The Centre For Business Relationships, Accountability, Sustainability and Society

Working Paper Series No. 54

Towards the real green revolution? Exploring the conceptual dimensions of a new ecological modernisation of agriculture that could 'feed the world'

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Published by

The Centre for Business Relationships, Accountability, Sustainability & Society (BRASS)
Cardiff University
55 Park Place
Cardiff CF10 3AT
United Kingdom
http://www.brass.cf.ac.uk

ISBNs 978-1-906644-24-6 (print)
978-1-906644-25-3 (web)

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Abstract

The challenge of food security is more urgent than ever. We argue that the dominant food regime has responded to this challenge by a 'narrow' ecological modernisation process of agriculture which may decrease environmental effects to a certain extent, but also causes new negative side-effects and exposes some important missing links. In this paper we outline what might be a 'real' ecologically modernisation process, including social, cultural, spatial and political aspects.

The central question concerns: is there evidence in practice that agro-ecological approaches can contribute to food security, especially in developing countries. We illustrate this by describing examples from Africa, Brazil and China showing a rich variety of such approaches in agriculture practices.

Our conclusion, based on an extensive literature overview, is that agroecological approaches could significantly contribute to feeding the world and thereby contribute to a 'real green revolution'; but that requires a more radical move towards of new type of agri-food eco-economy. This is one which includes re-thinking market mechanisms and organisations, more innovative institutional flexibility on a regional scale, interwoven with active farmers and consumer participation; and a re-direction of science investments to take account of translating often isolated cases of good practice into mainstream agri-food movements.

Keywords: ecological modernisation, food security, sustainable, agro-ecology, eco-economy, developing countries.

1. Introduction: the new race for resources and production spaces

This paper starts with the challenge to further critically consider agro-ecological perspectives for food production in a period of what might now be regarded as a new era of agri-food productionism. How can we 'feed the world' in a really sustainable way? Can sustainable agricultural farm systems and practices contribute to an efficient, productive and profitable agriculture, meeting the demands of a growing world population and adapting to climate change? Or will this new neo-Malthusian premise be met by a re-invigorated reliance upon the conventional agri-food paradigm and its associated packages of technologies?

In recent decades many scholars have discussed the side-effects of the dominant food paradigm and its myths of efficiency (Morgan et al 2006). Policies that promote industrial agriculture are justified by their proponents by the claim that large-scale, high-chemical-input, mechanized agriculture is the 'most efficient' form of farming. These premises have attained new power and status as a result of the 2007/8 'food crisis', which saw significant price rises and volatilities in basic food goods, in combination with rises in oil and agricultural inputs; and the emergence of biofuels as a palliative to 'peak oil' concerns. There is a new orthodoxy developing in the global food system, and in national policy circles that countries need to regain the former post-war priority of intensive productivism as a way of 'feeding the 9 billion by 2050' (Evans, 2009, Chatham House, 2009, Royal Society, 2009).

Indeed, recent research with the industry has witnessed a sort of 'paradigm lock-in' in this regard, amongst key public and private actors in the agri-food system who are unable to see how a more radical paradigm shift towards more agro-ecological methods could really take hold (Feindt and Marsden, forthcoming). Some also question the premise about the need to meet the rising demand; but nevertheless there has developed a vibrant and revised agri-industrial model which sees and promotes itself as the only pathway to meet the twin threats of climate change and the need to double food production by 2050 (FAO, 2008).

In the UK, for instance, the government has recently published a consultation document on 'food security'; and this is providing a fertile context for productionist

logics which are allied to GM acceptance and commercialisation, continued scale-enlargement of farms, and more complex privately- controlled supply chains built upon the hybrid public-private model developed in the EU over the past two decades (see Marsden et al, 2010). Such political and economic articulations are not only challenging the model of environmental 'post-productivism' which was established from the 1980s as an increasingly relevant model in European agricultural policy (see Marsden, 2003; van der Ploeg and Marsden, 2008). It is also significantly challenging those scholars who have developed some of the principles behind the sustainable rural development paradigm, whereby a more multi-functional and agro-ecological agriculture plays a renewed role in more regionally diverse countrysides.

The paper begins to critically challenge this emerging neo-productivist orthodoxy which has, somewhat paradoxically arisen out of the current global food crisis and its wake-up calls about food security and ecological risks. It does this by attempting to further develop the sustainable rural development paradigm as part of a revised ecological modernisation process. This is a critical debate to begin at this juncture given the onset of rapid forms of bio-industrial nano technologies which are currently being developed and applied to 'solve' the forthcoming 'peak-food' problem. In many ways we can see these debates as critical battlegrounds of rival paradigms, with each attempting to claim the ground of sustainable forms of ecological modernisation (see Lang and Heasman, 2004; Sonnino and Marsden, 2005).

Of course, many have claimed for a long time that the arguments about the efficacy of the agri-industrial model are based on criteria that are too restrictive; being two-dimensional in taking account of yields per unit of surface area. They do not consider the effects on soil, the third dimension, nor the agro-ecosystem's capacity for future production, with time being the fourth dimension (Fernandez et al, 2002, cited by McAfee). Standard agro-economic criteria are also mono-functional, considering only crop yield prices, while neglecting the effects of industrial farming on social well being and culture, on valuable crop and animal genetic diversity. On the other hand, agro-ecologists have discussed the more fragmented principles and practices of a wide variety of more sustainable and organic forms of agriculture, labelled by different terms like low-input farming, agro-forestry systems, multi- and intercropping farming,

poly-cultures, natural systems agriculture, organic production and so on. (See for example Mäder et al, 2002; Altieri et al, 2001, 2002, Jackson, 2002).

According to Altieri et al (2001: 123-124), agroecology, defined as a science that provides ecological principles for the design and management of sustainable and resource-conserving agricultural systems, offers several advantages over the conventional agronomic or agro-industrial approach:

> *"First, agroecology relies on indigenous farming knowledge and selected modern technologies to manage diversity, incorporate biological principles and resources into farming systems, and intensify agricultural production. Second, it offers the only practical way to restore agricultural lands that have been degraded by conventional agronomic practices. Third, it provides for an environmentally sound and affordable way for smallholders to intensify production in marginal areas. Finally, it has the potential to reverse the anti-peasant bias of strategies that emphasize purchased inputs as opposed to the assets that small farmers already possess, such as their low opportunity costs of labor".*

Under current conditions of food crisis in many parts of the world, the challenge remains about whether the heterogeneous variety of sustainable agri-ecological practices can offer a viable alternative against the market and scientific dominance of the current agri-industrial food paradigm. The need for more sustainable forms of agriculture as such is debated, but the issue of whether they can contribute sufficiently to the food security challenge is often left open. According to Delgado et al (1999) it is still uncertain whether progress towards agricultural sustainability will result in enough food to meet the future food need in developing countries after continued population growth, urbanization and the transition to meat-rich diets (Pretty, 2006). Such uncertainty becomes a significant weakness for the agri-ecological movement in the context of the increasingly dominant and articulated neo-productivist arguments now developed across the agri-food system. Furthermore it allows for a sort of paradigm capture around productionism and agri-industrialism to take hold which, in turn, further marginalises agri-ecological perspectives (see for example, The Economist, November, 2009).

Given these debates, the central and critical question addressed here is: *what are the potential dimensions and parameters of an ecologically modernising and sustainable*

agriculture that can contribute to global food security? This is a theoretical question as well as an empirical one. Theoretically, we frame these arguments by using and applying some of the theories of ecological modernisation. These began as theories which postulated that ecological progress could be made alongside social and economic progress. Yet these debates have, as we shall show, been partially appropriated by the corporate- dominated agri-industrial paradigm, especially as the squeeze of both climate change vulnerability and resource depletion becomes tighter. Indeed the race is on to convince both the public and the policy making community that there is indeed only one type of generic ecological modernisation: that there is only one game in town. Yet, as we shall begin to show in this paper, this is clearly not the case.

Empirically, the question is raised as to whether there is viable evidence of a new and real ecological modernisation paradigm which can be witnessed in agricultural and agri-food practices and policies. We will illustrate from an extensive critical review of available literature, that empirical case-studies from different continents express a rich empirical variety of locally-embedded and innovative farm practices. These produce a variety of agricultural products which meet the demands for their community often in suboptimal conditions, and they do so by using less external inputs.

First, the paper describes the public challenges being currently faced regarding the need for sufficient and sustainably produced food production in the context of climate change, urbanization, resource depletion and a growing population. It is argued that the search for eco-economical strategies which can address these challenges is urgent (see Kitchen and Marsden, 2009). We critically elaborate on the theoretical roots of the concept of ecological modernisation and how these have become recently far too aligned with the dominant agri- food paradigm. We then explore the social, cultural and spatial side-effects of this modernisation project in recent decades and elaborate on 'real- EM' as a scholarly and policy programme, influencing the position, freedom and power of farmers.

Second, as an alternative paradigm we can see in outline the rise of a new form of ecological modernisation that is re-embedded in space and place, leading to more sovereignty and autonomy for food producers and processors as a countervailing

power to the global forces of agri-food corporatisation. We analyse this with examples from sustainable and organic agri-food networks in different regions. In order to offer a real alternative, it is argued that sustainable agri-food networks have to be scaled- up and aggregated, disseminated and supported by a series of new and quite novel institutional and market arrangements. This requires the need to critically examine the main constraining factors in this field and the conditions for policy arrangements and partnerships that can support the scaling up and growth of sustainable agri-food networks.

2. The global scale and shape of the food challenge

More than two billion people live on less than US$2 a day. Approximately 2.6 billion people—men, women and children —rely on agricultural production systems, be it farming, livestock production, forestry or fisheries. Food security for a growing world population is positioned to remain a challenge in the next few decades (ISTAASTD 2009a).

Seventy-five percent of the world's poor live in rural areas of developing countries. They suffer from problems associated with subsistence production in isolated and marginal locations with low levels of technology. These subsistence and small holder livelihood systems are more risk- prone to drought and floods, crop and animal diseases and market shocks. However, they also possess important resilience factors associated with the use of family labour, livelihood diversity (non-farm activities account for 30-50 percent of rural income), and indigenous knowledge that allow them to exploit risky environmental niches and cope with crises (Scialabba, 2007).

Agriculture as the source of human food, animal feed, fibre and fuel, as well as biodiversity, plays a key role in efforts to achieve global sustainable development. It is a major occupational sector in developing countries, with the poorest countries being those with predominantly agricultural economies and societies (FAO, 2000). An estimated 800 million persons, i.e., more than half of the people living in extreme poverty, are occupied in the agricultural sector (CGIAR Science Council, 2005).
In sum, more than half of the earth's land surface is intensively used for agricultural purposes such as cultivation, grazing, plantation forestry and aquaculture; and since

1950, one third of the soil has been profoundly altered from its natural ecosystem state because of moderate to severe soil degradation (Oldeman, et al., 1991).

Food production is now grown on 40% of the total land area; 90% of farms worldwide have a size of less than 2 hectares (ISTAASTD, 2009a). Most small farms with a size of less than two hectares are in Asia (87%), followed by Africa (8%), Europe (4%) and America (1%) (Nagayets, 2005). Agriculture includes a large variety of ways of production like crop-, animal-, forestry- and fishery-based systems or mixed farming, including new emerging systems such as organic, precision and peri-urban agriculture. Although agricultural inputs and outputs constitute the bulk of world trade, most food is consumed domestically and locally, i.e., near to where it is produced.

Food security- defined as having enough food, in the right place at the right time- is becoming even more urgent. The world population grew from about 2.5 billion people in 1950 to 6.5 billion in 2005. Though in most countries, growth rates have just recently begun to decrease; trends indicate that the global population will reach between 7.5 and 11 billion people by 2050, depending on the expected average number of children per woman (ISTAASTD, 2009a). Food production has increased. In the last four decades total world food production grew by 145 percent. In per capita terms, agricultural production has outpaced population growth, breeding, and extension of irrigated area. Compared to food consumption in 1961, each person today has 25 percent more food. But these aggregate figures hide important differences between regions. The growth of production has differed across continents: in Africa it rose by 140%, in Latin America by almost 200%, and in Asia by 280%. The greatest production increases have been in China, where a 5-fold increase occurred, mostly during the 1980s and the 1990s (FAO, 2009).

We have, of course, known for a long time that the current agri-food system has caused serious environmental negative side-effects, which also can have a 'boomerang' effect on food production in the future. High-energy crop production has involved sharp increases in fertilizer, pesticide and water use, leading to increased emissions of nitrates and pesticides into the environment and depletion of groundwater aquifers (Moss, 2008). More than half of all the synthetic nitrogen

fertilizer ever applied on the planet has been used since 1985, and phosphorus use tripled between 1960 and 1990 (Millenium Assessment, 2005b). Along with an increase in agricultural output, water use in agriculture has increased to 7,130 cubic kilometres today and is expected to double by 2050 (CA, 2007). Another form of competition has recently been observed between the use of crops for food and feed and the use of the same crops (e.g., maize) for biofuels (Mol, 2007) moreover, competition at the world level is rising for the supply of protein-rich animal feeds. Some suggest that demand for Livestock products will double by 2050. Already more than one-third of the world's grain is fed to domestic livestock rising to nearly 70% in industrialized countries (The Royal Society, 2009).

The total cultivated area increased much less than the output, i.e., from 1.4 to 1.5 million ha between 1950 and 2005 although fallow systems were greatly reduced (Wood et al., 2000). Though in the past 40 years, per capita world food production has grown by 17%, with average per capita food consumption in 2003 of 2780 kcal per day, yet consumption in 33 poor countries is still less than 2200 kcal per day. It is expected that not only production but also food demands will both grow and shift in the coming decades as: (i) population growth increases the absolute demand for food; (ii) economic growth increases people's purchasing power, especially for meats; (iii) growing urbanization encourages people to adopt new diets and (iv) climate change variations and events threaten both land and water resources (Pretty et al, 2006: 1114).

It is argued that agriculture could meet the growing demand to some extent, because the agricultural production will further increase. FAO projections for the near future, the period of 1999-2030, estimate an increase of global agricultural production by 56%, with arable land expansion accounting for 21 percent of production growth in developing countries. For this same period, the share of irrigated production in developing countries is projected to increase from 40-47 percent (FAO, 2006a).

However, climate change will threaten food production in the future. About 30% of *global emissions* leading to climate change are attributed to agricultural activities, including land use changes such as deforestation (ISTAASTD, 2009a). A recent study of 23 climate models in Science (Battisti and Naylor, 2009) predicts that by 2090,

elevated temperature will not only cause excess evaporation but also speed up plant growth with consequent reductions in crop yields in many regions. Although rising temperatures may initially boost food production in temperate latitudes by prolonging the growing season, crops will eventually suffer unless growers develop heat-resistant versions that do not need a lot of water. The authors predict future production reductions of 20-40% whilst the population in tropical regions is expected to double to 6 billion. Further extreme events such as floods and droughts are likely to become more severe and frequent over the next century under all scenarios and for most land areas (Battisti and Naylor, 2009).

The expectation is that the World Food Summit target to reduce the number of undernourished between 1990/1992 and 2015 by half will not be met according to the FAO (WFS, 1996; FAO, 2006b). More than one billion people are hungry and undernourished worldwide (FAO, 2009). Although the number of undernourished people will decline according to the FAO (from more than 850 million at present to about 300 million by 2050), high rates of poverty and food insecurity are expected to continue under the present models of food production and consumption, along with further natural resource degradation (Scialabba, 2007:2).

The conventional approach to solving these problems of food security- and given its perceived success in the recent past- is to suggest a vibrant rejuvenation of the agri-industrial model which relies upon both expanding the area of agricultural production, and continuing to increase per hectare production especially in exporting countries through continued generic technological advances (see Tansey, 2008). This combines a continued neo-liberal regulatory approach which appeases increasingly concentrated agri-food corporate interests (McMichael, 2009). It is resulting in new international 'land-grabbing' appropriations whereby key industrialising countries, like China, Japan, Korea and Saudi Arabia are seeking out land and agricultural resources in parts of Africa. It is also speeding up the privatised research and development sector to find genomic solutions to the resulting limits being placed on yield increases, more diversified resource constraints (soils, water, and fuels), the effects of climate change, and the continued resulting ecological externalities. But as Evans (2009) and Ambler-Edwards et al (2009) indicate, there is also a stronger need to invest in what Parrot

and Marsden (2002) called a 'real green revolution'. The 20th century Green revolution achieved astonishing yield increases:

'Now, a 21st century equivalent is needed- one that not only increases yields, but that also moves from an agricultural model that is input-intensive (in water, fertiliser, pesticide and energy) to one that is knowledge-intensive. Genetic modified crops may have a role, but ecologically integrated approaches-such as integrated pest management, minimum tillage, drip irrigation and integrated soil fertility management-often score higher in terms of resilience and equitability, as they put more power in the hands of farmers rather than seed companies.' (Evans, 2009: 8).

Advocating a shift towards agri-ecological approaches, Pretty (2001) from an extensive survey of such projects, sees social learning as a vital keystone in this process of adjustment. This involves building the capacity of farmers and their communities to be able to learn about the complex ecological and bio-physical complexity in their fields and farms, and then to act in different and spatially contextual ways. Seeing fields as complex and multi-layered 'megabytes of information' about such aspects as pest-predator relationships, moisture and plants, soil health, and about the chemical and physical relationships between plants and animals on the farm and in the community, the task of the farmers and of the state is to unlock this complex knowledge and create new communities of interest (Morgan, 2009) around agri-food. His empirical evidence gives two important messages. Social learning leads to greater innovation together with the increased likelihood that social processes producing these alternative technologies are likely to persist. As we shall explore further in the final sections of this paper whilst these approaches have become more entrenched in the 2000's (see Parrot and Marsden, 2002), the social and institutional conditions for their spread, dissemination and scaling up are far less well developed or known. Indeed, the political and institutional mechanisms needed to create supportive policies in this regard are least developed, not least because of the dominant regulatory paradigm outlined by Marsden et al (2010). In both developing and developed countries the amount of state supported agri-food research and development has been declining despite these recognised needs. In the last 20 years, for instance, the proportion of foreign aid going to agriculture dropped from 17% (in 1980) to 3% in 2006. Total aid on agriculture fell by 58% in real terms over the same

period. Domestic governments have also followed this trend, with African governments spending on average only 4.5% of their budgets on agriculture-despite the African Union target of allocating 10% by 2008.

As the first decade of the 21st century comes to an end the growing ecological and knowledge-based disequilibria witnessed here becomes all the more apparent. In fact we can postulate that the conventional model of agri-food, and its complex global regulatory system which upholds it can no longer cope with the combination of food security issues which have now come to the fore. This means, we will argue here that both theoretically and empirically it is timely to critically re-introduce the concept of real ecological modernisation in the emerging context of global food insecurity.

3. The global- and regional eco-economy

Whilst this recent global and futuristic discourse has become clearly articulated, especially by development organizations, NGO's and scientists as the food and ecological crisis has deepened, it needs to be qualified by a more granulated understanding about the ways in which rural areas and their resources are embedded in their local and regional contexts. This is particularly important when considering sustainable agriculture and agri-food because its success lies in its ability to adapt to and to manage the complexities of local ecological and social resources. Somehow, then it is important for sustainability arguments to overcome the local/global divide in policy discourses.

Economically, politically and socially rural spaces are anchored in the wider networks and processes affecting the uneven development of their regions. Regional transformation results from the interplay of global and local forces. Examples of global forces include the global economy, increasing mobility of people, and the mass-production of culture (Woods, 2005). The global economy is strongly associated with free trade being promoted since the early 1990s by Washington DC based institutions such as the International Monetary Fund (IMF), the World Bank, and the World Trade Organization (WTO). This so-called Washington consensus claims that 'free trade' across the world can improve regional underdevelopment, poverty, and living standards. The EU Single Market (1993) and Nafta (1994) are well-known

examples of the application of free markets. Urbanization and counter-urbanization are two examples of increased mobility. The impacts can be positive (e.g. rural and urban growth) or negative (e.g. environmental degradation, social polarization between locals and newcomers, rich and poor). The mass-production of culture also affects regions. An example is the 'mcdonaldization' of society (Ritzer, 2008).

Woods (2007) develops the concept of the 'global countryside' to describe regional transformation processes through the globalization lens. The global countryside is the rural equivalent of the well-known 'global village': a virtual space having no fixed borders representing the advanced interconnection and interdependence of localities across the world. The global countryside is a helpful concept to demonstrate the challenges regions across the world are facing today:

1. Global commodity chains for food, leading to physical decoupling of food production and consumption, disintegration of local food networks, and alienation from food, farmers, and land.
2. Transnational corporations in agribusiness, i.e. the global seed market, retail food distribution, and food chain clusters.
3. Transnational migration of labor in agriculture, the meat-processing industry, manufacturing, tourism, and the service sector.
4. Transnational tourism (resorts, ecotourism).
5. Transnational counter-urbanization, both commercial (e.g. corporate concentration, resort speculation) and residential (e.g. holiday homes, permanent migration).
6. Commodification of nature: exploitation of natural resources, valorization of natural assets, and the promotion of global values of environmental protection and animal welfare.
7. The opening of new spaces for production and consumption, both large-scale (e.g. commercial forest, mining, resorts) and small-scale and subtle (e.g. monocultures, GM-food).
8. Competition between regions, leading to an inflow of capital and entrepreneurs, displacement of local business, and migration of residents.

Of course, globalization does not just happen to people and regions. There is a reflexive or dialectical relationship between the global and the local. The global

countryside constrains or enables meaningful action at the local level. At the same time, actors at the local level reproduce and transform the global countryside by their meaningful conduct, either intentionally or unintentionally. It is through this dialectical relationship that regional transformation takes place. (Pacione, 1995) We will come back to the role of local actors later in this paper.

Globalization in agriculture, aided by information and communication technologies (ICT), has resulted in economic opportunities as well as challenges, particularly in developing countries. Globalization is typified by the increased interlinkage and concentration at almost all stages of the production and marketing chain, with functional and regional differentiations, and includes transnational corporations that are vertically and horizontally integrated in globalization and their increasing power over consumers and agricultural producers. Globalization is also characterized by growing investments in agriculture, food processing and marketing, and increasing international trade in food facilitated by reduced trade barriers (FAO, 2003). The creation of intellectual property rights has become an increasingly important source of competitive advantage and accumulation in the production and trade of agricultural goods (Tansey, 2008).

Globalization has resulted in national and local governments and economies ceding some sovereignty as agricultural production has become increasingly subject to international agreements, such as the World Trade Organization's Agreement on Agriculture (WTO, 1995).

However, the progressive expansion of corporate-industrial relations in agriculture has put further strain on many small-scale farmers in developing countries who must also contend with direct competition from production systems that are highly subsidized and capital intensive, and thus able to produce commodities that can be sold more cheaply. Newly industrialized countries like India have increasingly subsidized inputs in agriculture since the early 1980s (IFPRI, 2005).

For many countries an obvious choice is to set forth on the path of economic growth and to compete with other regions for survival. There is, however, an increasing awareness that, in the long run, regions need to anticipate a more sustainable form of

development, including social, ecological, and cultural aspects (OECD, 2006; Millennium Ecosystem Assessment, 2005b). In practice, however, sustainable regional development is difficult to achieve. Neoliberal discourse has long argued that economic growth is one dimensional and that total control of nature (not least through the application of particular generic technologies) is within our grasp (Dryzek, 2005). Moreover, programs for regional development often express the vested interests of elite groups and people seeking sustainable alternatives are often excluded from powerful networks and the decision making processes.

Under these conditions, a key question is how can new ways be found for making sustainable rural development work within the prevailing globalised system? The challenge is here, we argue, is to explore new eco-economical perspectives. This requires a dual perspective. On the one hand we clearly have to take global forces into account because many transformation processes are global by their inherent nature (Woods, 2005). On the other hand, we can also interface and search for perspectives, rooted in the more autonomous nature of sovereign regions and locales. With sovereignty we mean here variable levels of control of regional actors over their use of regional resources (see Marsden, 2009; Kitchen and Marsden, 2009).

Drawing on various strands of literature, including ecological economics, ecological goods and services, and ecological modernisation we can conceive of the eco-economy as an alternative and diverse arena for the development of new production and consumption chains and networks. It consists of complex networks or webs of viable businesses and economic activities that utilise the varied and differentiated forms of ecological resources in more sustainable and ecologically efficient ways. Importantly, these do not result in a net depletion of resources, but instead provide cumulative net benefits that add value to rural and regional spaces in both ecological and economic ways (Marsden, 2009)[1].

The search for ecological modernisation in rural areas is an empirical as well as theoretical endeavour. It requires a more ecologically modernising agenda based upon

[1] Marsden, T. (2009), Mobilising the regional eco-economy: evolving webs of agri-food and rural development in the UK, draft.

a more diverse theoretical base (see Buttel, 2000; Gibbs 2000; Mol 2000; Murphy, 2000). A central theoretical question is then: "to what extent are we seeing the arrival of a more autonomous and countervailing ecologically modernising process operating in advanced societies; and as part of this, through rural development and agri-food trends specifically? Second, if we believe that this is a viable question, what conceptual development and empirical realities does it suggest with respect to the rural sphere?" (Marsden, 2004: 130).

We will, in the foregoing sections, use empirical evidence in the sphere of agri-food to address these questions. But first it is necessary to critically examine the roots of ecological modernisation in order to explain how these ideas then become aligned to and adopted by the current dominant food paradigm. Only by examining these processes can we then begin to reconstruct a real form of ecological modernisation.

4. Principles of ecological modernisation and some missing dimensions

Ecological modernisation has become a popular term in policy and politics. Its popularity derives in part from the suggestive power of its combined appeal to notions of development and modernity and to ecological critique (Christoff, 1996: 476). (EM) as such was first used by Jänicke (1984), described as the development of a modern society, based on new technologies, fitting within ecological boundaries. However, as a vision or strategy for the future it was earlier described by Toffler (1982) and Huber (1982), though they used different terms like super-industrialisation, three-dimensional growth or 'the third wave'. In his later work Huber also mentions the term ecological modernisation, referring to modernisation of production- and consumption cycles driven by new, intelligent technologies.

The term ecological modernisation has become contested since then. However, going back to the origins of the concept, ecological modernisation can be seen as a vision and strategy for the future based on an integration of ecological and economical goals within the industrialized society. According to Jänicke EM is a form of 'ecological rationalisation which will lead simultaneously to greater 'ecological and economic efficiency' (Christoff, 1996). According to Huber, the 'godfather' of the theory, society has to function within ecological boundaries, but there is no alternative for the

industrialized society: *'Es gibt Alternatieven in der Industriegesellschaft, aber keine zu ihr'* (Huber, 1982:10). Environmental and economical development is not seen as contradictory: 'There are no limits to the growth, because an expansion of boundaries is possible' (Huber, 1982:10).

Technology development is crucial in this societal strategy, as having an enormous potential for stretching the ecological boundaries. This technocratic view should not be seen as a blunt techno-optimism, because technology-development should be selective according to the early ecological modernists. Science has a role in delivering the means (technology, planning) to achieve this. The role of the state in this view is also important; as Huber stated, market and governance need each other, compensate and limit each other (Huber, 1985b).

To summarise, the main characteristics of ecological modernisation are 1) qualitative, economical growth; 2) realisation of ecological goals 3) modern technologies which reduce negative environmental effects, for example in energy-production, agri-business, biological and chemical sector and ICT; 4) A steering governmental role 5) a further 'scientification' of society.

Ecological modernisation theory emerged from attempts to address the perceived problems associated with early environmental policy-making and implementation in the 1980's, for example end-of-pipe practices that only shifted industrial-related problems between environmental media (Mol 2000; Mol and Sonneveld; 2000). New environmental policies since then increasingly emphasized on the mutually reinforcing environmental and economic benefits of increased resource efficiency and waste minimisation. (Christoff, 1996) Faced with the threat of a binary choice between economic development and environmental protection a spontaneous discourse coalition of governments, non-governmental organisation and inter-governmental actors shaped a policy-framework that sought to promote both elements (Kitchen and Marsden, 2009: 227).

The term ecological modernisation is for example adopted by environmentalists in the eighties in the Netherlands and seen by them as the equivalent of sustainable development comparable with the definition in the well-known Brundtland report (see

for example Reijnders, 1989a and Cramer, 1988). The theory of ecological modernization has developed since then. The first contributions in the eighties were characterised by a high emphasis on the role of technological innovations on environmental reform, from the late 1990's to the mid-1990's more attention was paid to the role of the state and market and the institutional and cultural dynamics of EM (see e.g. Hajer 2005). Since the mid-1990s EM theory also included ecological transformation of consumption (Mol and Sonnenveld, 2000). More recent EM theorists include Murphy (2000) and Murphy and Gouldson (2000).

Ecological modernisation can positively and optimistically be regarded as an attempt to integrate ecological and economical goals, and in this sense as a major precondition for sustainable development. Pessimistically however, ecological modernisation can also be seen as a survival strategy of the 'old economical paradigm', heavily dependent on new technological development and strong state-interventions.

In this context the distinction between weak and strong or narrow and broad versions of EM is relevant (Christoff, 1996; Dryzek, 1997). Christoff (1996:481) judges Jänicke and his colleagues who 'fail to identify or address potential political contradictions in their narrow vision of an EM embedded in larger processes of structural transformation'. Hajer (1995) has employed EM more broadly to define changes in environmental policy discourse, analysing narrow EM as 'a modernist and technocratic approach to the environment that suggests that there is a techno-institutional fix for present problems'. (Hajer, 1995: 32). But Hajer leaves the question open of EM might be a rhetorical ploy to take the wind out of the sails of 'real' environmentalists and he is not clear whether EM can be a step towards a sustainable society (Christoff, 1996).

Dryzek conceives of weak versions as EM for engineers and accountants, characterised by scientific, economic and policy elites addressing environmental problems by technocratic and corporatist modes of policy-making. A strong EM should therefore be concerned with restructuring the capitalist political economy. In this sense Dryzek's strong EM can be seen as a radical vision on sustainability (Hermans et al, 2010).

We can argue here that over recent decades a prevalent but weak form of ecological modernisation has become dominant in agri-food, aligned to the dominant food paradigm which is expressed in the current large-scale, high-input, intensive and highly mechanized forms of farming and food processing. The notion of ecological modernisation has been thus appropriated by the dominant agricultural regime in many European countries, formed by agricultural policy, extension services, research and education, of the last century.

The notion of an 'integrated agriculture' in the Eighties for example, reflected an alignment between an intensified, mechanized, and highly-productive agriculture, new technologies and the implementation of environmental measures. Concrete farm techniques were the use of integrative chain control mechanisms, use of bio-technology, computerised farm management systems, agrification (industrial processed products) and mechanisation for efficient pest and weed management.
Weak forms of EM may have led to a decrease in environmental problems, but also negative side-effects occurred. These effects illustrate the underestimation of the wider and much more diverse social, cultural, political and spatial dimensions of agriculture within the weak ecological modernisation project. We can outline at least four missing dimensions:

Socially, the notion of employment is seen as an element of the ecological modernisation strategy. The original aim was to lower the cost of labour to the expense of environmental costs. However, agricultural employment has decreased, starting already in the 19th century with the invention of harvest and sowing machines. New technology has replaced farmers labour since then. Furthermore, farmers are no free entrepreneurs but have faced a loss of freedom on their firm and more dependency of global markets, retailers, research and policy-measures (Van der Ploeg, 1991; Horlings, 1996). As Marsden (2004) states, primary producers are at the end of the chain, bearing the responsibility for the quality of products but are excluded from the often more lucrative, value-added retailer-led food markets. For those that do gain entry, the degree of informal control over their operations severely constrains their 'room to manoeuvre' (Marsden, 2004, p.137). Weak ecological modernisation in this sense can lead to loss of sovereignty and autonomy on the local scale.

Culturally, in many of the uses of EM, the 'environment' is reduced to a series of concerns about resource inputs, waste and pollution emissions. As cultural needs and non-anthropocentric values (such as those reflected in the concept of wilderness), cannot be reduced to monetary terms, they tend to be marginalised or excluded from consideration (Christoff, 1996). Within agriculture, the relation man-nature has been rationalized, marginalizing traditional ways of production creating synergies in man-nature relations. The notion of partnership with nature is no longer valid, except in organic farming.

Further more culturally-oriented food production, like traditional regional products or farm management is diminished over time. The culture of 'agri-culture' itself, expressed in craftsmanship and in the form of a large variety of farming styles, has become more marginalized as the external input of knowledge form extension services and knowledge-institutes became more dominant (Horlings, 1996). The field of agro-food has become populated with project managers, consultants, exchange agents etc, such that a profession has been established to which some are excluded (Marsden, 2004: 142).

Politically, Many of the EM uses narrowly focus on changes within industrialised nation-states. They are therefore unable to integrate an understanding of the transformative impact on economic globalisation on environmental relations, for example on agriculture. Such views also see EM as a next step in modernity, dependent upon the hegemony of Western science technology and consumer culture and propagated by leading Western (ised) countries. They offer 'a world divided by renewed or strengthened core-periphery relationships between industrialised and industrialising countries with world markets and the motors of progress dominated by leading industrial state(s)' (Christoff, 1996). Various scholars have even questioned the relevance of the EM concept for developing countries however some recent studies have pointed to the rapidly developing Asian countries as places where concepts and practices of ecological modernisation perhaps be most useful (e.g. Sonnenfeld and Mol, 2006). Different pathways are followed in ecological modernization in different countries. For example China formulated her own theory on EM in a report of The Chinese Academy of science entitled 'China Modernization

Report 2007; Study on Ecological Modernization'. The Chinese interpretation of ecological modernisation is limited to technological-economic dimensions of sustainable development, without entering too much into relations with equity, equality, citizen empowerment and the like (Zhang et al, 2007:665).

Spatially, intensive agricultural production has been decoupled and fragmented from space and place in three ways (van der Ploeg, 1992; Horlings, 1996). First, production processes do no longer automatically adapt to ecological circumstances; rather ecological conditions can be changed by technology on different levels, for example by land-restructuring (regional level), irrigation projects (local level) and bio-technology (micro-level).
Second, the physical relation between the soil and agriculture has been decoupled, for example, in glass house production and in intensive cattle production. Third, production has become disconnected from regional (physical as well as cultural) characteristics. Feta-cheese can be made everywhere, from goat- as well as cow-milk. This process is strengthened by technological development, food is deconstructed in basic components, which can be industrially produced and based on products from different parts of the world. An example is the production of sweets, based on sugarcane, sugar beets of chemically made. This gives the industrial producer the power to exchange his resources worldwide, making farmers more vulnerable to global markets.

5. Towards 'Real' Ecological modernisation as a scholarly and policy programme.

Ecological modernisation seeks, as Kitchen and Marsden (2009) describe, to find ways to work from within the prevailing capitalist economy to bring about both ecological balance and economy development and sees, to varying degrees the role of the multi-level state as a critical actor in intervening between the production and consumption of environmental goods and services. They argue:

> *"Its key features are policy integration across sectors, the adoption of the precautionary principle at all levels of policy-making and business-making, a belief in managed technological modernisation and innovation to reduce inputs without affecting outputs;*

> *greening supply chains, institutional reflexiveness in which institutions are self-critical concerning their practices and green taxes"* (Kitchen and Marsden, 2009: 277).

To understand what the side-effects are of a (weak or narrow) EM as a policy programme, insight from political theory is helpful. This shows how the role of the state has stimulated general bureaucratic procedures leading to a standardisation, schematisation and juridical regulation of society. We will elaborate on this here, because regulation and bureaucratic professionalization have become important constraining aspects in current agriculture. Scott already stated in his famous book 'Seeing like a state' how state-led social programs influenced agricultural systems, neglecting the creativity and craftsmanship of locally-embedded farming systems (Scott, 1998). The political scientist Frissen (2007) also describes how the positive values of equality and justice, have led to institutional arrangements in western societies that stimulate uniformity. Equality and justice are based on the notion of scarcity in his view:

> *"We know that scarcity leads to injustice and that's why we want to avoid this. We know that our unlimited desires lead to unequal outcomes and that's why we want to tax and level them. We know that capacities are unequally divided, that's why we try to level the starting positions. We know that un-equality is inevitable, but we can't combine this with our demand for justice"* (Frissen, 2007:55)

Frissen sees the notion of equality as the most important political program of modernity, which is due to fail, because it implies scarcity and thus can't avoid the unequal division of goods. This has three consequences for society. The first is that the (hygienic-bureaucratic) regulatory style of the modern 'caring state' has got different sectors in its grip, including agriculture. The approach is to try to level out differences and risks by formulating collective, unifying and standardizing arrangements. The second consequence is that every citizen has the same rights. This can however lead to more scarcity, for example in the health and housing sector. As a result detailed and bureaucratic prescriptions are formulated to apply for rights and benefits. The third consequence is the aim for (relative) equality of outcome, especially expressed in the sphere of income policy: the strongest shoulders have to carry the strongest weight'.

But now the 'caring state' has fallen into crisis, in financial terms. The state is trying to deal with financial shortages, but these attempts mainly contribute to the problems, because the main measurements are a refining of bureaucracy, fixation on cost limitation, general interventions and a further bureaucratisation. The political outcome and receipt is a combination of the discourse of entrenched liberal market orientation and of an intensified bureaucratic control. In the agri food sector this leads to, among other effects, to constraining market conditions for developing countries to export their products to Europe. As Busch and Bingen (2006) and Marsden et al (2010) have depicted, this has expressed itself in a massive proliferation of standards setting, both by the state and particularly by the global retailers. This has lead to more constraints in markets and the imposition of supply chain regulations. These are less transparent than traditional food markets and restrict entry to many producers.

As a new panacea, more spurious transparency is now being pleaded for, for instance through the processs of 'traceability'. But a lot of what is called more liberal market orientation can be seen as hyper-hygienic bureaucratisation. 'Who sows transparency, will harvest forms' as Frissen states, and: "There is no organisation more transparent like bureaucracy, where rules, protocols, standards and justice are dominant" (Frissen, 2007).

Several scholars have described how the role of the state has influenced agriculture in line of the ideas of weak ecological modernisation (e.g. van der Ploeg, 1999). Marsden describes the 'hygienic mode of regulation' in agri-food. As the industrial mode of food supply has become even more crisis-ridden, the State has attempted to largely 'correct' this by setting up highly professionalised and bureaucratic forms of environmental and food safety safeguards and instruments. Private and public forms of regulation have led to a schematisation which holds the added consequence of further constraining the real potential of integrated agricultural development as well as providing new regulatory barriers to market entry for many smaller producers and processors (Marsden et al, 2010). Hence both in developed and developing economies farmers in particular have faced significant market barriers and added regulatory costs, forcing many out of business, or fragmenting and marginalising new markets frameworks. This has forced many in the North as well as the South to advocate for more 'fair trade'. Hence it is not just 'the market' or the corporate sector which has

been driving the development and veracity of the agri-industrial model. It is, rather, that this has relied and benefited the complex development of a multi-level and hygienic bureaucratic state which has set the rules of the game under the masquerade of neo-liberal 'markets'.

The question remains if real ecological modernisation can be organised in an alternative way, so that capacities, resources, diversities and creativity in regions are utilised for a more integral sustainable development. Frouws and Mol see the outlines of such a modernisation processes as they delineate (1999: 271):

> *"The ecological modernisation theory analysis possibilities for a process of 're-embedding' economic practices-in view of their ecological dimension-within the institutions of modernity. This modern 're-embedding' process should result in the institutionalism of 'ecology' in the social practices and institutions of production and consumption…"*

'Real Ecological Modernisation' could therefore contribute to a socially and spatially definition of eco-economy, which could be defined as: the effective social management of environmental resources (as combinations of natural, social, economic and territorial capital) in ways designed to mesh with and enhance the local and regional ecosystem rather than disrupting and destroying it. The eco-economy thus consists of cumulative and nested webs of viable businesses and economic activities that utilise the varied and differentiated forms of environmental resources of rural areas in sustainable ways. They do not result in a net depletion of resources but rather provide net benefits and add value to the environment and the community (Kitchen and Marsden, 2009: 289). For this to be achieved, however, it clearly needs to contend with as well as find space from the demands of the hygienic-bureaucratic state on the one hand, and the forces of corporatisation on the other.

6. Constructing the conceptual dimensions of an alternative/real form of ecological modernization

The aim of a new alternative form of ecological modernisation is to realize food security, food sovereignty and sustainability as part of both global and local processes. Food security exists 'when all people of a given spatial unit, at all times,

have physical and economic access to safe and nutritious food that is sufficient to meet their dietary needs and food preferences for an active and healthy life, and is obtained in a socially acceptable and ecologically sustainable manner (WFS, 1996). Food sovereignty is defined by ISTAASTD (2009) as the right of peoples and sovereign states to democratically determine their own agricultural and food policies. Regarding the definition of sustainable rural development we follow a definition which suggests the potential symbiotic interconnectedness between farms and the locale: it implies a reconfiguration of the asymmetrical relationship between society and nature, technology and expertise (Marsden and Murdoch 2006). On this basis we define sustainable rural development as: '*territorially-based development that redefines nature by re-emphasizing food production and agro-ecology and that re-asserts the socio-environmental role of agriculture as a major agent in sustaining rural economies and cultures'* (Marsden, 2003). Sustainable development has a social-cultural, economical and ecological dimension. In table 1 we sketch the outlines of a weak and strong framework for ecological modernisation in agriculture and agri-food networks.

Table 1: Weak and strong mindsets for ecological modernisation in agriculture and agri-food networks.

Dimensions	**Weak Eecological Modernisation**	**Strong Ecological Modernisation**
Economical	Corporatization Productivity (yield) oriented Cost-price squeeze on agriculture	Agri-food networks Integral approach Food security Value-adding at farm level
Technological	Economically driven technology development Technological environmental solutions Closed loops of energy, waste and minerals	Technological generation as a demand-driven process and spatially sensitive
Ecological	Ecological and genetic engineering (industrial ecology)	Based on agro-ecological principles, flexible and adaptive to specific ecologies and places
Social-cultural	Dependency, scientification, rational man-nature relation, loss of farmers freedom/ agricultural employment	Sovereignty, Autonomy Synergy between man-nature Demand-driven research (mode 2 science) Labor-intensive
Spatial	Globalized Export-oriented Use of external resources	Locally embedded in the community Endogeneigty

		Use of local resources
Political	Top-down steering One-direction communication by extension services Power concentrated at multinationals and large retailers Privatized Research & Development	Enabling policy Participatory approaches Influence of communities in agri-food networks Local and regional institutional actors

Technology development is also in the new framework as an important aspect of agricultural development, but the difference with the old mindset is that it is regarded as a demand-driven process. Criteria for developing technology for poor farmers are according to Altieri (2002:2): 1) based on indigenous knowledge or rationale 2) economically viable, accessible and based on local resources 3) environmentally sound, socially and culturally sensitive 4) risk averse, adapted to farmer circumstances 5) enhance total farm productivity and stability.

A major question sustains how does the literature on agri-ecological alternatives fit with these concepts of real ecological modernisation and development of the eco-economy. What do they tell us about the strength of the EM dimensions (economic technological, ecological, socio-cultural, spatial and political) outlined in the table above?

7. Towards empirical 'evidence': the rich variety and (archipelago) of agro-ecological initiatives

We can search for examples and evidence of endogenous sustainable agriculture, contributing both to food security and food sovereignty, and addressing the dimensions mentioned in table 1. Of course we have to bear in mind that global food security averages cannot be extrapolated or interpolated to specific cases or simply vice-versa. This is partly the epistemological problem. Furthermore, food security is not only dependant on productivity in terms of yields per hectare but also influenced by internal allocation, distribution (supply chains) constraints, political limitations on access, inabilities to purchase available food, overconsumption in segments of a population, policies which encourage farmers to shift from family food production to cash crops, crop failure, storage losses, and a range of other factors. Like food itself,

these are inherently local and regional factors. Food *insecurity* has been defined in terms of availability, access, stability and utilization (ISTAASTD, 2009a). But at its base its meaning is local and regional.

Sunkvist et al (2005) speculate that local-scale food systems are more sustainable because they have 'tight feedback loops' linking consumers, producers and ecological effects. In such systems, positive adaptive responses are more possible because of earlier and stronger signalling of negative effects requiring a change in behaviour in the system. In his view 'intensification, specialization, distancing, concentration and homogenization are trends that can be identified as major constraints for tightened feedback loops' (Sunkvist et al, 2005). This suggests locally embedded food systems are more resilient. But they tend not to be measured in this way.

A major aspect for food security is undoubtedly the performance and sustainability of agricultural systems in terms of productivity. Different agricultural systems are not sustainable in themselves; this depends on the way production is situated within a specific context of space and place. Within agro-ecological systems it is important to recognise that they utilise space and place in completely different ways (see Morgan et al 2006). Indeed, they rely upon their local conditions as a means as well as a condition of production; and, not least to maintain and enhance diversity. Diversity means that it is rarely possible to generalise or to genericise sustainable production technologies; however much the scientific urge. Moreover, this makes the task of conceptually 'scaling up' examples of good practice all that more difficult.

Despite this inherent conceptual problematic research shows that there are a multitude of sustainable agricultural systems worldwide. They range from small subsistence farms to small-scale and large commercial operations across a variety of ecosystems and encompassing very diverse production patterns. These can include poly-cultures or monocultures, mixed crop and livestock systems, extensive or intensive livestock systems, aquaculture systems, agro-forestry systems, and others in various combinations. In Africa alone, there are at least 20 major farming systems combining a variety of agri-ecological approaches, whether they are small- or large-scale, irrigated or non-irrigated, crop- or tuber-based, hoe- or plough-based, in highland or lowland situations (Spencer et al., 2003).

From our extensive review we can broadly distinguish the following sustainable farming systems:

1) Organic agriculture
2) Urban and peri-urban agriculture
3) Conservation agriculture or zero-tillage
4) low-input agriculture
5) agro-forestry
6) aqua-culture.

We need to briefly explain these systems below. In practice these are clearly 'ideal types' with many combinations of these systems occurring.

Organic agriculture is a holistic production management system that promotes and enhances agro-ecosystems health including biodiversity, biological cycles, and soil biological activity (Codex Alementarius Commission, 2001). Organic agriculture is now commercially practiced in 120 countries, representing 31 million ha of certified croplands and pastures (0,7 percent of global agricultural lands) and 62 million ha of certified wild lands, for organic collection of bamboo shoots, wild berries, mushrooms and nuts (Scialabba, 2007).

Urban and peri-urban agriculture refers to growing plants and raising animals for food and other uses within and around cities and towns, and related activities such as the production and delivery of inputs and the processing and marketing of products (ISTAASTD 2009a).

Conservation or zero-tillage agriculture is one of the most important technological innovations in developing countries, as part of Sustainable Land Management approaches. It is a holistic agricultural system that incorporates crop rotations, use of cover crops, and maintenance of plant cover throughout the year, with positive economic, environmental and social impacts (Pieri, et al., 2002). It consists of four broad intertwined management practices: (1) minimal soil disturbance (no ploughing and harrowing); (2) maintenance of permanent vegetative soil cover; (3) direct sowing; and (4) sound crop rotation.

Low-input agriculture: We define this as an overarching term for all kinds of *farming techniques* which use less external inputs and reduce negative environmental effects, such as mixed cropping, perennial cropping, soil improvement methods, sustainable pest and weed management techniques, water management, use of specific seeds and breed and mixed (arable-livestock) farming systems.

Agro-forestry: is an integrated approach of using the interactive benefits from combining trees and shrubs with crops and/or livestock. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy and sustainable land-use systems (Wikipedia). This varies from alley-cropping till agricultural production in existing forests.

Aqua-culture: is the farming of freshwater and saltwater organisms including molluscs, crustaceans and aquatic plants. Unlike fishing, aquaculture, also known as aqua-farming, implies the cultivation of aquatic populations under controlled conditions (Wikipedia). An example is the Pond fish system in Malawi (Brummet, 2002 cited by FAO 2002; Russel et al, 2008).

In the next sections we will give some examples of the productivity of sustainable agriculture, in the form of organic agriculture, agroecological projects and farming systems.

Organic agriculture

During the international conference on organic agriculture and food security in 2007 it was stated, based on models of Badgley (2007) and Halberg (2006) that organic agriculture could produce enough food on a global *per capita* basis for the current world population- 2640 and 4380 kcal/person/day, depending of the model used (Scialabba, 2007). Badgley compared yields of organic versus conventional or low-intensive food production for a global dataset of 293 examples and estimated the average yield ratio organic: non-organic of different food categories for the developed and the developing world. For most food categories, the average yield ratio was slightly <1.0 for studies in the developed world and >1.0 for studies in the developing world. With the average yield ratios, he modelled the global food supply that could be

grown organically on the current agricultural land base. Model estimates indicate that organic methods could produce enough food on a global per capita basis to sustain the current human population, and potentially an even larger population, without increasing the agricultural land base (Badgley et al, 2007). These models suggest that organic agriculture has the potential to secure a global foods supply, just as conventional agriculture today, but with reduced environmental impacts.

High yield ratios in the developing world are obtained when farmers incorporate intensive agro-ecological techniques, such as crop rotation; cover cropping, agroforestry, addition of organic fertilizers or more efficient water management (Badgley et al, 2007: 92). In some instances, organic-intensive methods result in higher yields than conventional methods for the same crop in the same setting, e.g. the system of rice intensification (SRI) in ten developing countries (Uphoff, N. 2003).

A recent, extensive comparative analysis of organic and non-organic farming systems, based on more than 50 cases in the USA and Europe, and just over a dozen studies in developing countries, carried out by the FAO led to the following main conclusions (Nemes, 2009):

1) The overwhelming majority of cases show that organic farms are more economically profitable, despite of frequent yield decrease. Higher outcomes are due to premium prices and predominantly lower production costs. Most European studies including cereals, vegetables and mixed farming systems produced somewhat lower yields, whereas milk yields often showed similar results when measured in literature per cow. However, there is a wide range of discrepancy among studies related to what variable and fixed costs entail, so it is difficult to state a clear-cut conclusion on profitability;
2) Organic crop yields are higher in cases of bio-physical stress (e.g. drought)
3) The major difference is the profitability of the two systems is very often determined by the different management skills of the farmers.

These conclusions can also be drawn from studies in developing countries, but there, higher yields combined with high premiums are the underlying cause for higher relative profitability. An example is the organic cotton production in India (textbox 1).

Text box 1. Examples of cotton yield increases in India (Nemes, 2009)

A study conducted by IWMI in 2003 in India showed that organic cotton yields were somewhat higher than in conventional farms. A 13 percent increase of yield was found in another organic cotton project in Andhra Pradesh in 2005. Similarly, the Central Institute of Cotton Research in Nagpur found that organic treatment resulted in 11-21 percent higher yields. Another study by Jackson (2005) found that organic cotton yields in Kutch were on average 2.5-2.75 t/ha, similar to or even in excess of those obtained under non-organic systems, and much more than irrigated conventional hybrid cotton yields in other states, such as Punjab and Andhra Pradesh. Factors explaining these differences lie in low pest populations due to dry climate, the widespread use of Desi varieties and greater attention paid to soil fertility.

Agro-ecological projects

Pretty and Hine (2001) carried out a study of 208 agro-ecological projects in 52 countries, which showed how farmers have improved crop productivity and at the same time increased both water use efficiency and carbon sequestration, and reduced pesticide use.

> *"It was calculated that almost 9 million farmers were using sustainable agriculture practices on about 29 million hectares, more than 98 percent of which emerged since 1990. These methods are working particularly well for small farmers; about half of those surveyed are in projects with a mean area per farmer of less than one hectare, and 90 percent in areas with less than two hectares each"* (Pretty, 2003).

Their dataset contains reliable data on yield changes in 89 projects. The proportional yield increases were generally: 50-100% for rainfed crops (though considerably greater in a few cases) and 5-10% for irrigated crops (through generally starting from a higher absolute yield base). The relative yield increases are greater at lower yields, indicating greater benefits for poor farmers and for those missed by the recent decades of modern agricultural development.

The team found improvements are occurring through 4 different mechanisms:

- Intensification of a single component of a farm system
- Addition of a new productive element to a farm system
- Better use of nature to increase total farm production
- Improvements in per hectare yield of staples through the introduction of new regenerative elements into farm systems.

The most common mechanisms were yield improvements with regenerative technologies or new seeds/breeds; these occurred in 60 percent of the projects and were applied by more than one-half of the farmers in about 90 percent of the area.
Factors underlying the success of the described agro-ecological practices and movements are (Pretty and Hine, 2001) 1) appropriate technology adapted by farmers' experimentation 2) secondly social learning and participatory approaches; 3) good linkages between farmers and external agencies, together with the existence of working partnerships between agencies and 4) the presence of social capital at local level.

Some of the most path-breaking examples of sustainable agriculture from developing countries in Africa, Asia and Latin America are described below.

The 'Ensete' agroforestry system in South Ethiopia (Kippie, 2002)

This is a form of land use and agroforestry system, five thousand years old, practiced by the Gedeo people in the highlands of Southern Ethiopia. It is well-documented in a dissertation by Kippie, a farmer's son and director of the agricultural institute from this region, who did a PhD in the Netherlands. Gedeo land use emphasizes perennial cropping and initiates nature to a great extent, the emphasis on trees lend the system a forest-like appearance.

The system is able to produce ensete, a high quality food and also an export product Yirga-Chaffee coffee, one of the best coffees of the world, which is grown under the trees. Also honey, timber and a superior race of highland sheep are produced. The cropping system has a good resilience against drought. Since only a small proportion of the farm area is harvested and replanted, damage to the site by rainwater erosion or by sunburn is also minimised.

There is a biological differentiation in cropping between the three zones in the highlands. Ensete is one of the core components of all the zones, accompanied with annual crops like barley, horse bean, pea and vegetables like kale (cabbage), onion and garlic. In the lowlands maize, qoqee, haricot bean, sweet potatoe, and root vegetables like yam, godarre, and/or pumpkin are grown alongside ensete. In the

midlands coffee is the main subsidiary component. Woodproduction and livestock are present throughout the three land use versions, although their shares vary, depending on the altitude.

Ensete has a rotation of 7-12 years, has anatomical water-stocking and storage mechanisms, with its fibrous root system forming a mat-like structure 30-60 cm deep, which prevents erosion. It captures water with its fan-shapes leaves. The system can store a decade's need of biomass in cohorts of crops plants.
Key components like Ensete function as a pacemaker (i.e. regulation of agro-ecosystem rhythm); spacemaker (i.e. provision of biotope space for other crops) and/or placemaker (i.e provision of living space, or niche for other organisms). Components with subsidiary roles are regarded as 'fillers', because they put to good use the extra agro-ecosystem functions still unoccupied. These are annual crops, coffee or farm animals.

This type of agroforest management needs high precision of the farmers. Weedy flora is used to protest future yields, first by providing physical cover, second by conserving soil nutrients in its biomass. The soil management is organic, using crop by-products, lead litter from multipurpose trees and 'weeds', household wastes, rotation of dwelling sites and farmyard manure. Most farmers do not know mineral fertilisers.

High productivity of Ensete and judicious use of accompanying crops result in a very high carrying capacity. Six mature Ensete plants feed an adult during a year, so a farm household of seven persons the needs an area of no more that 0.2 hectare for a sustainable yearly supply. Ensete proves to be the highest-yielding Ethiopian food crop, the crop yields over 5,6 tons ha/year in agroforests. Though the crop is essential for food security of Gedeo farmers and town populations, development projects don't commensurate with its important existence.

Ensete has some problems like the ensete wilt in monocultures, but this is of minor importance in the mix crops system of the Gedeo. Kippie analyzed that still unused biotopes can be opened up in the system like the use of tree species like Morinaga, a leguminous hardwood, which leaves can be eaten. Diverse species of mushrooms can

be domesticated. Also composting processes can be improves and miniature crops can be added like nitrogen-processing bacteria, mycorrhizal fungi or medicinal lichens.
Gedeo farmers also produce for the market. The study of Kippie shows that 'the Rift Valley and its inhabitants were a source of civilized human development for millennia and that principles of sustainability were successfully woven in some of their societies'.

Plantio Direto' Zero-tillage in Brazil (Benites and Ascburner, 2001; Pretty, 2003; Derpsh, 1999; UNCED, 2002; Vaneph and Benites, 2001,).

In Brazil, there are some 15 million hectares under 'plantio direto (also called zero-tillage even through there is some disturbance of the soil. In Argentina, there are more that 11 million hectares under zero-tillage, up from less than 100.000 hectares in 1990, and Paraguay had another I million hectares of zero-tillage. Many of the Clubes Amigos da Terra, literally 'friends of the land clubs', which are essentially farmers organized into groups, have been closely involved in this transformation.
The principles of zero-tillage are: no mechanical soil disturbance; permanent soil cover; judicious choice of crop rotations (Benites and Aschburner, 2001, cited in Vaneph and Benites, 2001). After harvest the crop residues are left on the surface to protect against erosion. At planting, sees is slotted into a groove cut into the soil. Weeds are controlled with herbicides or cover crops. This means that the soil surface is always covered, and the soil itself no longer inverted. Although zero-tillage is a mono-cropping system, which uses pesticides, it can be regarded as a step forward to more biodiversity and sustainable agriculture.

The approach in a few years led to higher yields in crop production, decline in labour costs, diversification into livestock as well as agro-processing, resulting in improved food security of small farmers (UNCED, 2002) Zero tillage practices in combination with suitable crop rotations consistently reduce weed infestations (Derpsch, 1999). According to Pretty (2003), zero-tillage has been a major factor in changing the top-down nature of agricultural services to farmers towards a participatory, on-farm approach.

Organics and agroecological experiments in China

Despite the onset of intensification and urbanisation as defining features of modern China, it is also recognised that many regions display a fertile basis for agro ecological and organic agricultures. The interest of local state entrepreneurs in value-added agricultural development, in combination with a growing export market for organic food has lead to the rapid expansion of self-identified organic agricultural products in rural China (Thiers, 2002). This has benefited from the establishment of the Green Food Development Centre (Green Food). The certified green food can be divided into 2 groups: grade A (allowing using certain amount of chemical materials) and Grade AA (another name of organic food). In 2004 there were 2836 certified enterprises, producing 3142 different products on 8,94 million hectares of land (Bin et al, 2006). More than 20 provinces have formulated Measures for Green Food Management and Measures for Administration of Green Food Labeling. The export value (90% under the AA grade) increased from 71 million USD in 1997 to 2140 million USD in 2007 (Lin et al, 2009)..

The state both at national and local level plays an important part, with most organisation being developed through 'production bases' (shengchan jidi) rather than through individual peasant farmers. County and township institutions are established which coordinate production, the cropping patterns and technical practices. In China, 'entrepreneurial state fragments' see organic production as an economic development strategy for the benefits of the local institutions and area. In many cases local government provides scientific and technical infrastructure, the re-training of the local extension services, donating land, labour and capital to organic field trials, and conducting training workshops. This represents a distinctive 'fragmented entrepreneurial state' model of organic organisation, whereby the state creates the conditions for various types of ecological entrepreneurialism (see Smith and Marsden, 2005).

In addition to organic 'green production' more emphasis is being placed on Chinese Ecological agriculture (CEA), following agro-ecological principles (Ye et al, 2002, Pandl-Zika (2008), and Zhen et al, 2005). As pressure upon increasingly scarce resources (such as water and soils) increases as a result of the intensive model. This is attempting to create integration of the natural-social—economic farm system. For

instance in Northern China (Li et al 1999, Yet et al 2002) several food chain production models, notably, pig-biogas-grain-fruit, pig-bio-gas-vegetable/melon/mushroom, beef cattle-biogas-pig-grain/grass were extensively adopted in Ankang District, Shanxi Province (Sun and Zhang, 1993). Many of these schemes are again government led, as with the Fushan Integrated Ecological Farm in the suburbs of Hangzhou (Ye at al 2002). The Hangzhou municipal government coordinated the Fushan village experiment of 224 farm households. This has steadily derived benefits for the wider rural economy as well as the farms themselves. Analysis of the soils has shown improvements in the state of soil structure and nutrient composition due to the development of applying biogas residue. This also led to large reductions in fertiliser applications and increases in crop yields.

8. Scaling up? Constraining factors and conditions for institutional arrangements

The key challenge, addressed by Altieri (2002) among others, is to understand why agro-ecological initiatives have not disseminated more widely, and how scale up among these initiatives could take place so as to have a wider structural impact? Scaling up is defined as the dissemination and adoption of agro-ecological principles over substantial areas by large numbers of farmers and technical staff (Altieri, 2002:17). We thus focus here on three following dimensions of upscaling based on our critical review:

i) The challenge of diversity and context dependency:

One important factor limiting the spread of agro-ecological innovations is that for the most part NGOs promoting such initiatives have not analyzed or systemized the level of success of local initiatives; nor have they been able to validate specific strategies for the scaling-up of such initiatives. It is conceptually and methodologically difficult to 'scale up' diversity without giving way to generic systems approaches. A starting point, therefore, should be in the understanding and dissemination of the agroecological and socioeconomic conditions under which alternatives were adopted and implemented at the local level.

That involves adopting an evolutionary approach to understanding the development of such cases, and in particular how that contends with the dominant agri-industrial paradigm. Such an approach can shed light on the constraints and opportunities farmers to whom benefits should be expanded at a more regional level are likely to face (Altieri, 2002). Altieri (2002) also suggests that scaling-up strategies must capitalize on mechanisms for the spread of knowledge and techniques such as:

- Strengthening of producers' organizations thorough alternative marketing channels;
- Develop methods for rescuing/collecting/evaluating promising agroecological technologies generated by experimenting farmers and making them known to other farmers for wide adoption in various areas;
- Training government research and extension agencies on agroecology in order to for these organisations to include agroecological principles in their extension programs
- Develop working linkages between NGOs and farmers organizations.

Focusing on agro-forestry systems, Cooper and Denning (2000) identified 10 essential elements for scaling- up agroforestry innovations: building local capacity, facilitation, farmer-centred research and extension approaches, germplasm, knowledge and information sharing, learning from successes and failures, market options, policy options, strategic partnerships, and technology options (see also Franzel et al, 2004).
From their worldwide survey of sustainable agriculture initiatives, Pretty and Hine (2001) also raised the question of up-scaling and stated that if sustainable agriculture is to spread to large numbers of farmers and communities, attention needs to be focused on:

1. Enabling the policy environment is enabling rather than disenabling;
2. Investing in infrastructure for markets, transports and communications;
3. Ensuring the support of government agencies, in particular, for local sustainable agricultural initiatives
4. Develop social capital within rural communities and between agencies.

Sunkvist et al (2005) questions refers to upscaling to the global food system when he speculates if ecological feedbacks, which are more likely to appear in local-scale

food systems, can operate over longer distances in the world food system. He also questions whether new environmental and food audits can act as a vector for genuine ecological feedback. But what is missing from this example is any kind of critical engagement with the emergence of audits as a new form of global governance in food relations (Campbell, 2009).

What is often not addressed by authors on agro- ecological practices is how an enabling policy or package of policies should be shaped, based on the dimensions of a new ecological modernisation in agriculture.

ii) Enabling policy

Parrot and Marsden (2002) describe in an extensive overview on organic and agri-ecological cases what some of the political issues are. One issue is *the concentration of competence in certification* in industrialised countries. The lack of certification capacity in the South raises cost and logistical barriers for producers. This can be prohibitively expensive for many small 'Third World' producer groups (Parrott & Marsden, 2002:95). The authors suggest a list of activities governments can be active in such as: identifying areas where organic and agro-ecological approaches are already practised, the effectiveness of existing practices, the depth of the knowledge and the problems experiences, but also identifying areas where traditional and/or chemical-dependant farming practices no longer provide adequate solutions. They also suggest e.g. developing 'bottom up' capacity, reorienting the priorities of state-funded research and educational institutes and giving consideration to the market potential of OAA in both local and international contexts and in terms of primary and value-added produce (Parrot and Marsden, 2002: 99).

Policy aspects are also addressed by The International Assessment of Agricultural Knowledge, Science and Technology for Development (ISTAASTD, 2009a/b); 58 countries approved the results of this assessment so far. One of the conclusions was that successfully meeting development and sustainability goals and responding to new priorities and changing circumstances would require a fundamental shift in agricultural knowledge, AKST, including science, technology, policies, institutions, capacity development and investment. Policies and institutional changes should be

directed primarily at those who have been served least by previous AKST approaches, i.e. resource-poor farmers, women and ethnic minorities.

Important options for enhancing rural livelihoods include increasing access by small-scale farmers to land and economic resources and to remunerative local urban and export markets. Policy options for improving livelihoods include a large variety of measures: access to micro-credit and other financial services; legal frameworks that ensure access, and tenure to resource and land; recourse to fair conflict resolution; and progressive evolution and proactive engagement in intellectual property rights regimes and related instruments.

Developments are needed that build trust and that value farmer knowledge, agricultural and natural biodiversity; farmer-managed medicinal plants, local seed systems and colon pool management regimes. Each of these options, when implemented locally, depends on regional and nationally based-mechanisms to ensure accountability. The suite of options to increase domestic farm gate prices for small-scale farmers include fiscal and competition policies; improved access to AKST; novel business approaches; and enhanced political power (ISTAASTD, 2009b: 5).

The last few years we can witness more public and private attention for agro-ecological approaches in new structures and institutions such as greening corporates, professional auditors and food-related social movements:

> *'the new language of measurement of food safety and environmental performance; the definition of quality to include ecological variables; and the cultural re-valorising of taste, localness, history and safety as branded, profit-generating drivers of new investment, can all be argues to have created information flows and feedbacks between consumers and distant ecologies'* (Campbell, 2009: 316). |

This development is described by Campbell as a shift from a 'Food from Nowhere' to a 'Food of Somewhere regime'. An example of new politics within global-scale supply chains is demonstrated by the GlobalGap alliance, which expanded its vision from 'residue free' produce to include a range of other ecological qualities in

production. But the question remains if we are on the threshold of a new food paradigm.

Campbell suggests that the 'Food from Somewhere' regime represents a 'breach in the fabric of the 'Food from Nowhere' regime, rather than a new set of clothes in itself. There are other indications that a new food regime is not yet emerging. In a recent advisory report of 'the Royal Society' in the UK it is stated that the challenge of global food security should be met by intensifying agriculture with respect to environmental boundaries; an approach we have described as weak EM. The committee promotes 'a large-scale 'sustainable intensification' of global agriculture in which yield is addressed not just per hectare, but also per unit of non-renewable inputs and impacts upon ecosystem services'. (The Royal Society, 2009: 47).

iii) Building the agri-ecological paradigm through enhanced and engaging research and development

Much of the literature deals, logically, with specific cases with the agricultural outcome being highly dependant of space and place. There are only a few overarching reports which deal with the performance of complete farming systems, compared to the dominant systems of food production. Examples are the described FAO study on organic agriculture and the study of Pretty and Hine on agro-ecological movements.
Besides, much literature is limited to some aspects of the system like the agricultural productivity, the ecological outcome (biodiversity and so on), (technical) ways of production, (economical) marketing of products or social aspects (community building, participative processes, learning processes). An integrated approach of the performance of agricultural systems is still not common.

A complicating factor which makes it difficult to compare for example organic and non-organic agriculture is the different framings of organic 'systems'. Conventional and organic farms represent different systems. Negative off-farm implications of specialized conventional systems such as environmental pollution or social effects on farmers are often not taken into account when organic and non-organic forms of agriculture are compared in literature.

Furthermore, long-term experimental field studies of the effect of organic agriculture have been mostly carried out in the USA and in European countries. In less developed countries, very few studies have been conducted on the profitability of organic agriculture. Long-term studies, especially in developing countries, are hardly existent; only about a dozen studies compared both yields and net income, mostly focusing on coffee and cotton. Some of the complicating factors referring to literature on productivity in developing countries are (Nemes, 2009):

- Many farmers are tenants and do not own the lands and as consequence have less motivation in investing into better management techniques;
- Livestock represents a critical element of organic farming; animals are not only a source of manure, but also of farm power and immediate cash. Yet most economic studies leave them out;
- Most studies rely on interviews with farmers. Consequently, many of the responses may be based on perception than on well-kept records. In many areas, farmers are mostly illiterate, so they do not keep written accounts.

Clearly the second part of this paper has empirically demonstrated that there is enough evidence at a case study level to severely question the legitimacy of the agri-industrial paradigm as the only answer to the new global Malthusianism and the neo-productivism which it now cleverly and vibrantly articulates. However, if the debates remain at a global level without critically confronting or transcending both the problems of scale, diversity, context dependency and the sanctity of generic technologies, it is unlikely that such a legitimacy will be seriously challenged. Real ecological modernisation (as postulated in table 1) could indeed become up-scaled. But it will rely on the support of new and more vigorous research and development (of which critical and normative social science should play a key part); as well as supportive multi-level state structures and processes which hold the power to devolve in ways which stimulate Frouws and Mols (1999: 271) process of 're-embedding' economic practices and the institutionalisation of ecology in the social practices and institutions of production and consumption.'

Indeed, it may be in Europe, rather than in the developing world, where at least some governance structures are moving in this direction (see van der Ploeg and Marsden, 2008), even if they are still confronting a rejuvenated neo-productivist backlash. What

is clear, however, is the need to engage more effectively with this backlash both in the North and the South, and to demonstrate that the corporately controlled architecture which had been developed around the establishment of complex privately controlled supply chains is only one game in town.

It is important also to recognise that the 2008 food crisis provided a real opportunity to critically 'see' the scale and integration of the corporately controlled agri-business, energy, auto, biotech, nanotech and financial recombinant model. This is now a model which explicitly espouses the bio-economy rather than the eco-economy. That is what we have argued is a necessarily 'weak' form of ecological modernisation and its logic is set against the establishment of the agro-ecological and rural sustainable development paradigm outlined here.

Moreover, we should not expect the State, especially at global level, to necessarily support alternatives to the logic of this model. As McMichael (2009: 244) observes with regard to the recent World Bank's (2008) World development report:

'In sum while 'agriculture-for-development' is a new mantra, so long as corporate markets (value chains) are the standard, the greater productivity (and planet cooling effect) of diversified small farming will be sacrificed to the Bank's need to renew its legitimacy, and to the depredations of the corporate market. In addition to failing to feed the world, the institutionalisation of the 'new agriculture' inevitably extends to an agrofuel 'gold rush' because of peak oil, exacerbating the chronic food crisis of the neo-liberal food regime, and re-enforcing the path dependence of an exclusionary corporate agriculture'. This would suggest at the very least that the stakes are getting much higher for real ecological modernisation and the eco-economy, but that it is a challenge that critical social scientists should indeed confront (see Thompson and Scoones, 2009).

9. Conclusions

Clearly, the challenge of food security is more urgent than ever, because of the growing population on the one hand and forces that threaten food production such as climate change, urbanization, the decrease of agricultural resources and erosion, on the other. We argue that the dominant food regime has responded to this challenge by

a ‘weak’ ecological modernisation process of agriculture which may decrease environmental effects to a certain extent, but also causes new negative side-effects and exposes some important missing links. Examples are the standardisation and hygienic bureaucratisation of agriculture, the distancing of food production and consumption geographically and institutionally, and the marginalisation and fragmentation of the role of agriculture in local communities. In this paper we have sketched the outline of what might be a ‘real’ ecologically modernisation process, including social, cultural, spatial and political aspects.

The central question posed has been is there evidence in practice that agro-ecological approaches can contribute to food security, especially in developing countries. The agriculture practices show a rich variety of such approaches mostly implemented by small-scale farmers, such as organic agriculture, urban and peri-urban agriculture, conservation agriculture or zero-tillage, low-input agriculture, agro-forestry and aqua-culture.

On different continents we see examples of farming systems that are locally embedded in communities, more resilient towards external threats and globalisation, environmentally friendly, contributing to biodiversity and, not the least important, productive in terms of yields. Indeed, especially in sub-optimal agricultural circumstances, occurring in large parts of the developing world, organic agriculture can be more productive. The 5000 years old agroforestry system in Ethiopia for example, is probably one of the most sustainable forms of agriculture, which produces a large variety of products, for self-sufficiency and for export, so that production risks are decreased.

Clearly the second part of the paper has empirically demonstrated that there is enough evidence at a case study level to severely question the legitimacy of the agri-industrial paradigm as *the only answer* to the new global Malthusianism and the neo-productivism which it now cleverly and vibrantly articulates. However, if the debates remain at a global level without critically confronting or transcending both the problems of scale, regional and local diversity, context dependency and the sanctity of generic technologies, it is unlikely that such a legitimacy will be seriously challenged.

Real ecological modernisation can be up-scaled, but this depends on three major conditions. First, we have to deal with the problem of diversity and context dependency of agricultural practices. Sustainable, local practices build upon and are intertwined with local physical and social circumstances and cannot be directly copied. A starting point, therefore, should be in the understanding of the agroecological and socioeconomic conditions under which alternatives are adopted and implemented at the local level.

The second condition is an enabling policy. The ISTAASTD report (2009a/b) has given useful recommendations on this point. We can also witness a new set of counter-logics for the current food regime in for example NGO initiatives, some FAO reports and in new institutions like Global Gap and Fair Trade networks.

The third challenge is the re-direction of agricultural research, development and knowledge transfer. A more integrated and regionally and locally embedded approach to the performance and resilience of agricultural systems is still not common.

The 2008 food crisis provided a real opportunity to critically 'see' the scale, logics and integration of the corporately controlled agri-business, energy, auto, biotech, nanotech and financial recombitant agri-industrial model. This is still a model which explicitly espouses the bio-economy rather than the eco-economy. Examples can be found in recent advisory reports promoting a more 'intensive, sustainable agriculture'; a form of weak EM, based on specific technologies such as genetic modification. This would suggest at the very least that the stakes are getting much higher for real ecological modernisation and the eco-economy; and this it is a challenge that critical social scientists need to urgently address.

Agroecological approaches could help to feed the world sustainably, and thereby contribute to a 'real green revolution'; but this requires a more radical move and debate amongst scientists about fostering a new type of agri-food eco-economy. This is one which includes re-thinking market mechanisms and organisations, more innovative institutional flexibility on a regional scale, interwoven with active farmers' and consumers' participation; and a re-direction of science investments to take account of translating often isolated cases of good practice into mainstream agri-food

movements. The times are now urgent for this re-thinking and debate, and they need to critically inform more effectively the growing legitimacy of bio-economic solutions as to why more and more people are going hungry.

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