurance
  - Structural adjustment measures (aimed at reducing production volume)

- Public funds in support of measures within government-defined environmental and conservation programmes.

- Public funds for regional support programmes.

Public support measures for agro-environmental programmes are currently limited to compensation for higher costs or losses incurred by producers. They do not cover incentive measures to expand production volumes.

The current negotiations of the Doha Round are intended to revise the criteria applied to the clusters of public support measures listed in the 'green box', as the box was initially designed to serve the interests of developed countries, supporting structural changes and the reduction of production capacity. The package of measures adopted at the WTO Ministerial Conference in Bali, in December 2013, enables the specification of general public services which will be explicitly accepted as agro-environmental programmes in developing countries. They include measures aimed at the settlement and resettlement of farmers, land reform programmes, rural development and livelihood security programmes, and drought and flood management programmes.

The extent of the permissible public support for agro-environmental programmes is not the principal problem. Of more immediate concern are:

a) The financial capacity of governments in developing countries to implement such support programmes: at present, flexibility options under the green box are mostly used by a small number of large and rapidly industrializing countries, such as China, India and Brazil.[24]

b) The lack of a clear will and strategy with respect to enhanced public support for agriculture and small-scale farming at the national level.[25]

## REDUCING THE EXCESSIVE DEPENDENCE ON INTERNATIONAL TRADE FOR FOOD SECURITY

The sustained decline in food prices since the mid-1970s has prompted international financial institutions and other bilateral donors to encourage developing countries to modify their food production patterns, shifting the emphasis from the production of staple foods to so-called cash crops for export (notably fruits, vegetables and cut flowers). Developing countries are then expected to use their increased export revenues to import cheap staple foods from the international market to cover domestic consumption. This strategy led to the reorientation of private and public agricultural investment, which gradually undermined the countries' capacities to produce staple food for their national markets.[26]

To counter the recent trend of soaring, yet volatile international prices for staple foods, it would be wise for developing countries to strengthen their food sovereignty in general, and the production capacity of smallholders in particular. They should aim to become regionally and nationally self-sufficient, and to increase the capacity of truly sustainable forms of production, notably various forms of agroecological production. To achieve this, developing countries must follow national strategies that systematically exploit the potential mechanisms for flexibility in the AoA green box, as described above.

A further aspect of strengthening food sovereignty is the toleration by international trade rules of consumers' preference for regionally and locally produced foods, which are seen as safe and environmentally more sustainable, and which support regional economic and social development. There are also cultural, historical and religious reasons for consumers to prefer certain local products. Such products rarely compete directly with the 'mass-produced' products readily available on international food markets.

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[24] For a detailed review see ICTSD, 2014:11. Whereas in developed countries recent public support for agriculture addresses 21% of the agricultural production value, in developing countries this figure is only around half this, at 11%.

[25] In the Declaration of Maputo in 2003, the member countries of the African Union (AU) committed themselves to increase the level of public support for agriculture within five years, to 10% of government expenses. In 2008, however, only seven of the 53 AU member countries had achieved this goal. The same number of countries had even recorded a drop in the share of agriculture (Actionaid, 2009).

[26] The least developed countries (LDCs), for instance, imported some 20% of their food needs shortly before the food price crisis of 2008-2009 and the financial import bill in this regard had already doubled before the crisis (De Schutter, 2011: 13).

This implies that their promotion (including government support) would not violate the non-discrimination principle of the WTO. Irrespective of this fact, it would provide more legal certainty if the AoA were modified to permit such local preferences.[27]

## CONCLUSIONS

In the light of climate-change-induced volatility of production volumes and declining growth dynamics of agricultural productivity, the international agro-food trade is likely to increase in importance in the future, especially in developing countries with a high rate of population growth. The rules governing international trade (WTO disciplines and the WTO+ rules enshrined in bilateral, regional and mega trade liberalization agreements) have a critical influence on – and impinge upon – national sovereignty over agricultural policies. Even so, the existing flexibility mechanisms in the AoA and those currently being negotiated in the WTO Doha Round could enable interested and determined governments to pursue policies that create the conditions for, or strengthen, food security and sustainable rural development, and to promote the truly sustainable transformation of agriculture, including agroecological production. The main precondition in this regard is that the clear political will exists to move in this direction, and that this is translated into a realistic strategy which incorporates appropriate flanking and supportive trade measures.

Food security and sustainable rural development have recently moved to the very centre of the WTO Doha Round negotiations. Many countries have stressed the fact that international trade should make a constructive contribution to achieving these objectives. Without consensus on this issue it is unlikely that the negotiations as a whole will make tangible progress.

It is therefore pertinent to follow up on the proposal made by Olivier de Schutter (2011: 4 and 18) to conduct a detailed review of the existing WTO rules, and of those trade and agriculture policy measures introduced after the 2008 food price crisis which aim to use agro-ecological/eco-functional intensification (i.e. more quality than volume) to foster food security, sovereignty and sustainable rural development, as well as the concomitant enhanced resilience. An integrated review of this kind would go beyond the AoA and also include other relevant WTO agreements, such as those on anti-dumping, public procurement or the agreement on services. Such an analysis would also scrutinize the problematic general incentives in the trade rules which foster excessive specialization, factory-like mass production and the enormous cost-related pressures.

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[27] For more information in this regard see: Fuchs and Hoffmann, 2013: 266-275.

# 5.
# THE ROLE OF PARTICIPATORY GUARANTEE SYSTEMS FOR FOOD SECURITY

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## A RATIONALE FOR PARTICIPATORY GUARANTEE SYSTEMS

The primary tool for assuring quality of organic products and preventing fraud, and also for promoting commerce, is third party organic certification, which aims to regulate and facilitate the sale of organic products to consumers. Certification plays a role along the entire supply chain and is used by organic producers to identify products that are approved for use in certified production (Fabiansson, 2014), while also serving as product assurance for consumers (Sethuraman and Naidu, 2008). Although third party certification systems play an important role in organic production and trade, they are not always suitable for small-scale operators and local market channels. Third party certification can act as a barrier to entry for smallholder producers looking to access organic markets because of the high costs involved (Lundberg and Moberg, 2009), the paperwork and bureaucracy required (IFAD, 2003) and complex norms (Nelson, 2015). To address these challenges, some farmers have sought alternative certification systems that are better adapted to specific local contexts. One such alternative for conformity assessment is to use participatory guarantee systems (PGS), which rely on the participation of multiple stakeholders to guarantee the organic integrity of products.

## WHAT PGS ARE AND HOW THEY WORK

Participatory guarantee systems are locally focused quality assurance systems that certify producers based on active participation of stakeholders. They are viable organic verification systems that offer an alternative and are complementary to third party certification and are built on a foundation of trust, social networks, knowledge building and exchange (IFOAM, 2011). With their relatively low associated costs and lower burden of paperwork, PGS are particularly appropriate for local markets and organized smallholder farmers (Nelson et al, 2010). PGS are also context-specific, with each responding to the particular challenges and conditions faced by producers, consumers and other stakeholders in the organic sector of a specific place. Although this means that every PGS initiative is locally-adapted and to some extent unique, they all share a number of key elements and features. These include a shared vision; active participation of multiple stakeholders; transparency of process; trust as a foundational element; conceptualizing certification as a learning process; and horizontality, meaning that all members share equally in the rights and responsibilities related to how the system is established and maintained (IFOAM, 2011).

A typical PGS initiative involves producers and other stakeholders such as consumers, the staff of NGOs, universities and extension services, government representatives, and consultants (Nelson et al, 2010). Producers, and sometimes other stakeholders, are typically organized in local groups that are collectively responsible for ensuring that all the participating producers adhere to PGS standards and processes. The usual practice is that each farmer receives an annual site visit from this locally based group. Results of the farm visit are summarized in a report, which provides the basis for the decision made by the group regarding the extent to which a producer is in compliance (or not) with the agreed organic standards. Summaries of the documentation and certification decisions are usually then communicated to a higher level, for example a regional or national council representing PGS stakeholders. These higher-level councils or organizations are generally responsible for the overall oversight and administration of the PGS program, and they often represent the PGS in communications with external stakeholders such as the government and IFOAM (Castro, 2014). In some cases, they endorse certification decisions made by the local groups, while in others they grant approval for local-level authorities to use the PGS label independently.

## PGS AND SOCIAL PROCESSES

Participatory guarantee systems are more than just a low-cost mechanism for organic certification. They are also a means of facilitating social processes that enable inclusion, farmer empowerment and mutual support; both among farmers and between farmers and consumers. The social processes include the networking involved in gaining PGS accreditation and a range of parallel processes that both support, and are supported by, the PGS. Some of the most important and consistent findings of research on PGS relate to these parallel social processes (including the collective use of knowledge and resources) and the contribution they make to the unity and sustainability of PGS groups. Participation in social processes has been shown to help foster the mutual trust and strong personal relationships that are a key factor in the long-term success of PGS. In addition to contributing to the stability and success of the PGS, social processes also provide direct and indirect benefits to participating farmers.

The trust-based relationships play an important role in providing organic farmers a sense of community that might otherwise be lacking. Experience gained by PGS initiatives around the world has shown that participation in PGS creates opportunities and favorable environments for peer learning and for sharing of knowledge and resources between farmers (Kirchner, 2014). This enables farmers to build capacity that can help them improve the quality and quantity of their organic production over time. One manifestation of social processes that is frequently observed in the context of PGS is the organization of collective use of resources, sometimes known as self-help groups, which are important to the success of many PGS. Self-help groups have become an entry point into many PGS communities at a grassroots level and provide a platform for various intervention activities, such as:

- Collective buying, which reduces costs.
- Joint marketing, which is essential to the expansion of market opportunities.
- Establishing seedbanks, which gives farmers access to varieties suited to local conditions.
- Supporting collective logistics in transportation for farmers who are often geographically isolated.
- Enabling farming households to access affordable credit for agricultural and other purposes (Home et al. in review).

Participation in the collective actions of self-help groups (that have their own social processes) reinforces the social inclusion, farmer empowerment, and mutual support between producers and consumers that are inherent in PGS. Given that PGS are commonly composed of people living in close proximity and sharing the same ideals, support can be delivered in a way that is tailored to their individual needs. For example, monitoring use and repayment of credit is easier, with less need for coercion (Home et al., in review).

## PGS CONTRIBUTIONS TO FOOD SECURITY

By increasing market access and, more specifically, making an organic label and associated price premiums more accessible to small-scale producers, PGS often lead to at least some increase in income for participating farmers. Increased income directly contributes to improvements in food security because many farmers still rely heavily on purchased foods to meet their household needs.

The capacity building for organic production that occurs through the social processes associated with PGS also contributes to food security in that it enables farmers to increase the scale, diversity and quality of their production. Thus, PGS can make it easier for them to meet more of their households' nutritional needs through subsistence production. Enhanced self-sufficiency not only helps farmers increase the quantity of food available but, because the production tends to use agro-ecological best practices, the quality of the food is also high. The social processes associated with participation in PGS also foster this improved self-sufficiency by empowering the participating farmers. Examples of farmer empowerment include facilitating their access to credit and/or to seedbanks with locally-suited varieties; by supporting collective buying, joint marketing, and knowledge-sharing; and by including them as active participants in the certification process (Nelson et al, 2015). Collectively, these empowerment benefits enhance the farmers' ability to produce a surplus to their own food needs, and thus contribute to food security.

PGS can also increase the food security of community members not directly engaged in production because they increase market access for organic products sold at fair prices, and support the development and strengthening of local markets, (Nelson et al, 2015). This is especially the case in communities where access to safe, high quality, nutritious foods may be limited by low incomes.

## RECOMMENDATION: SUPPORTING PGS CAN FACILITATE THE POTENTIAL FOR AGROECOLOGY TO FEED THE WORLD

PGS initiatives have the potential to build capacity for organic production based on agroecological ideals and to develop equitable markets for the goods produced. By strengthening both the supply and demand sides of the organic market, PGS make it easier for that market to feed more people. With this in mind, we recommend encouraging the use of PGS through both financial and in-kind investments, as well as policy and other structural support. PGS are typically driven by a small group of people, or sometimes by an individual, who take the initiative to establish a system at the local level. Providing support to such people, who adopt the role of the change agents, will encourage the spread of PGS, which in turn will increase trust in the system.

PGS initiatives will be more sustainable if they base their activities on long lasting social processes and are well connected to consumers, markets, regulation bodies, governments, and the communities in which they operate. A key to the success of the social processes of PGS, and therefore to the success of PGS in general, is the trust built by involvement of consumers in PGS certification. This is in agreement with the observation by Nelson et al (2010) that PGS are particularly suited to local markets in which consumers have some understanding of the local conditions.

Lack of governmental support has often been cited as a problem in establishing and maintaining PGS. PGS proponents call for increased advocacy efforts and greater involvement in local politics to gain more political support, such as local government involvement in projects for the further development of PGS in a region. Examples of advocacy might include pressing a city to provide adequate space for a farmers' market, or lobbying for government-level facilitation of agroecology in the form of policies offering preferential treatment for those who produce quality food and who also protect natural resources (Home et al., in review). Fundamental to the sustainability of PGS is its formal recognition as a legitimate quality assurance system, which may require ongoing negotiation with local, regional and national governments as well as with organic regulation bodies. A number of countries, including Mexico and Brazil, have included PGS in their national organic regulatory frameworks. Other countries interested in promoting the use of PGS could look to them for examples of how PGS can be included effectively in their legislation governing the organic sector. Recommendations and various scenarios for the role that governments can take in the support of PGS can be found in the IFOAM PGS Policy Brief: How governments can support Participatory Guarantee Systems (IFOAM, 2015).

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# 6.
# THE ROLE OF LIVESTOCK IN AGROECOLOGY AND SUSTAINABLE FOOD SYSTEMS

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Livestock play an important part in food systems. They are a source of high quality protein and other nutrients, such as vitamins and minerals; and raising livestock is a way of utilizing otherwise unusable areas and resources for food production – namely grasslands, by-products of food production, and organic waste. Livestock also play a significant role in on-farm and regional nutrient cycles, and they provide people with incomes, assets and livelihoods. However, over the last 50 years we have seen a more than fourfold increase in global meat and egg production, and milk production has more than doubled. At the same time, there was just a twofold growth in the global human population (FAOSTAT, 2015).

Over the same period, the livestock sector has become increasingly specialised and industrialised, and its environmental impacts have grown accordingly, most notably in terms of greenhouse gas emissions, nitrogen overload, land-use change and deforestation (Ripple et al., 2014; Steinfeld, 2006). The outlook remains bleak as, according to recent FAO forecasts, production is expected to rise by a further 70% by 2050 (Alexandratos and Bruinsma, 2050). Actions to curb the adverse effects of livestock production are therefore of paramount importance, and it is vital to reflect on the role of livestock in future sustainable food systems. Here it is necessary to take a whole food system perspective, especially when talking about 'feeding the people' and not merely about agricultural production.

## LIVESTOCK IN AGROECOLOGY

As in organic farming, livestock could play an important role in agroecological production systems. Unlike in organic production, this has not traditionally been the rule in agroecology. This situation might be changing, however, as several research contributions show (e.g. Dumont and Bernués, 2014; Bonaudo et al, 2014; Dumont et al 2013). Dumont et al (2013) suggest five principles for agroecological livestock production:

1. Improving animal health.
2. Reducing inputs.
3. Reducing pollution by optimizing metabolism in the farming system
4. Enhancing diversity for greater resilience.
5. Preserving biological diversity.

Integrated crop-livestock systems are therefore a key aspect of agroecological and organic livestock production (Dumont and Bernués, 2014). Such integration allows for better management of nutrient flows and of landscape structures, with beneficial effects, for example, on biodiversity. Achieving integration and greater diversity, for instance by combining different animal species with differing feed preferences on the same pastures, or using integrated crop-livestock-forestry systems, can lead to higher productivity and reduce the use of inputs, while improving the overall economic performance (Latawiec et al, 2014, Accatino et al, 2014). It should be emphasized that such combined systems can be quite knowledge-intensive and their implementation can pose considerable challenges, particularly in contexts where no such tradition already exists. It can cause problems, for example, if new species or varieties are introduced in places where they are not reared traditionally.

Nitrogen flows are particularly relevant for identifying potential reductions in inputs and for optimising farm system metabolism. External and internal nitrogen sources and sinks need to be clearly identified. Feed and mineral or organic fertilizers (including manure and compost) imported to the farm are clearly external sources. Internal sources include manure, crop residues, compost, litter and roots, as well as the soil nitrogen pool. External sinks or losses include nitrogen runoff and emissions of various compounds such as nitrous oxide and ammonium, as well as the produce that leaves the farm. Nitrogen fixing by legumes actually counts as an additional external source of nitrogen, as it produces reactive nitrogen from atmospheric molecular nitrogen. Finally, the deposition of atmospheric nitrogen must be considered as another external source, as it can reach high levels in relative terms, in particular on grasslands (Stevens et al, 2004).

However, when assessing the nitrogen cycle and a potential imbalance between inputs and outputs, it is not the source of fertilizer that counts, but the ultimate source of the nitrogen it contains. All the nitrogen in manure stems from nitrogen in the feed. Therefore, unless it is imported into the system, manure is not a source of nitrogen, but merely a means of storage and spatial redistribution, where the nitrogen is partly sourced from grasslands. This enables farmers to collect external nitrogen from rather low intensity but extended grassland areas for use on more intensive croplands. They can also store it to optimize the timing of its application. This is one important role of livestock in agriculture.

In light of the fact that integrated crop-livestock systems are important for sustainable food production, and since grasslands and reusing organic waste are important for the crop-livestock system in general, the question arises as to whether the farm is the best unit of analysis. A regional focus should be adopted instead, enabling the assessment of nutrient cycles at the regional level. This is more appropriate for the dynamics of many ecosystems for which a regional scale is relevant. Examples include structural elements in the landscape that affect biodiversity or hydrological features. It is also better suited to grasslands, which are a representative reference point for systems on this regional scale. A farm-level perspective can impose an artificial division that is not appropriate for the relevant system dynamics. The landscape perspective is more often seen in the context of agroecology, while in organic farming, the farm-level perspective is still more common.

## FOOD SYSTEMS

Much could be achieved using sustainable integrated crop-livestock systems, ideally conceived on the landscape scale. However, livestock can help farmers move towards more encompassing approaches, embracing whole food systems, as is proposed in some recent work on agroecology (Wezel et al, 2009).

Global food system modelling has shown that it is possible to devise a sustainable food system capable of delivering the necessary calories and proteins to meet the needs of over nine billion people in 2050 (Muller et al. 2015). This could be achieved, for example, by i) pursuing more sustainable production practices such as organic agriculture (certified or not), while ii) reducing the use of animal feed concentrates, using grassland-based ruminant production at the same time as reducing the content of animal products in human diets, and iii) reducing the amount of food wastage.

None of these three strategies needs to be implemented in full, but a partial implementation of all three together could bring considerable improvements in terms of all the relevant environmental indicators. Achieving partial implementation of several strategies in combination is a much more realistic ambition than full implementation of a single strategy.

The combination also alleviates the pressure on certain aspects of the individual strategies, such as the yield gap in organic production. If food wastage is reduced, for example, the pressure to reduce the yield gap also falls, as less output needs to be produced. These aspects are overlooked if the focus is only on sustainable production rather than the whole food system, which includes consumption.

Ultimately, therefore, the role of livestock is related to the bigger question of how protein is produced in the food system. Animals can play an important role in this, especially grassland-fed ruminants and monogastric animals fed on the by-products of food production such as bran, whey and food waste.

However, it would be possible to source a greater share of our protein from crops than currently happens. In this respect, innovative protein sources could also be considered in agroecology and organic farming, such as algae or insect protein (Shockley and Dossey, 2014). For example, some locusts thrive on grassland while providing a rich protein source without the disadvantage of methane emissions. It may be worth considering an investment in breeding locusts and using them in food production, and in designing systems for managing their populations and harvesting them on grasslands.

Discussing the role of livestock in agroecology therefore serves to emphasize the importance of a food-system focus that treats aspects of consumption with equal importance to production. Food wastage is also a good example of this. As long as 30-40% of food is wasted (Gustavsson et al, 2011), it makes little sense to produce that waste more sustainably unless we work at the same time to considerably reduce it.

Finally, as part of this food systems approach a discussion should be started about utilizing the nutrients from human faeces and urine. Only by including this can we complete the picture of a whole food systems approach that encompasses consumption and aims at a closed nutrient cycle. Ultimately, this would just be the same as using manure from livestock in food systems.

## POLICIES AND STRATEGIES

At the strategic or policy level, the discussion described above reflects the more general discussion of 'coarse-tuning' and 'fine-tuning' (Minsch et al, 1996). Policies for sustainable development often need to be coarsely rather than finely tuned, addressing aspects that have a lot of leverage, such as the share of animal products in human diets, rather than the emissions per kg of animal products, or addressing the issue of food wastage rather than the land area required per kilogram of food.

Currently, most approaches to raising the sustainability of livestock production fall far short of this. For instance Thornton (2010) and Gerber et al (2011) focus on increasing the efficiency of livestock production without addressing the absolute size of the sector. Gerber et al (2013) propose a range of effective and important measures to increase efficiency in the livestock sector. If these were all implemented, greenhouse gas emissions from today's livestock sector could be reduced by 30%. However, without curbing demand, in 2050 those emissions would still be 20% higher than today as the production will increase by 70% (Alexandratos and Bruinsma, 2012). If, on the other hand, the amount of animal protein that people eat is reduced by two thirds, and the rest is produced with agroecological methods (concentrate-free feeding rations, grassland-based ruminant production and monogastric animals fed on by-products of food production), then the greenhouse gas emissions projected for 2050 would fall by 20% compared to today's emissions (Schader et al. 2015). This example illustrates well the problem of fine-tuning strategies such as efficiency increases, compared to the benefits of coarse-tuning, such as targeting absolute quantities.

The advantage of coarse-tuning strategies is that they can rely on generally robust rules that do not depend on further detailed research findings for their successful implementation and would not be altered by new insights into details. The disadvantage is that such strategies tend to address fundamental aspects of society. Whereas a fine-tuning strategy may inform consumers about the greenhouse gas emissions of various food products, and leave it up to them to choose the climate friendly options within their established diets, coarse-tuning aims at a fundamental change in what people eat. This cannot be achieved using ordinary policy instruments, such as those used to support increased emissions efficiency, for example. Especially in liberal societies, coarse-tuning poses a challenge as it is often perceived to interfering with individual freedoms.

It is all the more important to emphasize, therefore, that the example above illustrates a coarsely tuned strategy for a more sustainable food system which is not extreme in any of its dimensions, although its aims are high. Its strength lies in the combination of substantial but partial improvements in terms of livestock feed, ecological production, food wastage and human diets. Together, these improvements achieve the environmental goals, while none of the individual approaches has to be implemented to 100% in order to achieve the goals.

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# 7. AGROECOLOGICAL INNOVATION

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Innovation, in the broad sense of applying new ideas to daily practices, has always occurred. Agricultural practices have always responded to changing environmental conditions. Agroecology 'is by definition an innovative, creative process of interactions among small-scale producers and their natural environments' (IATP, 2013).

However, the term 'innovation' has become narrowly defined as meaning technological, commercialised innovation. From the 14th century onwards, social innovations have contributed to that narrowing, especially through various privileges and patent laws that reward novelty. By the early 20th century, innovation was understood as the commercial adoption of technological inventions. This, in turn, was seen as causing cultural or social changes – rather than being dependent on such changes (Godin, 2008 and 2015). Hence 'innovation' has underpinned a technological-deterministic explanation of societal change.

Emphasising capital-intensive technology, this model has become deeply embedded in policy and research frameworks. It ignores existing farmers' networks, thereby marginalising the cooperative exchanges of knowledge which facilitate novelty. The prevalent definition of innovation has hidden and devalued farmers' knowledge, which generates most agricultural improvements, while attributing those improvements elsewhere, for instance, to external innovators, agro-supply companies or patent holders.

All this has privileged laboratory-based knowledge, favouring agri-biotech in particular in research agendas, at the expense agroecology (Vanloqueren and Baret, 2009). As in industrial processes, a top-down 'knowledge transfer' from researchers reduces farmers to mere users of technology. Moreover, the transfer is targeted at individual farmers in isolated farms (Moschitz et al, 2015).

Agroecology faces the task of reclaiming 'innovation' for knowledge production and policy support. This includes innovation across the entire agro-food chain, linking farmers with other farmers and with inputs of natural resources, as well as consumers who support agroecological methods. Such initiatives act together to challenge the dominant models of innovation and agriculture. Agroecology embraces other forms of innovation, alongside the technological-scientific:

- Know-how innovation: the development of new management approaches and the introduction of both new and traditional knowledge related to methods and practices.

- Organisational innovation: introducing changes to the actual patterns of management and cooperation, right across the agro-food value chains as well as between the farmers that share common landscapes.

- Social innovation: changing the behaviour of groups in society, while maintaining or strengthening cooperation within farmers' networks, for example empowering primary producers vis-à-vis input suppliers and retailers, and altering the relationships between companies and the general public (IFOAM EU Group et al, 2012: 3).

This section first examines farmers' innovations, then takes a look across the agro-food chain. Specific examples here come mainly from Brazil and Europe (especially France), where agroecological innovation is well documented and promoted as such.

## FARMERS' AGROECOLOGICAL KNOW-HOW INNOVATION

In promoting agroecology, expert studies have pointed to farmers' traditional and local knowledge as a basis for innovation. This was highlighted in 2007-08 when stakeholders discussed the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD). According to the IAASTD report, in systems of agricultural knowledge, science and technology (AKST) no official recognition is given to innovation by farmers:

> Partly because the innumerable but diverse innovations resulting from local and traditional AKST are hard to present as statistical data they typically are overlooked, undervalued and excluded from the modelling that often guides AKST decision making (IAASTD, 2009: 71).
>
> Enabling resource-poor farmers to link their own local knowledge to external expert and scientific knowledge for innovative management of soil fertility, crop genetic diversity, and natural resources is a powerful tool for enabling them to capture market opportunities (Ibid: 27).

Inequitable power relationships create barriers to such opportunities. To develop agroecology further, it is necessary to evaluate the extent to which farmers are able to innovate. They use and share their knowledge in innovative ways in order to adapt techniques to local conditions. 'Analysing the drivers of farmers' choices thus requires a flexible analytical framework, context-specific indicators and a focus on farmers' capacity to innovate, rather than uptake and consume innovations.' (Silici, 2014: 22).

Contrary to the prevailing system, in which technological fixes are meant to compensate for the limitations of nature and farmers, the agroecological perspective recasts 'innovation':

> Innovations by agroecological farmers are in response to technological constraints/failures, in relation to issues of weed resistance, loss of soil fertility, and pesticide-related health problems….. Often extension services have not developed agroecological expertise and farmers have had to work collectively to find appropriate solutions (FAO, 2014: 7-8).

For the past decade, agroecological farmers and scientists in Brazil have been playing a globally leading role. Agroecological methods have been promoted there by small-scale farmers' organisations, especially parts of the landless movement, the Movimento dos Trabalhadores Rurais Sem Terra (MST, 2015). Responding to the new demand, in 2004 Brazil's Ministry of Agriculture developed an agroecological programme to support family-based ecological agriculture. This initiative included a nationwide competition for documenting alternative experiences in agriculture (Caporal, 2006). An NGO that advises family farmers' organisations tested various methods of documenting farm-level innovations. This encouraged more exchanges of information regarding farmers' experiments with agroecology (AS-PTA, 2006).

Such informal exchange networks can be undermined by packages of top-down 'technology transfer'. To avoid this problem, Brazil's agroecological innovation has been strategically linked with a programme for agricultural and societal transformation, in order to promote an economy based on solidarity (MST, 2015; Thies, 2013). In 2012 diverse stakeholder groups agreed a National Plan of Agroecological and Organic Production (PLANAPO), which included a broad definition of family farming that encompasses more activities and livelihoods. The Plan also involves substantial state funding to promote socio-economic innovation related to agroecology.

Partly thanks to La Via Campesina, this Latin American agroecology agenda has since inspired transformational strategies by farmers' and civil society organisations elsewhere. These draw on farmers' long history of agroecological experimentation, which has recently been gaining official recognition, especially in Europe (SCAR FEG, 2008). Indeed, agroecology should be given priority in research agendas, according to the EU's Standing Committee on Agricultural Research:

> Approaches that promise building blocks towards low-input high-output systems, integrate historical knowledge and agroecological principles that use nature's capacity and models nature's system flows, should receive the highest priority for funding (SCAR FEG, 2011: 8).

The European organic sector and its supporters have worked together to promote agroecological research with the concept of 'eco-functional intensification'. This links practical innovation, farmers' knowledge and scientific research.

> [Eco-functional intensification means] more efficient use of natural resources, improved nutrient recycling techniques and agro-ecological methods for enhancing diversity and the health of soils, crops and livestock. Such intensification builds on the knowledge of stakeholders using participatory methods… [It means] activating more knowledge and achieving a higher degree of organization per land unit. It intensifies the beneficial effects of ecosystem functions, including biodiversity, soil fertility and homeostasis (Niggli et al, 2008: 34).

Thus intensification can result in lower input costs and higher productivity through resource-recycling and biodiverse systems, not simply through increased yields.

A French network of small-scale farmers, the Réseau Semences Paysans, has played an important innovative role by saving, exchanging and improving seeds (RSP, 2008). Their long-standing experience provides the basis for participatory plant breeding (PPB. This research process is carried out jointly with scientists, who now recognise that opportunities for farmer participation depend on the sources and methods of varietal breeding.

> Farmers' involvement in the breeding process is also closely linked to the vegetal material that is used, valued and shared. Depending on the type (genetic resources, segregating pure lines, populations or advanced material), farmers may be in a position to innovate, adapt or to manage the process dynamically. In addition, if farmers are allowed to handle the materials, this may help them to explain their preferences better when expressing opinions during interviews, in which they face the added pressures of the researcher or the social control of their peers (Chiffoleau, and Desclaux, 2006: 123).

Their seed-breeding goals include climate resilience and higher productivity with minimal external inputs, which can be enhanced by heterogeneity, as appropriate (Bocci, 2014). To facilitate cooperation between farmers and researchers, a civil society organisation attempted to identify and overcome existing barriers. Its research project produced a number of recommendations, as well as a noteworthy book about farmers' visions with respect to PPB research (Sciences Citoyennes, 2012). The project linked the co-piloting of research with civil society participation, in order to produce ecologically useful knowledge.

## ORGANISATIONAL INNOVATION ACROSS THE AGRO-FOOD CHAIN

Beyond cooperation with other farmers and scientists, agroecological methods aim at improvements that affect whole landscapes, enhance the natural resource base and strengthen links with consumer groups that support such methods.

> Promoting more diverse systems of local crop production at farm and landscape scale, to create more diverse habitats for wild species/ecological communities and for the provision of ecosystem services. This will require institutional innovations to enable efficient marketing systems to handle diversified production (IAASTD, 2009: 29).

> New modes of governance to develop innovative local networks and decentralized government, focusing on small-scale producers and the urban poor (supporting urban agriculture; direct links between urban consumers and rural producers) will help create and strengthen synergistic and complementary capacities. (IAASTD, 2009: 6-7).

In this broad sense, 'agro-ecological innovation' has been promoted by a European alliance of farmers and civil society organisations (ARC2020 et al, 2015).

Over the past decade, Europe has seen more initiatives designed to bring food producers and consumers closer together. These are variously known as alternative agro-food networks, short food supply chains (SFSCs, or circuits courts), or agro-food re-localisation. As a social innovation, SFSCs complement product innovation, for example when local breeds and varieties are used or in the case of on-farm processed products (Galli and Brunori, 2013). Such initiatives are necessary to incentivise and remunerate agroecological methods by securing consumer support, especially for those farmers who lack the premium price of certified organic products. More ambitiously, such networks can empower new citizen-community alliances as a counterweight to the dominant agri-food system and its competitive pressures (Fernandez et al, 2013).

Alternative food networks build up consumer support for agri-food methods, which (among other benefits) minimise external inputs and enhance aesthetic food qualities. Many farmers maintain regimes that aim to preserve the environmental quality of landscapes, maintaining agro-biodiversity by preserving local traditions and varieties. Although most such initiatives began by marketing organic products, they have also expanded the opportunities for producers to secure better remuneration and policy support for agroecological methods more generally (Karner, 2012). On-farm food processing is designed to conserve nutritional quality, minimise energy inputs and strengthen links with consumers.

In such ways, local food systems depend upon innovation in linking agroecological methods with the entire food chain. Farmers, entrepreneurs and others demonstrate the capacity to innovate, to find new forms which can promote sustainable communities, to reconstruct local identity and to enhance the local economy by building on local traditions. The potential to expand, and to bring meaningful change in the agro-food system, depends upon four main factors involving social innovation:

- They must professionalise their skills, with help from specialist intermediaries.
- They must build and maintain consumer loyalty, especially as supermarket chains sell more products labelled as 'quality', even as 'local'.
- They must constantly learn in order to keep up with changing circumstances and to remain competitive in the market.
- They need the continued dedicated effort and innovation of leaders or 'champions', who can link diverse stakeholders and policy-makers (Karner, 2012).

In many places, social innovations have been promoted as agroecological methods. In Brittany in north-western France, an agricultural extension service persuaded municipalities to adopt policy measures which help link urban consumers with agricultural producers, thereby minimising resource burdens (Maréchal and Spanu, 2010). A citizen-led certification scheme in the region evaluates whole-farm sustainability. An agronomist makes two farm visits, the first to collect data and the second to give feedback and negotiate a progress agreement with the farmer (Galli and Brunori, 2013). This process generates a commitment to continuous improvement, rather than a priori criteria for certification.

At the same time, agroecological methods have recently been adopted by some actors who also promote conventional agriculture. Examples include agrochemical companies and some governments, especially France. As such, agroecological methods have also been incorporated into 'sustainable intensification', where they are combined with other methods (including biotech) to increase yields, while also lowering the pressure on land and natural resources. This process has been criticized by some NGOs and farmers' organisations (ARC2020, 2015: 1; Levidow et al, 2014; Levidow, 2015).

In this context of an incorporation process, agroecology provides an alternative strategy across the agro-food chain. It empowers primary producers vis-à-vis input suppliers and retailers; it alters the relationships between companies, civil society organisations and the general public. As a result, various agroecological innovations remain key to the transition of the agri-food system.

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# 8.
# SMALLHOLDERS, URBAN FARMERS AND NEO-RURALISM

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The idea of agroecology is mainly being taken up by small-scale farmers around the world, who actually produce the food – not commodities – for the majority of the people, mainly locally. It is no surprise that the terms 'agroecology' and 'food sovereignty' do not appear on the websites of big agro-industrial companies like Monsanto, Syngenta[28] and Bayer Crop Science, whereas 'sustainable' and 'food security' are easily found as defined through the lens of the input industries.

## IS THERE A BASIS UPON WHICH TO BUILD NEW MODELS?

In the industrial agricultural paradigm, the existence of subsistence farming serving local communities is an indicator of a lack of industrialization and, as such, a lack of 'development' in a country. Agriculture for subsistence and local or household food production is commonly described as self-sufficiency farming (Waters 2007). The typical subsistence farm has a range of crops and animals which the family or community needs to eat during the year. It also produces building materials, medicinal plants, textiles and fuel. Planting decisions are made based on those needs rather than global market prices.

Mainstream market-oriented economists find this an undesirable form of existence, born of necessity, and they believe a country's policies should aim to overcome this ('backward') development as quickly as possible. Subsistence farmers should either move on to more lucrative off-farm jobs or adopt market-oriented principles and turn the farm into a mechanized, if possible, industrial operation.

Subsistence farmers are effectively invisible because they mainly produce outside of the global market and continue to frustrate mainstream economists or, as Tony Waters (2007) puts it eloquently:

> Economists, politicians, and strategists since at least the end of World War II dream of the world's rural farmers becoming a wealthy, healthy, and modern middle class. Implicit to this dream is peasants moving off the farms (...) to staff factories in an ever-wealthier world. When this doesn't happen, the Ph.D.'s do indeed sigh, sweat, and swear not at themselves, but at the peasants that frustrate the models on which their development plans are based. [...] In short, peasants resist the siren song of the economists' models, [...] and are relatively immune to its enticements. [...] If markets failed, life on the farm was more uncomfortable, but there was still food to eat, and a place to live. In the modern market though, market failure means that unpaid workers are evicted from their houses or unable to buy food.

Hilbeck and Hilbeck (2015) postulated that, contrary to common belief, subsistence farming still exists even in highly industrialised countries, such as Germany. Indeed it plays an important – though undervalued or ignored – role for societal groups that live under precarious conditions to this day, and has monetary, health-related and socio-ecological relevance. In turbulent times especially, subsistence agriculture serves as buffer, either by providing necessary calories or by complementing a uniform, non-diverse food supply. Wherever people have the option of returning to the countryside, however small their piece of land it will always be a buffer in times of social insecurity and turmoil – even in developed countries. The latest examples of this phenomenon can be found in the countries like Greece and Portugal that have been hardest hit by the financial crisis, but it can also be seen in China.

> As Greece's blighted economy plunges further into the abyss, the couple are joining with an exodus of Greeks who are fleeing to the countryside and looking to the nation's rich rural past as a guide to the future. They acknowledge that it is a peculiar undertaking, with more manual labour than they, as college graduates, ever imagined doing (New York Times 2012).

> In a country where unemployment is at an all-time high of 14%, the minimum wage is €485 and the minimum retirement pension is €254, cultivating a vegetable patch has its attractions. Joao Fernandes, 72, said he easily saves up to €150 a month on his plot in Quinta da Granja, a green haven in Lisbon. "*Instead of buying stuff, I have here what I need*," said Mr Fernandes, a former cook, as he passed on gardening advice to a neighbour grower. For an annual fee of €50-80, plus the cost of seeds, tools and fertilizers, one can rent 150 sq. meters of land, wood-fenced all around. Woodshed and water supply are included. "*I plant beans, tomatoes, peas, potatoes and cabbage. It is all for personal consumption, for myself, my wife and my two sons*," he said. (RTE News, 2012)

[28] 'More Crop per Drop for Universal Food Security', on http://www.syngentafoundation.org/db/1/898.pdf, (see page 13)

In Portugal, the government has set up programmes that encourage and assist jobless city-dwellers to resettle in rural areas and take up subsistence farming.

> …The government is trying to get others to follow in his footsteps. In February it launched an initiative to map the country's unused land and terrain that does not have a known owner, with the aim of making it available to be rented to those who want to work it. The government has also approved a land exchange scheme by which private owners of unused land will win tax benefits if they make their properties available to be rented by farmers. Around 1.5 million hectares are expected to be made available through the scheme. (RTE News, 2012).

In China the urban-to-rural return migration of millions of factory workers is acknowledged to have 'buffered' them from hardship. However, people voice concern about the declining productivity of industrial farming, as the land is now being used for subsistence, which is considered economically inferior to industrial farming – an approach that has become a 'god-given' default in both world economic systems, almost amounting to a natural law.

> In statistical terms, no less than 15 million rural migrants (more than 10 per cent of total migrants) returned to rural villages in 2009. About 80 per cent of them went back to the rural farming sector, where they worked, on average, for 52 per cent of the year. … Based on our findings it is probable that the rural agricultural sector provided the employment buffer for return migration and rural off-farm employment during the global financial crisis. Because of this buffer effect, no open unemployment was observed. This is certainly a good thing for political stability, but also means a reduction in agricultural productivity. In the long run, small-scale farming will inevitably give way to large landholding and higher agricultural productivity. This will naturally lead to the consolidation of farmland, and many small landholders will need to sell their land. For these workers, then, future employment shocks will have to be cushioned by other means. (East Asia Forum, 2010).

Subsistence agriculture systems that still exist outside the markets in (semi-) industrialized countries offer opportunities, inspiration and unconventional knowledge. This could be harnessed to find new ways of producing diverse foods, and to sustain the genetic diversity, both of the crops and of the flora and fauna associated with these farming systems. These hidden riches remain largely unappreciated and under-explored in the context of today's mainstream agricultural policies (Hilbeck and Hilbeck, 2015).

In almost all developed countries today, surveys of consumers show that a growing number of citizens are concerned about the industrially produced foods on offer in most supermarkets. This concern also manifests itself in the rapidly growing number of people who opt for foods produced in alternative systems, such as those described elsewhere in this brochure. At the same time, bringing farming to the cities is becoming a booming field of activity.[29] While on the production side, much knowledge has developed and many alternative, sustainable methods of agricultural and horticultural production have proved their worth, in many parts of the world this is not matched by a commensurate development in other fields required for a broad-based adoption of these progressive new agro-food systems. For example, appropriate political support and regulatory frameworks (reward systems) for agroecological production systems are either entirely lacking or they are only in their infancy.

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* further comparisons in other chapters

[29] http://www.brighthub.com/environment/science-environmental/articles/39036.aspx

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Dr Hans Rudolf Herren completed his PhD at ETH Zurich. After post-doctorate studies at Berkeley University, California, he began working in Africa in 1979, at the International Institute of Tropical Agriculture (IITA) in Nigeria. Later, he developed the International Centre of Insect Physiology and Ecology (ICIPE) in Kenya into a leading institution and centre of excellence, particularly in the area of malaria control. For his efforts to improve nutrition and the basis of human life, he received the German Brandenburg Prize in 2002 and the Tyler Prize for Environmental Achievement in 2003. Herren has been president of the Millennium Foundation, in Arlington, Virginia (USA) since 2005. Alongside other commitments in international committees for ecological and sustainable development, Dr Herren was co-chair, with Professor Judi Wakhungu of Kenya, of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), which was published in April 2008. In 2013, Dr Herren and his Biovision Foundation won the Right Livelihood Award, which is sometimes called the 'Alternative Nobel Prize'.

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## LES LEVIDOW

Dr Les Levidow is senior research fellow in the Development Policy and Practice (DPP) Group at the Open University, UK. Since the late 1980s his research interests have included controversial agricultural technologies, especially agbiotech and bioenergy, as well as alternatives to agri-industrial systems, such as short food-supply chains and agroecology. These topics have served as case studies for several policy-relevant issues: agri-environmental sustainability, European integration, trade conflicts, governance, public participation, regulatory science, the precautionary principle and eco-efficiency. Since its inception in 1987, he has been managing editor of the journal Science as Culture, and its editor since 2005.

He is co-author of two books: Governing the Transatlantic Conflict over Agricultural Biotechnology: Contending Coalitions, Trade Liberalisation and Standard Setting (Routledge, 2006); and GM Food on Trial: Testing European Democracy (Routledge, 2010).

## ADRIAN MULLER

Dr Adrian Muller studied theoretical physics and received his PhD from the University of Zurich in 2000. Since 2001, he has worked in various areas of policy instruments, sufficiency strategies, climate change adaptation, land-use modelling and productivity in agriculture. He has held post-doctorate and senior researcher positions at the University of Zurich, the University of Gothenburg and ETH Zurich. Since 2009, he has been a part-time senior researcher at the Research Institute of Organic Agriculture, FiBL, in Frick, Switzerland, and he is a scientific collaborator at the Chair for Environmental Policy and Economics, ETH Zurich.

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## MICHEL PIMBERT

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Dr Michel Pimbert has previously worked for the UK-based International Institute for Environment and Development (IIED), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), in India, the University François Rabelais de Tours, in France, and WWF in Switzerland. He has also done research for the UN Food and Agriculture Organisation (FAO), the United Nations Research Institute for Social Development (UNRISD) and International Union for Conservation of Nature (IUCN). Dr Pimbert has been a board member of several international organisations working on food sovereignty, sustainable agriculture, the environment and human rights. He has worked in Asia, Europe, Latin America and West Africa. He is currently a member of the High Level Panel of Experts on Food Security and Nutrition (HLPE) of the Committee on World Food Security (CFS) at the UN Food and Agriculture Organisation.


In this image: Soil erosion in a GM maize field after severe rain, South Africa, 2010

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