Transition scenarios to agroecology in Europe: relevance and challenges of a fundamental contribution to the EU debate on agriculture and environment

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List of acronyms

AE	Agroecology
BAU	Business As Usual (scenario)
HNV	High Nature Value
NGO	Non-Governmental Organisation
SI	Sustainable intensification
TYFA	Ten Years For Agroecology
UAA	Usable Agricultural Area

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Table of Contents

1 Agroecology in the policy agenda: a future thinking issue

1.1 Addressing the challenges of agriculture and environment in Europe: agroecology as a relevant candidate for EU's agrifood transition

The impact of agriculture on environmental resources in Europe has been analysed for decades (Baldock & Beaufoy, 1992). The recent history of the agri-environment issues—from the 80's—shows a clear evolution in the way of setting the problems. In the 80's-90's, the issue was to put environment on the agricultural agenda and propose tools able to "solve the problem", through incentives (agri-environmental payments) and/or regulations (notably the nitrate directive and, later on, the water framework directive and cross-compliance). After decades of stagnation in terms of environmental performance, it was clear that the issue was not only to marginally adapt practices, but to propose a new paradigm for agriculture, compared to the "conventional" productionist one.

Two main candidate paradigms can be identified. The first one is "sustainable intensification" (SI). It stands on the idea of "*simultaneously improving the productivity and environmental management of agricultural land*", (Buckwell (dir) 2014) while in practice priorities or probable trade offs between the two goals are not explicitly dealt with; SI might cover a wide range of situations. However, a key idea of sustainable intensification is to propose a strategy of rising environmental management standards that remain compatible with the present organisation of agribusiness and the continuation of high levels of production. The question remains however whether this objective can really be consistent with a demanding environmental agenda: beyond resource efficiency, how can sustainable intensification address altogether biodiversity's rapid degradation, the difficulty to reduce the impact of pesticides or antibiotics on the environment and on health, and the major challenge of increasing carbon storage in soils? to quote only some of the issues arising from some forms of intensification that are central to the business as usual scenario from which SI does not seem to represent a radical deviation.

The second paradigm for change currently debated is agroecology. This concept started in the 1970's, with Miguel Altieri's work in Central America. Compared to sustainable intensification, it proposes a more comprehensive and systemic approach and encompasses social, economic and organisational changes. One of its strengths is to combine technical aspects—notably the use of local semi-natural resources, natural ecological functioning of agroecosystems, and local knowledge—with social ones. It acknowledges that technical issues are central—while they are the material link between our environment and our societies—but that they need to be put in a wider frame. This allows a socio-technical perspective for thinking through the needed changes, which sustainable intensification tends to omit, notably because it keeps the existing socio-economic organisation unchanged.

Box 1: The principles of agroecology

The following principles are those set out in the project 'Agro-Ecological Innovation' of the IFOAM EU Group, TP Organics and ARC2020. They are based on (Stassart, *et al.*, 2012)

"*As the definition of agroecology is rather wide, a better understanding of the concept can be obtained by exploring the principles that guide researchers, practitioners and social actors active in the field of agro-ecology. The following list proposes such a set of principles, however not to be understood as a closed framework.*

- *Recycle biomass, optimise and close nutrient cycles.*
- *Improve soil conditions. This means in particular improving organic matter content and biological activity of the soil.*
- *Reduce dependence on external, synthetic inputs.*
- *Minimise resource losses (solar radiation, soil, water, air) by managing the micro-climate, increasing soil cover, water harvesting...*
- *Promote and conserve the genetic diversity of crops and animals.*
- *Enhance positive interactions between the different elements of agro-ecosystems, by (re-) connecting crop and animal production, designing agro-forestry systems, using push-and-pull strategies for pest control...*
- *Integrate protection of biodiversity with production of food.*
- *Integrate short-term and long-term considerations in decision-making. Aim at optimal yields rather than maximum yields. Value resilience and adaptability.*
- *Contribute to the transition towards sustainable agriculture and food systems. Identify lock-ins that impede this transition and propose pathways to unlock them. Propose new governance structures that support innovative niches of sustainability.*
- *Acknowledge the similarities and linkages between agricultural systems in the global North and South. The North can learn from agro-ecological experiences in the South and vice versa. Because of the increasing globalisation, the transition towards sustainable food systems asks for integrated and simultaneous solutions in North and South.*
- *Investigate existing power relations, decision-making processes and opportunities for participation in food systems. Investigate the role of citizens and consumers in food systems.*
- *Valorise the diversity of knowledge (local / traditional know-how and practices, common knowledge and expert knowledge) in the definition of research problems, the definition of people concerned, and in finding solutions.*
- *Promote participatory research driven by the needs of society and practitioners, while at the same time guaranteeing scientific rigor.*
- *Develop knowledge and innovation systems that conserve and allow exchange of agro- ecological knowledge. Special attention should be paid to local knowledge, which is a scarce resource in itself and due to its specificity is difficult to disseminate.*" (IFOAM EU Group, Arc2020, TP organic).

Agroecology is gaining in importance in the research and policy agenda. It is establishing itself as a common concept for a coalition of NGOs proposing a radical change of European agriculture (for instance, in France with the PAC 2013 coalition before the2013 reform of the CAP, or within ARC2020 at the European scale). The statement is that the current system is

so locked-in and impacts so much the environment that solutions can only be found in a complete re-design of not only the farming sector, but the whole agrifood chain (Meynard, *et al.,* 2013). Agroecology therefore appears as a very relevant candidate for an agricultural transition able to encompass environment, rural development, animal welfare and food security concerns. Indeed, its principles allow developing a comprehensive roadmap for a future European agriculture and food system that has to be reconciled with nature and consumers as well as with farmers themselves, altogether. AE proposes a conceptual frame able to address issues that, until now, are addressed separately. In this regard, it can be seen as a major change in the pressure for change that are exerted on our European agrifood system and the Common Agricultural Policy from different perspectives, and enables to build a consistent coalition amongst civil society organisations.

However, when it comes to giving flesh to the transition towards agroecology at the scale of Europe, the image blurs or becomes patchy. Examples of farming systems matching the AE principles are given, but the analysis is frequently fragmentary, not fully revealing if all the dimensions of AE are addressed (Guillou *et al.,* 2013; Dumont *et al.,* 2014). When it comes to the food system, the narrative of "local markets are the backbone of agroecology" is dominant, but not sufficiently equipped to reveal how such a principle of re-localization can be scaled-up to organise the whole European food system. All the more, the European scale dimension of AE and food system is missing. The agroecology project is at risk of appearing, in the representations of policy makers and public opinions, as a collection of local food projects mainly selling organic vegetables and poultry in local markets. But does this address the trends and the organisation of the European agrifood system? The question is still unanswered. And not being answered, it allows conceptual drift and, at end, anyone to capture AE. The example of the French Ministry of Agriculture's call for AE is a good one to pin the lack of clarity of the concept, as the awarded projects range from really demanding ones to other simply implementing "better practices" far from the AE vision of transformation.

Our intent is not to undermine agroecology by saying it is a weak concept. It is on the contrary to start from the present blind spots in the transition scenario towards agroecology for Europe, in order to enable a better capacity for such a transition to be openly debated and not just discarded by opponents in the public policy debate, and also to better understand the strategic levers that would enable such a transition.

Put in transition management's terms, the project is to discuss under which conditions agroecology could get out of the position of an eternal niche, and become the next dominant socio-technical regime instead. For this purpose, we need to understand the current dominant regime, how it is locked-in and the way it challenges any transition pathway towards AE.

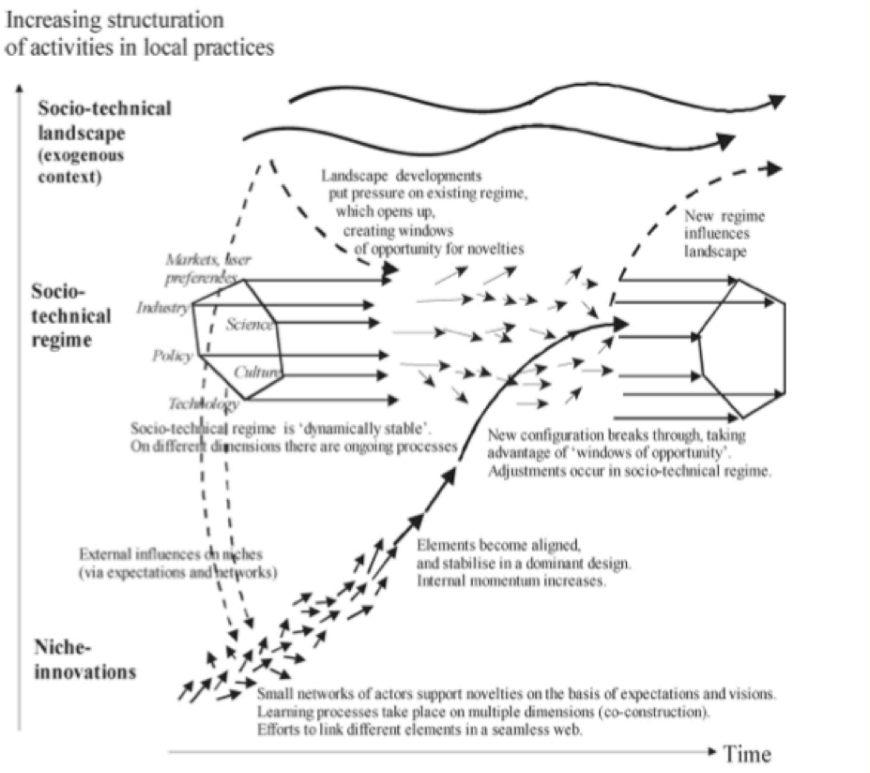


Figure 1. The multi-level perspective - a theory of change (Geels et Schot, 2007)

1.2 Addressing an agroecological transition project requires a structured scenario analysis

Clearly, agroecology is a future-oriented concept. Not that forms of AE do not exist today—on the contrary, a large share of World and Europe's farms are indeed functioning according to AE principles when making use of local environment assets and local knowledge instead of imported agro-chemicals. We here defend the point that High Nature Value Farming (HNV), which is representing around 25% of EU28 UAA, is already a genuine form of AE farming. But the AE project, to name with this terms for convenience the transition project towards agroecology at the scale of all Europe, is to reverse the present trends in which these systems are disappearing under the pressure and competition of industrial farming and large scale agrifood chain, and to enable that other pathways of change can be made possible for all farming systems in Europe.

Thus, the conceptual challenge that needs to be addressed for the AE project is dual:

- Show that the whole EU agro-food systems can be converted to AE without "going back to the Middle-Age". This would indeed be unrealistic both on the production side (too little food produced), on the consumers' side (too demanding in terms of changes in diet and lifestyle, too expensive) and the global side (too selfish when there is a call to "feed the World"). But this being said, and the criticisms being identified, the demonstration is still missing.

- Show that pathways towards such a future vision are both possible and plausible. Such an assessment of the plausibility of the project is needed, simply because AE is not—and by far—the dominant paradigm in the present situation. The nature of the needed change for the agro-food system is such that it goes beyond simply adapting the present system, as already said. It is a more radical process of change that needs to be designed.

Considering these two points leads to conceptually design the AE project as a scenario analysis. It is indeed a scenario matter to envisage long term radical plausible changes, to specify the ins and outs of an AE agro-food system, to better quantify the consequences of this assumption on land-use, on production and on diet notably in the context of climate change. There is a need for a combination of alternative narratives in the future, addressing socio-economic issues, with systematic and quantified analysis: in brief, the very substance of scenario (see box 2).

The transition project to AE makes it necessary to develop a proper transition scenario. For this, we need both a desirable and feasible *image* of what would be an AE scenario and a plausible *pathway*, bridging present and future. In doing so, we put scenario analysis in a strategic perspective: we assume that the policy debate, *sensu lato*, is missing a plausible AE option and that it is a priority for stakeholders wishing to influence the future development of policies to be a force for bringing forward proposals. We indeed consider the debate on the different projects for European agro-food systems as a "future-oriented debate" (Treyer, 2009), that is the co-evolution process of:

- a corpus of representations of the futures in a specific field, in this case the future of agro-food systems, each representation being elaborated in reference to the others;
- a community of persons and institutions associated to the elaboration and discussion of these representations of futures.

For an AE scenario to be audible in the policy debate, it needs to exist in the future-oriented debate. Thus, when designing an AE scenario, one should pay attention to the content of the scenario (how does it relate to other existing scenarios on the future of agro-food systems? How does it make the corpus of those scenarios evolve?) and the way it can be discussed in the arena of discussion of the future-oriented debate (what are the rules of discussion of this arena? Who participates in the discussions? How can a new scenario access the discussions?). This document mainly focuses on what we believe are the basic requirements for an AE scenario to be able to exist in the future-oriented debate on European agriculture, that is (i) responding to the elements considered in other scenarios, in order to be audible in the debate (e.g. the global food security issue, see first section of this document), (ii) considering blind spots of the other scenarios, in order to improve the quality of the debate (by adopting a systemic approach, see second section, and by showing a transition pathway, see last section).[1]

[1] An analysis of the rules of discussions of the future-oriented debate (actors involved, degree of pluralism of the debate…) could also be realised, notably in order to design a dissemination strategy for an AE scenario, but it is out of the scope of this document.

Box 2: The key characteristics of scenarios

A scenario is a narrative about a plausible future[2] of a social, economic and technical system. It aims at revealing what significant changes can take place in a given time horizon (e.g. 2050, the horizon depends on the nature of the system taken into consideration).

It formally consists of an image and a path, i.e. a chronology of events explaining how to bridge the future image with the present one.

A scenario reflects values - hopes and fears – in a rigorous approach. It is founded on a past and present story of the analysed system, forming the "basis" of the scenario.

It is both an analytical and comprehensive, systemic approach. It combines qualitative and quantitative assumptions in a consistent story, or narrative. Scenarios help at identifying the external forces and the degree of freedom (choices).

Added-value of scenarios is not their capacity to predict what will happen, but to explore what may happen under different plausible assumptions. The design of their discussion is paramount. Their strategic goal is to question and re-open the spontaneous implicit anticipations of future. They support new objectives and/or new means of actions to reach a desirable future or avoid an undesirable one.

Scenario analysis differs from the definition of the idea of AE in Platonic terms: in such an approach, AE exists as an Idea and stands on sufficiently explicit criteria that would allow the building of the "true" AE scenario. Our understanding is that this approach is not adapted to the nature of the question, as the policy debate is not only situated in the world of ideas, but could progress much more through a discussion that is not only based on ideal principles but also about their pragmatic translation into the reality and the diversity of food and farming systems throughout Europe. An AE transition scenario is necessarily a social construct and a process, based on assumptions, reflecting political choices and situated values. In other words, designing an AE scenario is a constructivist project, subject to errors and interpretations. This is an important difference with respect to very common approaches of debates of normative visions for future changes, where the priority is put on (1) firstly making *fully explicit* a definition of the concept underlying the norm [here, AE, but it could be "sustainable development", "local market", "competitiveness",…—any embracing concept in fact] (2) and then only *deducing* what the corresponding scenario could look like. In practice, most time resources, in such a sequence, is spent on debating the purest definition of the concept, which is made difficult by the fact that there is no concrete example of its meaning, which leaves very little time for developing a complete image of the concrete scenario of change.

Compared to such approaches, the scenario analysis that is proposed in this paper contends that the appropriate approach is a combination of deduction—based on the existing works on the principle of agroecology—and induction—based on a scenario building approach in concrete cases and situations. We assume that we have enough principles on what AE is to start a process of scenario analysis, and that it will in return enrich the understanding of what AE can be in different situations and in the future.

[2] Underlined items are those forming the usual vocabulary of scenario methodology.

1.3 The aim of this document: showing the added value and challenges of building an AE transition scenario in Europe

Our aim is this document is not to present an already built AE scenario for Europe. It stands on a preliminary level, identifying the methodological needs and challenges for designing sound scenarios, in the strategic perspective that we have set in the above lines. “How to make an AE scenario convincing?” could be the overarching question of our thinking.

The insights discussed in this document are based on discussions with a coalition of European NGOs and researchers. Those stakeholders were gathered by the TYFA project (Ten Tears For Agroecology—the "ten years" referring to early actions putting on the path towards an Agroecology image that would take place in a longer term, 2050 being a convenient horizon). Those discussions took place between 2013 and 2015, with the support of the Fondation pour le progrès de l’homme, as a contribution to strategic thinking of EU scale coalitions, and led to the design of applied research projects. We felt that useful findings could be drawn from these discussions, which would propose a step forward in the setting of an AE agenda, going further than general principles and/or scattered examples.

This paper is a way to display the findings that came from those discussions amongst the TYFA community, but also at a wider scale, for the stakeholders involved in the transition towards European agrifood systems with a radically new capacity to deliver environmental and social performance, on top of the economic one..

Box 3: The actors involved or having contributed in the design/preparatory phase of TYFA

A "core group", consisting in different NGOs involved in different ways in agroecology has been gathered twice (March 2014 and 2015) in order to identify and discuss the key challenges of TYFA. The involved organisations were:

Aprodev, Arc 2020, Birdlife Europe, European Environmental Bureau, European Forum on Nature Conservation and Pastoralism, Friends of the Earth Europe, Greenpeace, IFOAM TP Organic, Pesticide Action Network, SlowFood, Sustainable Food Trust (Greece),

A "methodological group" consisting in different research bodies that contributed to the methodological design of TYFA, under the lead of IDDRI and EFNCP:

Université de Liège (BE), AgroParisTech (F), Wuppertal Institute (D), Institute of Social Ecology (Vienna, Austria)

The present document is organised in two main folds:

- One is dealing with the socio-technical dimension of the AE scenario: what should be represented explicitly in the image of the AE to make it fully convincing, and thus able to support a constructed debate on future transformations of agrifood systems in Europe?
- One is dealing with the status of such an AE scenario in the future-oriented debate: how should it be positioned relatively to a “business as usual" scenario? How should it address the "transition" (= the pathway)?

But before dealing with those two central folds, we felt it unavoidable to address a first preliminary issue: what is the meaning of proposing an AE transition for Europe when taking a global food security perspective?

2 The Europe/global issue of an agro-ecology transition

Is a transition to AE relevant when considering the impacts on global food security? This seems a relevant question in a moment when the Sustainable development goals agreed on by all UN governments in 2015 make it necessary for each country to seek for its own sustainable development pathway, according to the singularity of its specific situation, while making sure not to export unsustainability to other countries

The issue is that while there are evidences that AE might bring higher yields in tropical countries, in which the concept had been developed, it might lead to *lower* ones in the temperate context of Europe. Is it realistic and acceptable to envisage this when the call for food security seems to coincide with an increase of production on all available land? The figure of the 9 billion mouths to feed in 2050 is a powerful one, endorsed by institutions like FAO, DG Agriculture, and the European Parliament.

Thus, for the sake of making an AE transition scenario debatable in the current policy debate, but also because global impacts of changes in Europe need to be considered in order to be able to assess the sustainability of proposed changes, this question of the global impacts of the EU transition scenario needs to be addressed.

2.1 Agroecology in Europe: lower yields… (with current references)

The concept of agroecology was developed in the 1980's by Miguel Altieri, in the context of Central America (Altieri, 1983). Its fundamental statement was that not only crop diversification but more fundamental spatial organisation, at the landscape level, would bring a better resilience of the agronomic system and at the end higher production at the farm level. In this context, local resources (seeds, knowledge) are obvious factors for implementing both resilient and productive systems that are minimizing the use of non renewable inputs. A reference paper by Pretty (2008) shows that in the context of developing countries, yields in systems having adopted "sustainability technologies"—whose principles are those of agroecology—are higher than when using conventional technologies.

But the European context is different and the above conclusions cannot simply be transposed:

- the temperate climate and less fragile soils make the principles of AE less obviously necessary for the very viability of EU farming systems (the soil/climate conditions are more favourable in Europe, and make farming systems at least apparently in the shorter term less fragile);

- the technologies developed in Europe have been based on high level of chemical inputs and seeds accordingly selected in order to reach high yields on limited areas (the situation is different in other temperate countries such as the US or parts of Argentina in which more land availability entails lower yields).

Those two factors combined make the yields of production without artificial inputs (i.e. those of the organic farming requirements) lower in Europe. Fiessbach, *et al.* (2001) show that in Switzerland, yields are around 20% lower between organic farming (biodynamic and "organo-biologic" farming) when compared with conventional farming. In (Guyomard (dir) 2013), statistical comparison in France shows nearly half yields for organic wheat and barley, when compared with conventional ones.

Caplat (2015) and other authors discussing Guyomard (op. cit.) point out that simply comparing crop yields "with" and "without" fertilisers and pesticides is not relevant for two main reasons: (a) the seeds used in most organic farms in the framework of such comparisons are the same than the ones used in conventional ones, thus not selected yet to grow without chemical inputs (b) the productivity should be compared at higher levels of space and when comparing systems fully adopting AE principles (multicrops, agroforestry,...). Caplat (2015) rightly points that organic farming, and AE, is much more than "conventional farming without chemistry". He states that in the agronomic and present socio-technic contexts, it is unavoidable that organic farming has lower yields in Europe—which is not the case in North America for instance—and that closing the gap is a matter of fundamental change in research and policies that might reduce the differences in yields between organic and conventional in the longer run.

2.2 Why lower yields in Europe are not a concern for global food security

2.2.1 Some figures to frame the debate

Lower yields in Europe are a concern only if one assumes that Europe needs to export its commodities in order to feed other countries. This vision founds the "we need to feed the 9 billion World's citizens" narrative that indeed implies high yields if Europe has to export to ensure global food security. Different lines of argumentations contradict this narrative.

Firstly, an implicit underlying hypothesis of the "we need to feed the World" narrative is that Europe is currently feeding the World. Which is not the case. For cereals, a key commodity for the basic supply in calories, EU28 exported 22-24 Mt in 2011-12 and 2012-13 but in the meantime imported 16 Mt, thus a net export of 6 Mt to be compared with the 2,500 Mt of cereals produced in the World—figures from (Agreste, 2015). Thus, in broad terms, EU28 has a net contribution of 0.24% (!) of the cereal supply outside its boundaries. It should be remembered that global trade of cereals represents 12% of the total production, thus 88% of production is produced and consumed at a domestic level. Food security in currently food insecure countries relies more on the capacity of these countries to feed themselves than to only import food produced in other regions of the world.

In comparison, EU28 imports the equivalent of 12-16 Mha of soya beans, mainly from South America (Chemnitz & Becheva, 2014). Those figures can be compared to the equivalent 1Mha mobilised for the above net export of cereals from EU28. In short: the net land use on cereals and soya, the two main commodities in terms of impact on land use, shows that EU28 *imports* the equivalent 11-15 Mha, mainly for its meat production. To put it simply, the

present situation is that the World feeds EU28,[3] particularly because of the importance of the demand for feed as inputs to animal production systems in Europe.

In a future horizon, it is frequently argued that the increase of population—the 9 billion people in 2050—means the need to increase the global production by 70%. (De Schutter 2010) reminds us that this estimate assumes an average meat consumption increasing from 37.4 kg/person in 2010 to 52 kg/person in 2050 (+40%), in which half of cereals would be used for animal feed. Agrimonde (INRA ; CIRAD 2009), estimates that a 3,000 Cal/day in 2050, with 2,500 of vegetal origin and 500 from animal product would entail an increase of overall production (as measured in calories) of +28%. Europe of course should increase global tensions between global supply and aggregate demand for food and agricultural biomass, by increasing its dependency on food or feed imports. But changes in yields and EU agricultural output are not a sufficient indication to assess this global impact of the EU agrifood system, as internal demand for feed and food, as well as the type of animal production systems, are other variables that also need to be taken into account.

The main conclusions of this short discussion are:

1. Due to its lack of large (new) agricultural area and already high yields, Europe is not and has not the future possibility to be a significant raising contributor to food security (as simplified as a supply of calories).
2. A key variable is meat consumption. A limited decrease in meat consumption will have a major positive impact on the "need" for higher yields, in Europe and elsewhere. It has been observed that the global production already covers more than the needs of the World population and, with a more vegetal based diet, could feed 10 billion persons (Foley *et al.*, 2011).

2.2.2 The food sovereignty dimension

On another level of analysis, more fundamental, the issue about food security is not first a question of global availability. Many authors point that the main issue is poverty in developing countries. The observed food crisis and the persistent high level of undernourished people is caused by a lack of resources to buy food or, in some cases, by lack of rural infrastructures to display food in some areas.

In this context, improving agricultural production for small farmers in the developing countries should be the priority for two reasons: it is the basis to fight rural poverty and it allows a local food supply, less dependant on import. Olivier De Schutter (op. cit.) argues that agroecology is an appropriate way to increase agricultural production, especially in the context of developing countries (Pretty, op. cit). In this vision, at a more global level, less competition from exports from developed countries, mobilising industrial agriculture, could be a solution, particularly in least developed countries, because of the necessity to increase first local production. Even if the pressure on local markets in food insecure countries does not primarily come from Europe but more and more from South America, which is today the

[3] For our purpose, the analysis is led on physical quantities. In monetary terms, EU28 agrifood trade balance is nearly balanced, with a recent net surplus. This surplus is mainly due to wines and quality products, not to commodities.

main low-cost food exporter, the level of food exports from Europe to these countries is not a guarantee of their food security, and might well be the contrary.

One should note that this analysis does not mean that there is no point in thinking of strategic stocks for some commodities to be exported to structural net importers of food in cases of crises. For example, Egypt is a country structurally dependent on food import (self sufficiency in food supply is out of reach given the limited amount of land and the high population). Supplying this country, and others that are on fragile balance, is a responsibility for countries able to export, notably Europe. But the meaning of this responsibility greatly varies if the cereals or commodities exported towards these countries are the ones left after pigs and poultry have been fed, or if this export is combined with a greater sobriety in our food consumption models (human first, pigs and poultry if possible).

The above short discussion tends to demonstrate that the risk of lower yields in Europe associated with a transition to agroecology should not be used to discard such a scenario from the onset using a global perspective. It might indeed have a positive effect, on the contrary on some aspects (less pressure on developing food markets). It is therefore necessary to describe in much more details the intended transition scenario, the way it deals with animal production systems, and the level of imports and exports it makes necessary, in order to address its global impact on food security, and to compare it to how a business as usual scenario would perform, in a world where demand for feed seems to be increasing everywhere, which might end up in creating lots of tensions of global commodities like soybeans if the demand for animal food is not reduced.

But burning questions remain: wouldn't lower yields in Europe radically alter the European food economy and model and its place on global markets?

2.3 To what extent are lower yieds in Europe a concern for Europe itself?

2.3.1 The food availability perspective

In the worst assumption for yields in an AE scenario, is halving those yields for cereals only acceptable from a food supply perspective? There is no simple answer to this and, in fact, answering them would mean designing the still missing agroecological scenario for Europe. It is clear that a strong reduction in yields[4] would mean a radical change in the overall EU production, while livestock consumes around 50% of cereals. Scarcer cereals would mean a strong decrease in livestock production based on grain, which might not be substituted by imported soybean. Reversely, more grass based (extensive) production and more legumes might have beneficial impacts on health and environment, including water resources. This option can positively be envisaged from a diet perspective (the present EU diet is too rich in meat and dairy products, compared to nutritional standards), all the more when considering the 30% wasted food.

The question is the extent of this reduction in terms of livestock consumption. With regards to this issue, Greenpeace proposes the concept of "*Ecological livestock [that] are default*

[4] Let us remind that the half yield in cereals is a lower simplistic assumption as it mainly stands on "the same system without chemical inputs", without mobilising the principles of agroecology.

land users, i.e. they don't monopolise land that is required for other intrinsic elements of the agriculture system and they do not compete with humans for prime arable land. Their role is to exploit the use of biomass not accessible to humans and to make efficient use of agriculture wastes, surpluses and marginal biomass. A "default" livestock diet is one "that provides meat, dairy and other animal products which arise as the integral co-product of an agricultural system dedicated to the provision of sustainable vegetable nourishment" (Fairlie 2010)" (Greenpeace Research Laboratory 2012). This concept provides an analytical framework for representing and computing the relative share of cropland (for direct human consumption) and grassland (for animal products) at EU scale that would be consistent with an AE option. Even without available quantified figures, and with the worst assumptions on yields, it can be assumed that there is sufficient room of manoeuvre and that agroecology would not mean EU crisis in terms of food availability. Just to give an idea, working on order of magnitudes and focusing on cereals only, which is a simplistic approach: the present production is 1.6 t of cereal/person/year in EU28 while 0.3 t would be enough to bring the necessary calories for one person/year. There is room for strategic export outside Europe, even with lower production. The main issue is the relative share of livestock in our diet and in land use.

Beyond the simple availability calculations, envisaging a radical change in the EU diet is not as simple as it may look on paper, notably for socio-economic reasons (less production might mean higher prices, protected markets in a way). Such aspects will be developed in the next pages of the document. But addressing this crucial issue also needs to address the counterfactual one: what would be the consequences of staying on the present "higher yields track" on environment, health, agrifood economy and social issues inside and outside EU28? And firstly, is it technically possible to follow such a path? Yields in Europe have reached a plateau for a decade. If the causes of such stagnation are still discussed, it is reasonable to envisage that a stagnation of yields and a reduction in overall crop availability in Europe is a plausible option in the medium-long term. We will discuss the comparison of the agroecological scenario with the business as usual one in a specific section further in the document, but we should not forget at this stage of discussion on yields the reasons for envisaging such reduced yields: this is not an end it itself, but it is a way to open to alternative ways of farming, while the present ones are causing more and more negative impacts. High yields are not a compulsory assumption for Europe. There are alternatives if animal production systems are considered part of the changes!

2.3.2 The trade balance perspective

Our purpose here is not to make an extensive analysis of the EU trade balance, but to give milestones. The EU agricultural trade net balance has varied around equilibrium (e.g. -5.3 billion euros in 2008 and +7.7 billion euros in 2010).[5] While the overall agricultural production weighted around 355 billion euros in 2010, the net balance represents around 2% of the overall value. This estimate is highly subject to commodity price volatility.[6]

[5] 2008-2010 data. All data in this subsection from *L'agriculture dans l'Union Européenne, informations statistiques et économiques 2011* - DG Agri, 2012.

[6] For example, between 2005 and 2014, the overall agricultural value of EU27 varied between 290 and 370 b€.

This net balance consists of the result of exports/imports flows representing around 80-95 billion euros. Sometimes exports are higher than imports, sometimes it is the other way round. The main exported items are drinks and spirits (15-18 b€), processed food (cereals, fruits and miscellaneous products, 15 b€) dairy products (6-8 b€), meat products (6-7 b€) and cereals (4-6 b€). The main imported commodities are fruits (12-13 b€), coffee and tea (6.5-8 b€), oil seeds and principally soya bean (7.5-9 b€) and oils and fats (6-8 b€).

As a whole, an agroecology transition scenario would mainly impact the export capacity for cereals and dairy-meat products in terms of volumes (Solagro, 2014). While drinks and spirits would have to change their production pattern in such a scenario, there are room of manoeuvre for technical adaptation - organic farming is an increasing reality in the sector. As a whole, the resulting equation (when computing in value and not in volume) is rather complex to solve, because the likely decrease in cereal and livestock production can be fully or partially offset by price variation (less products accessing market would mean higher price for those commodity, all the more that they would have a specific quality on the world market), less imports on soya and overall net consumption (less meat produced, but less meat consumed as well).[7]

In addition, the import/export balance is clearly an important factor for economics, but it is not an end in itself. It makes sense to export what Europe is irreplaceable and good for, with intrinsic added value - namely drinks and spirits - taking into account environmental and social conditions. And this is feasible. Reversely, it makes sense to import coffee or other tropical products that are now part of the European food culture—the level of such imports can be discussed, but they are not bad in nature—under the same environmental and social conditions. But for other products, like the cereal and dairy/meat/poultry ones, the gross value of exports should be assessed against:

- added value—when the production costs of meat are higher than the market prices, what is the meaning of producing for export?
- direct public costs—intervention but also sectorial supports;
- environmental and social costs, including health ones.

Given their economic and environmental importance, some imported products such as soya and palm oil should also be assessed against a sustainability grid, taking into account the fact that Europe can produce substitutes to those commodities and that, in absolute terms, their consumption should be reduced.

Again, our purpose here is not to give the last word on this complex trade issue, but it is at least to ensure a fairer debate between the Business as usual scenario and the AE transition scenario, particularly in order to be much more specific when discussing the too simplistic following argument " *agroecology scenario is nice for the environment, but it would ruin the agrifood trade balance when Europe is desperately looking for export's share*".

[7] Such a shift could have important consequences on the Brasilian or Argentina's trade balance and agriculture, as those two countries heavily rely on soy export. While this goes well beyond the scope of this paper, but could be considered at some points in the debate.

3 The strategic socio-technical content of agroecological transition scenarios

3.1 Clarifying the framing before the content

The previous sub-section was meant to open up the possibility of existence of AE transition scenario for Europe from a global perspective. But it does not give any prescription of the content of such a scenario. This content is highly dependent on the matters of interests that such a scenario wants to address or, on the contrary, keeps unaddressed. Such a framing and scoping exercise, preliminary to scenario analysis, is key to determine what are going to be the "resulting variables"—or the desired outputs—as well as the "explanatory variables"—or driving forces. For example, there are fundamental differences in design and in the potential impacts between a scenario addressing landscape management, which will be based on geographic factors and one addressing food production at EU level, which will be based on structural and agronomic factors. Not that those two issues cannot be addressed jointly and consistently, but the angles of analysis will be different and one can imagine a "landscape scenario" which does not analyse food production issues and vice versa, a "food production" scenario which leaves blank the page of landscape management.

While food and environmental management issues are clearly central in the scenario, they are not the only ones. A comprehensive AE scenario must indeed consider a broader set of issues if it is to follow the principles of agroecology put by (Stassart *et al.,* 2012) [presented in Box 1], which call for a holistic view of the concept. On a technical stand, this approach emphasises linking production (yields, diversity of products) with ecology and the optimisation in the use of local resources. But the approach also puts the development of agroecology in a wider socio-economic, political and territorial perspective, at the scale of the whole food system and its integration in economies and societies.

3.2 A scale issue: the need to upscale and downscale - the meso level

Consistent with a framing of agroecology which focuses first on the local level, many authors conceive the transition to AE as a a bottom-up and grass-root based development process. This approach allows capturing a wide range of matters of interest for civil society groups: local employment, local environmental management (dealing with biodiversity, landscapes, soil conservation, water protection—all issues that can only be properly defined and managed at a local level), local governance and autonomy. This local entry also helps to think of the diversity of agricultural products, seeds, knowledge, institutions and cultures at their very root. There would be a logical contradiction in thinking agroecology from a centralised and top down perspective. If we assume that AE is also supporting multifunctionality, then an AE scenario needs to capture local dimensions.

In addition to this local perspective there are at least two reasons to complement this perspective by an EU level analysis. A first, “technical” one, lies in the fact that the availability dimension of food security issues, that was so crucial in the development of the first CAP, can only be analysed at this level: there is a need to check that the sum of individual AE

experiences will produce enough food and in a balanced way to cover the needs of future EU diets and demands. An AE scenario needs to provide a balanced share of cereals/fruits and vegetables/meat/dairy/drinks (including alcoholic ones) at EU level, and abroad. More broadly, intra European food exchanges are a reality today, and might well be an important feature of a sustainable agroecology transition scenario for the future. In this perspective, the iconic image of self-supplying regions/countries—rather strong in some approaches of AE which tend to promote self sufficiency at local and regional level—can be called a "regional trap" and must be identified and avoided (Clancy et Ruhf, 2010). The assumption of regional self-sufficiency leaves unaddressed the fact that all the regions are not equally populated and/or producing the different kinds of food forming the EU diet. This is all the more true as for political and statistical reasons, self-sufficiency is today mostly thought of and promoted at the level of administrative regions, while is no reason that they coincide with consistent production and consumption basins. In short, some EU regions are exporting some products towards other EU regions, which are importing.[8] This is the case in present and we assume that it should be the case in future, notably because extensive livestock systems are taking and will take place in peripheral regions of Europe, where they constitute an important part of the economy and of land use. For biodiversity and food efficiency reasons—*cf.* the "ecological livestock" or "default livestock" concept above—such regions should play a joint role in food production and biodiversity conservation in the future, which the assumption of self-sufficient regions would not allow.[9] There is thus a need to keep a European perspective in the analysis, all the more that local production basins and community play a major role in the AE scenario.

Besides that, there is also a second reason for taking a European perspective to build an AE scenario. It lies in the fact that as of today, lock-ins are not only technical or commercial but also political, and they are very often coming into play at the European level. All farming and food systems in Europe have to face overall trends in the processing and retailing industry that tend to homogenise the situations experienced locally, and to standardize the characteristics of the food systems. On top of that, the predominance of the first pillar in the CAP has generally rather reinforced a pathway of past transformations that has led to increase the capitalistic intensity and concentration of farming systems, in a trend that was very consistent with and also that was reinforced by the characteristics of the downstream and upstream industries. That is to say, the political and institutional framework at both the EU and national levels drive the agro-food system towards its “reproduction” rather than towards a radical change compatible with an AE project. There is thus a need to both (i) take into account the lock-in effect of the EU wide food system (as we will see in the next section) but also the lock-in of European policies themselves to explain / understand the current situation, (ii) identify possible political levers to bring about changes in those systems and these policies and (iii) clarify the possible political as well as socio-technical pathways through which a given change in the politico-institutional framework could contribute to the achievement of an AE scenario.

[8] Not only densely populated area import some products. Ireland is a net exporter of livestock products and could continue to be such in an AE scenario—at a much lower level—but will import fruits at least. Rural Irish communities deserve the right to eat the oranges they cannot produce.

[9] This discussion does not mean that reducing material flows between regions is not consistent with the AE scenario. The search for spatially balanced production is a central challenge in the design of the scenario.

As a whole, an AE scenario should then articulate both bottom-up and top-down approaches. It cannot fully stand on only one perspective. It is neither the local application of a centralised productive plan, which would allocate production to optimal areas, nor a consistent image magically resulting from the up-scaling of local initiatives. There is a need to take into account vertical (sectors) and horizontal (territories) roles of agroecological systems in order to address economic, social and environmental issues.

Having said that, there is clearly a need for intermediate levels of analysis, between EU28 and local situations capturing multifunctionality. A typology approach, trying to capture the diversity of eco-agrarian situations (soil, climate, structures, social context) while proposing the most synthetic understanding of this diversity is a key methodological challenge. We have proposed such a typology that can contribute to this conceptual task (Poux 2013), but other approaches should be mobilised in order to cross different angles of analysis (see for example the nitrogen assessment showing the differences between EU regions in (Leip 2013)). This "meso" level of analysis—between micro and macro—will have to play the key role between both the upscaling and downscaling analysis, embracing a range of diversity, if not all the diversity.

3.3 Agrarian systems as vertical/horizontal analytical frames

The multifunctional dimension of agroecology implies mobilising analytical frameworks able to represent different dimensions of farming systems in a comprehensive manner.

3.3.1 A "vertical" perspective: a combination of EU agrarian systems to feed European citizens

A relevant entry point from an AE perspective is the issue of fertility, as the closing of nutrient cycles is one of the key characteristic of AE systems. Here comes the issue of the nitrogen cycle which can be naturally closed—without use of synthetic nitrogen—through the mobilisation of nitrogen fixing crops (legumes) in crop rotations and/or fertility transfers from natural pastures, being fertility sources, to cropped areas, through manure. Without going into detail in this document, this perspective calls for a regional framework of analysis in which the key descriptors are the balance between livestock and crops production and the resulting land use in terms of pastures/nitrogen fixing crops/pit crops,[10] allowing fertility management at local scale.[11] The agricultural practices forming the management system of fertility (nutrient and pest control) are central in the analysis and are of course also linked to the issues of yields discussed previously.

If we cross this angle of analysis with the need to have "meso" levels of analysis, the concept of regional agrarian systems can usefully be mobilised as one will have to distinguish between different situations, considering the climate-soil fertility (thus the possible balance between cropped/non cropped area) and other geographical factors of agronomic interest (slopes, mountainous context, climate). Taking into account climate change impacts is necessary in this view. Exchanges or transfers of crop products and animals between

[10] We here mobilise a grid in which we distinguish between land use able to be a source of fertiliser (nutrients), namely permanent pastures and nitrogen fixing crops and the other land use through crops that are net user of nutrients, being thus "pits" as the biomass (e.g. grain, fibers,…) is exported from the agro-ecosystem.

[11] I.e. without envisaging long distance nitrogen fertility transfers, neither under organic nor synthetic forms.

agrarian systems must also be considered (e.g. cereals exports towards livestock areas, transhumance or other livestock transfers).

From the European scale perspective of food balance mentioned above—from exporting agrarian regions to importing consuming ones—the issue is to quantify whether the amount of crops and livestock products will be (a) sufficient in order to meet dietary needs, that might change, as we will discuss further; (b) combined in such a way to allow fertility management. The scenario exercise *Afterres 2050* is a very detailed and good example of such an approach, mobilising in-depth agronomic reasoning for closing a food supply/demand balance while minimising the use of inputs in 2050 at French level (Solagro 2014).

In combination to this "metabolic" analysis of agrarian systems, another useful perspective in order to strengthen the credibility of an AE transition scenario is to analyse their socio-economic and structural dimensions. The combination of production factors, land, capital, labour, biological factors, knowledge in different farming systems should be consistently described accordingly to the functioning of agrarian systems. The needs of different models of productions in terms of workload, capital and machinery must be analysed at the farming system and regional levels. Furthermore, the economic balance of such systems must be understood in broad terms (how is value-added formed? what is the importance of economy of scale? what is the structure of costs and related risks?). All these descriptors, that a regional agrarian system would enable to develop, are key elements necessary to discuss how agroecology would concretely impact regions and local societies.

3.3.2 An "horizontal" perspective: addressing territories and spatialized issues

The above perspective of agrarian system analysis mostly emphasises a "vertical", sectorial approach of land use. It is used in a productivity and production perspective in which the different European agrarian systems are components of a wider agrifood system, and more and more of an energy supply system.

But if we consider the multifunctional dimension of agroecology this vertical analysis needs to be complemented by another one, taking into account territorial issues such as landscape management and the related biodiversity and natural risks items notably. This territorial angle encompasses more qualitative dimensions such as the vitality of rural communities, the cultural value of farming, which is at risk of being considered as secondary—if considered at all—when only focusing on the "vertical" analysis. This horizontal analysis of agrarian systems is more complex and shall mobilise history, human and physical geography; it should envisage the relationships between farmers/rural and urban communities, in which not only the provision of food matters but also resource and landscape management as well as recreation, at least, and other potential cultural or social links. The spatial distribution of jobs becomes a specific issue in this vision, notably justifying the importance given to maintaining farming activities in peripheral regions, which would not really matter in the "vertical" vision. For example, in some regions heavily depending on the export of food commodities (e.g. Ireland for beef, Andalusia for olive), the share of agriculture might be very significant in the absence of alternative sectors for the economy.

These complementary "vertical" and "horizontal" visions relate to the question of the optimal land use, and notably the issue of the share of extensive livestock. For example, *Afterres 2050* (ibid.) is a typical of a scenario mainly built on a "vertical" vision, in which the optimal land use stands on farming systems able to supply food and energy chains. For example, in the 2050 image developed in this scenario, land is supposed to be "freed" from extensive livestock in order to develop energy crops. This assumption is arguable from a food and energy point of view, but puts a burden on biodiversity management—and notably the share of high nature value farmland. An alternative and arguably desirable combination of agrarian systems, addressing horizontal issues in a more balanced way, would be on the contrary to maximise the share of extensive land for livestock production, arguing on the lack of competition with edible food from these areas combined with the provision of multifunctional landscapes. One can argue that these "functions" are more inherently associated with farming than the supply of energy that can be obtained from other sources (wind, solar).

Our purpose, again, is not to present an exhaustive analysis of the subject, nor the optimal or most feasible and desirable AE transition scenario, but to point at (a) how different vertical and horizontal agrarian system analysis perspectives must be combined in order to address the different dimensions of agroecology (b) how the framing of the desirable social "functions" of agroecology can lead to potential conflicts between food production, energy production, landscape, biodiversity, climate change mitigation/adaptation, rural communities,... We assume that the line between extensive and intensive land use is probably one of the most structuring of the debate, but this would only be clarified through the development of different scenarios for the AE transition, illustrating the different political that would have to be made and could result in very different farming and food systems in Europe.

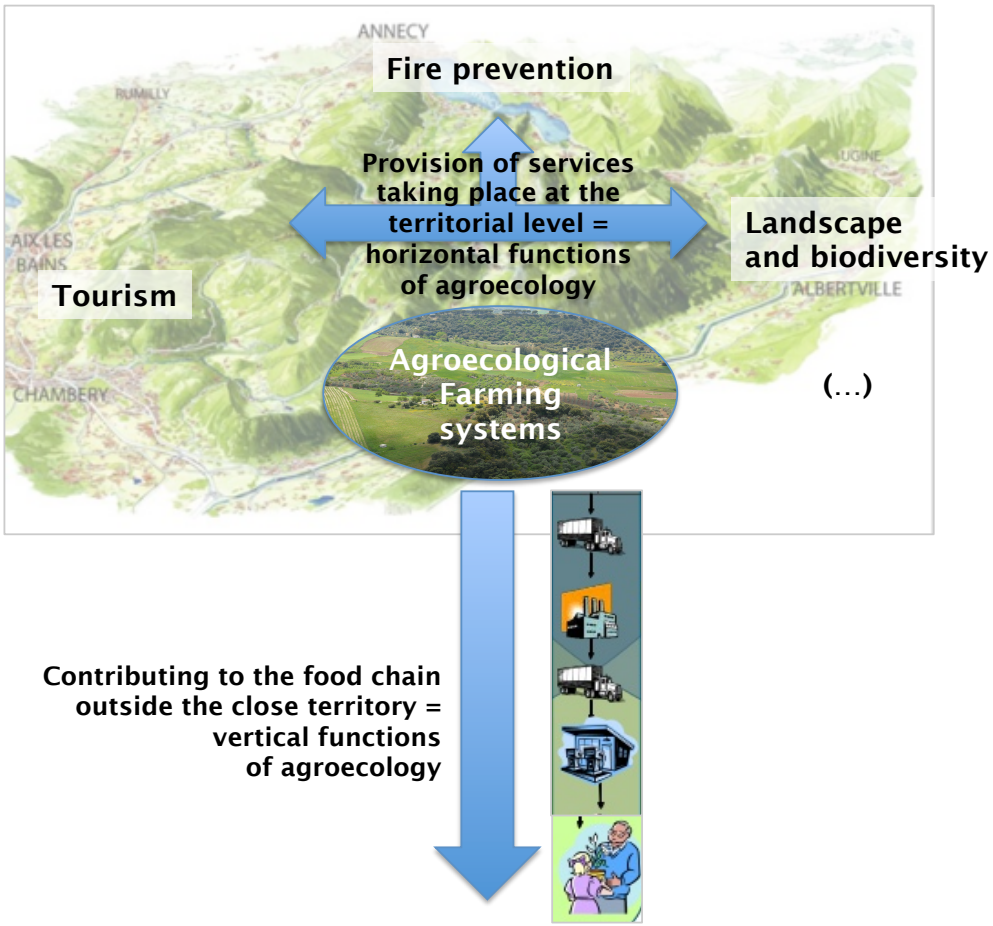


Figure 2. The horizontal and vertical functions of agroecological farming systems - two complementary perspectives

3.4 Changes in diets and food chains

The above discussion between the "vertical" and "horizontal" functions of agrarian systems does not aim at opposing the two perspectives and/or install a hierarchy between them. The agroecology transition project stands on the key assumption that producing a healthier food, in a sustainable way is indeed the best way to reach the "horizontal" functions. When confronting this statement with the recent history of agriculture and food systems, it is clear that change in farming systems and in the food system should be consistently analysed in the AE transition scenario. Unsustainable diets and food systems have produced and driven unsustainable land use at EU and global levels.

it is therefore necessary to address two issues:

1°) what would be the changes in diets, and notably the share of meat/dairy products in EU diets, that could be consistent with a sustainable EU land use (provided that the EU food footprint is reduced to the import of non-substitutable products such as coffee, cocoa, etc. (see above)).

2°) what would be the organisation of the food chain, taking stock of the fact that an AE transition scenario would have to go against the present trend of spatial specialisation and intensification of food supply basins, imposed by the development of agrifood industries.

3.4.1 The diet issue (1): livestock

The issue of diet has been a rising one over the last decade. After the *Livestock's long shadow* publication (Steinfeld 2006), the question of the ecological consequences of animal production and consumption appears as one of the most structuring issue. It has been extensively investigated, although as far as we know no synthetic quantification(s) of a desirable diet(s) do(es) exist for Europe (the Livewell reports for Europe, developed by WWF, give nevertheless interesting indications of what a healthy and more sustainable diet might look like, while maintaining a continuity with current specificities of dietary patterns in national contexts).

If one can assume that all types of AE scenarios will necessarily envisage a radical decrease in meat and dairy consumption (from 10 to 50% percentage to give an order of magnitude)[12], the debate about how far it is necessary/desirable to go can be analysed with the following milestones, structuring potential differences in visions.

A radical and extreme vision will defend a purely vegetarian diet. Animal products are neither necessary from a health and dietary perspective nor desirable for climate and ethic reasons (slaughtering, animal conditions for dairy livestock). This vision is arguable in principle but raises serious concerns: notably cultural and environmental.[13] Fairlie (op.cit., 2010) argues that removing all kind of animal products from our diet would cause problems in land use—maintenance of grazed landscapes—and would not be the most efficient land use as herbivores value land producing biomass that is non edible for humans. As already mentioned above, he calls for a "non-regret" land use (grazing livestock on pastures) which is a type of win-win as it produces food from otherwise useless land as well as valuable landscapes and biodiversity.

Beyond the case of grazed areas, livestock is also a key variable in the use of legumes in cropping systems: while legumes are necessary in closing the fertility cycles in crops systems, their agronomic share goes beyond the requirements from a strict human diet. In brief, agronomically well-designed systems would provide more proteins than humans may eat. From this perspective, some other agroecologically inspired visions, such as *Afterres 2050*, defend a land use pattern based on relatively more intensive livestock systems (increasing the relative share of cropped legumes compared to semi-natural ones), allowing a remaining higher share of land for other purposes (exports, energy crops) and only a limited share of outdoor grazing, because it causes uncontrolled GHG emissions.

The diversity of livestock systems and of consumption patterns should nevertheless prevent from developing a unique optimal system as the only possible vision of the future. The "horizontal" perspective, embedded in local and regional societies, is also applicable in the

[12] In *Afterres 2050* (Solagro, op. cit.), it is estimated that the amount of animal products in the French diet should be halved between 2010 and 2050 to meet dietary recommendations. France is a high consuming country for those livestock products.

[13] The issue of accepting or not the idea of animal slaughtering is of another nature, that is out of the scope of agroecology, that puts animal production in its core principles.

diet analysis. The Irish and the Spanish lambs are not the same and do not meet the same cultural demand; a map of the social value of cheeses could for instance be drawn across Europe, to illustrate the importance of linking dietary changes to territories of origin of the products and also to the places where they are consumed.

Again, our intention is not to give a clear-cut answer to this issue of the desirable share of meat/dairy products in an AE scenario. It is to recall that (a) this share should radically decrease (b) by doing so, it considerably lowers the "needs" for high crop production (c) the balance between the level of livestock production and land use should be carefully analysed, having in mind the multifunctionnality discussion carried above.

3.4.2 The diet issue (2): health, pesticides and antibiotics

Another structuring issue about diet in an AE scenario is the case of pesticides. The debate focuses on a grey area between two clear situations:

- the present one, in which pesticides are a major "silent" threat on human health, and reductions in the use of pesticides seems very difficult in a business as usual scenario, as illustrated by the impossibility to attain the objectives of halving pesticide use in 10 years that was set in France in 2008. Although many uncertainties remain in the precise causal chains, it is more and more plausible that the present use of pesticides has huge health impacts: cancers, Parkinson's disease, endocrine disorders, etc. Pesticides are a major systemic risk for human health, however complex is the analysis when trying to apprehend the detail.
- a potential future situation without pesticides use (taking stock of the persistant effects of some of them), which would radically tackle the systemic risk.

The in-between situation is difficult to characterize, beyond the fact that everyone will converge on the idea that there is a need to reduce the use of pesticides. But up to what degree? The issue is not only to meet the legal standards in the end of the food chain (i.e. in the end foodstuff in the plate). Water contamination is also a (sometimes underestimated) issue that calls for a systemic prevention. In addition, some experts estimate that the standards are far too high if one takes into account the "cocktail effects" of *combined* pesticides. Thus, it seems quite complicated to define a "safe" threshold of pesticides beyond 0.

This human health issue—combined with wider health issues in the environment (how can we accept healthy Humans while fishes and other animals are unhealthy because of pesticides?)—calls for a radical preventive approach that would indeed be a condition enabling the transition to AE to occur. One cannot exclude that the search for the "safe" threshold is out of reach by principle, as crop protection services might also defend the need to develop convincing alternatives to chemical crop protection at the scale of the whole of Europe, but the burden of proof should be reversed (the proof of harmlessness should be strongly justified) and the interest of playing with such a line should also be assessed. At the end, is there such a difference between hardly any pesticides and no pesticides at all? Is it worth being negotiated?

The issue of antibiotics used for animal rearing in an industrial way is another burning issue. The risk of resistant strains "selected" by the undue use of antibiotics is susceptible to cause

a potential major crisis. The model of industrial livestock is also fundamentally questioned by this issue.

3.4.3 Food chains

Food chains have to be considered in two different ways when trying to develop an AE scenario for Europe. First, the current structure of European food chains is undoubtedly one of the key drivers of agricultural change all over Europe. Both the oligopolistic structure of the input segment and the monopsonistic structure of the retail segment have determinant impacts on the possibility for farmers to go for certain technical or commercial options (e.g. Dries, Reardon & Swinnen, 2004 analysing the consequences of the rise of supermarket on the agricultural sector in central Europe).

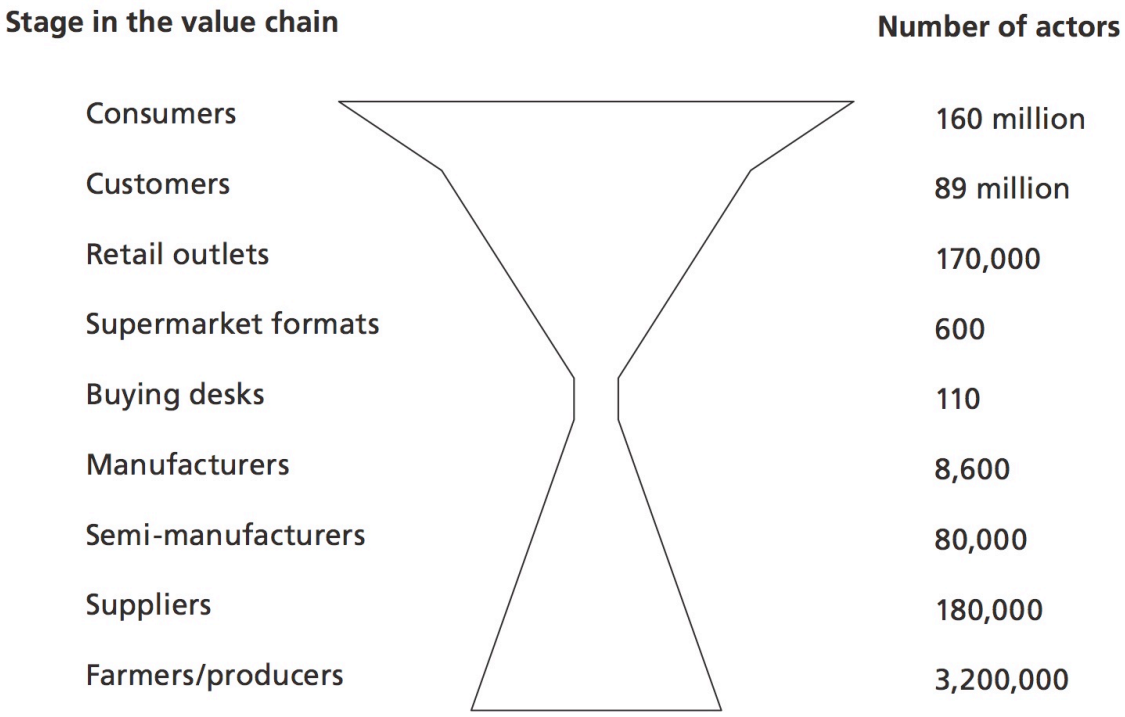


Figure 3. The European food chain funnel (from Grievink, 2002, *in* Humphrey, 2006)

In this perspective, one of the questions that an AE transition scenario needs to address is: to what extent is the structure of current european food chains an obstacle to an AE transition, and how to overcome it?

But the reverse perspective is also to be considered: how do European food chains look like under an AE scenario, considering a new geography and intensity for animal products on the one hand and the absence (or quasi absence) of pesticides on the other hand? Without answering those questions, one can already envision some possible trends (Pimbert, Schmutz et Wright 2014). The most obvious consequences would be less standard products, more volatility in supply and larger supply basins/or smaller collecting points as the spatial density for one given product will be smaller. In brief, economies of scale on standard products will not be the common rule any longer, while economies of scope might justify

alternative diversification strategies. Having these principles in mind, the scenario analysis should be built on the understanding of the food chain, making explicit assumptions about how the food system would be organised and would be evolving over time in the AE transition scenarios, and in particular concerning the following issues:

- The technical organisation of the food chain: flows of commodities between sectors (and notably understanding the share of human food and animal feed flows) and the technical drivers of such flows (energy, transport chain, etc.). Labour intensity of the chain should also be assessed.
- Relationship between upstream suppliers (seeds, fertilisers, pesticides, machinery) and downstream retailers should be analysed—what are the converging and diverging interests?
- The economic organisation of the food chain and the share of value between the different links of the chain, and notably the role of the financial rationale in critical choices (concentration, mutual dependence of agrifood industries and retailers) and the strategy with regards to export/import should be analysed. Economic conditions for a higher share of small and medium enterprises should be specifically analysed.
- With regards to the two above themes, a difference should be considered between "old" EU15 member states—holding the highest share of retailing and processing companies—and "new" EU13 member states, which are seen as new frontiers for developing agro-industries.
- The consumers' perspective should also be crucially analysed, with emphasis on understanding behaviours and consumption patterns (demand for health and nutrition, demand for ready-made meals due to allocation of time decisions…) and mutual relationships between retailers and consumers (reciprocal influences, role of advertising, marketing services, as well as consumers associations).
- Taking into account different food patterns across EU28 must be considered in the analysis, while local farming systems imply to meet the demand of different food cultures. Share of vegetables / starch and animal products and origin of fat should ideally be considered.

3.5 Agroecology: a comprehensive change of socio-technical regime

In the previous paragraphs, we have mainly considered the technical and economic dimensions of an AE image. All these dimensions are interlinked with one another in what transition management specialists have described as a “socio-technical regime”, often self-reinforcing. The current situation of the food system in Europe has been described as a socio-technical lock-in situation, where changes in one dimension of the sociotechnical regime is for the moment made impossible by the stability of the regime on the other dimensions. These different dimensions can be very diverse, from technological innovation, norms and standards, access to financial or symbolic resources, political power, societal values, evaluation criteria and methods… One of the key elements of such a regime that needs to be described in an AE transition scenario concerns the interlinked policies that are at stake. Even if this is not enough to account for the lock-in of the sociotechnical regime

(see also next section to account for innovation systems), a broad set of public policies which need to be considered in building an AE transition scenario:

- agricultural policies (aiming at supporting or changing the pathway of change for farms)
- rural development policies
- environmental policies
- land and land use planning
- energy policies
- food policies (food safety, nutrition, public procurement, among others…)
- market and wider economic policies (trade)
- research and innovation policies

Without detailing any further these different policy domains, which would in practice mean building this key component of an AE transition scenario[14], two key ideas should be put forward.

The first one is that one policy alone cannot make all the changes required for the AE transition to happen. Notably, the "horizontal" and "vertical" functions discussed above call for a combined approach of environmental and rural development policies on the one hand and food and supply chain policies on the other hand. It seems to be challenging to fully integrate environmental criteria such as landscape and biodiversity and improved soil management in a food chain policy alone. And reciprocally, a sum of territorial and environmental policies does not automatically address the specific needs of different food chains. To this regards the research agenda is crucial as agro-ecology is meant to propose technologies that no longer oppose the provision of food and landscape/biodiversity and other environmental services at the farm level. It is part of the discussion whether a holistic approach of agroecology carried out in new research policies would completely resolve the tension between the horizontal/vertical or "only" considerably reduce it. Another condition in this regard is not only the research policy but the innovation policy, and the implementation of changes in the overall agricultural knowledge and innovation system in order to support alternative pathways of change.

The second is the magnitude of change to be envisaged in each of these policy fields. Indeed, if one acknowledges the socio-economic dimensions of agro-ecology, policies (in their wider meaning of structure and rules shared and adopted by a society, in our case the European society) form the matrix of the image: policies are the values, organisations and actions making the image desirable and plausible. It is not possible to describe the policies without the image and reciprocally. While the overall budget needed in an AE transition scenario is not necessarily significantly different than in a conventional/BAU one, policy goals are clearly radically different, in terms of both the beneficiaries and the contributors to the different policies. Changes in goals also entail changes in means—human, financial—and governance. While we acknowledge the fact that policy change—whatever its magnitude—

14

would probably not be sufficient to fully drive an AE scenario, we make the assumption that it represents one of the key drivers able either to maintain the status quo in the sociotechnical regime, against any type of bottom up strategy for change, or on the contrary to trigger change and un-lock the sociotechnical regime. And in our view, making an explicit scenario analysis precisely contributes to intervene on the policy process to help such changes to happen.

The following section discusses those issues of change.

4 Introducing/positioning AE transition scenarios in the socio-political debate

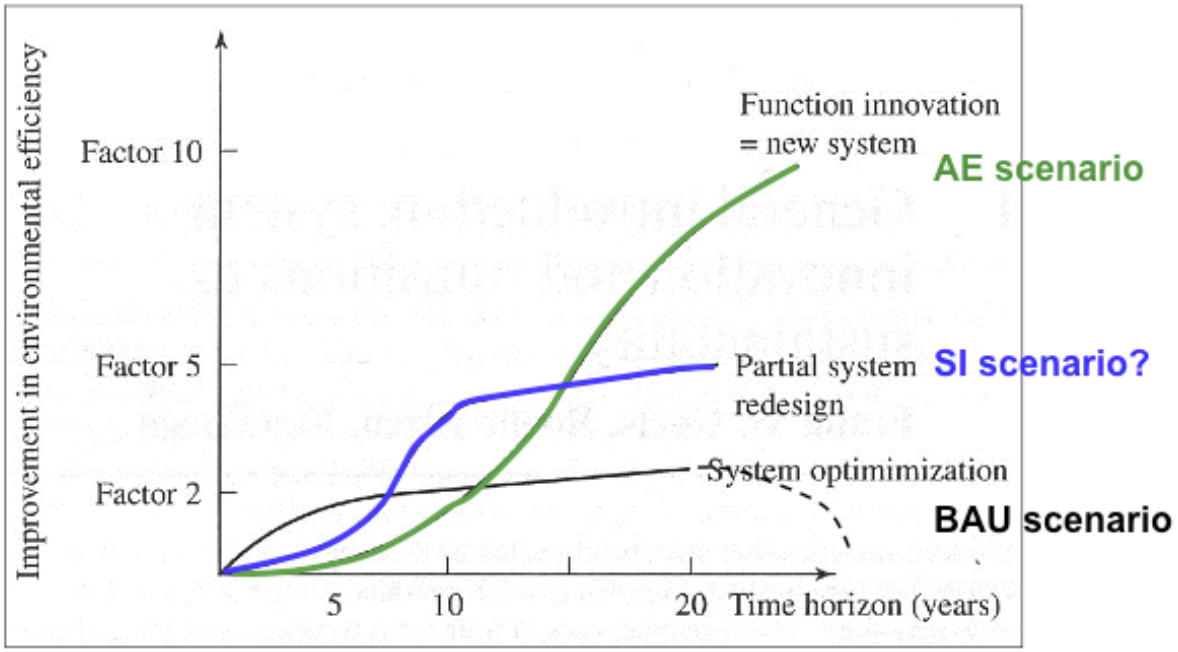
The two previous sections focus on the framing and content of AE transition scenarios, highlighting several principles and conditions necessary to ensure the building of coherent and systemic scenarios that would be fit for a structured debate. However, the potential impact of scenarios does not depend only on their content, but also on their status and the way they are discussed in the debates around the issues they address. Indeed, a foresight exercise on AE transition needs to be considered as an intervention in an already existing "future-oriented debate" (Treyer, 2009) on the future of agro-food systems. The following section aims to give insights on the way AE transition scenarios can fit and gain some weight in those debates on the future of European agro-food systems, given the current state of those debates.

4.1 Dealing with competing narratives

As already outlined in the introduction of this document, debates on the future of agro-food systems are framed by some competing paradigms, which consider different directions for change of agro-food systems. The EU's Standing Committee on Agricultural Research has identified two main narratives supporting underlying paradigms for the future of food systems (SCAR, 2011): a productivity narrative and a sufficiency narrative. The productivity narrative is consistent with the current dominant productivist agro-food regime, arguing for an increase of production in order to feed a growing global population, relying strongly on technical innovation, such as genetic engineering (Vanloqueren & Baret, 2009). Agroecology can be linked with the sufficiency perspective that relies on agro-ecosystems both productive and respectful of ecosystems and on changes in diets and food chains to meet food security, health and environmental challenges. A third paradigm, sustainable intensification, could be seen as an alternative way between the two others, while in fact, despite efforts to lower dependency on non renewable inputs, its priority objective remains an increase in yields (Levidow, Pimbert, & Vanloqueren, 2014).

These three narratives also diverge on the patterns of innovation underlying their main assumptions, which are particularly relevant in a scenario perspective, as those patterns reveal the speed and extent of change considered for each paradigm. Two extreme patterns can be identified in innovation research: system optimisation or system innovation (Barbier & Elzen, 2012). System optimisation relies mainly on technical change and tries to fix existing problems without changing existing systems. On the contrary, system innovation involves a complete redesign of the systems concerned and therefore involves different types of changes (on practices but also on regulations, organisations, infrastructures, markets…). Obviously, the perspective defended in this paper on an European-scale AE transition project implies a system innovation pattern. Figure 4 illustrates the different patterns of innovation and relates them with results in terms of environmental efficiency. We argue that the system optimisation pattern can be associated with a business-as-usual (BAU) scenario (very low redesign of food systems but still a small improvement on environmental efficiency through technical adjustments), and that sustainable intensification can be considered as a partial

system redesign. An AE transition scenario should describe how a thorough system innovation pattern would unfold.



Weterings R. et al. (1997), in Barbier, M., & Elzen, B. (2012)

Figure 4. Different patterns of innovation can be associated with the paradigms underlying the scenarios[15]

This figure also highlights two important issues to position AE transition scenarios in the debates on the future of agro-food systems, that both entail methodological challenges:

- the need to provide comparable assessments of these three types of scenarios and to compare them. It is therefore necessary to identify the proper set of assessment criteria that would enable to discuss along the terms currently present in the debate (for instance, global food security) while also ensuring that the performance criteria that are at the heart of the AE project are also assessed. Indeed, Figure 1 shows the effects of innovation patterns in terms of environmental efficiency, but as we assume that AE scenarios should capture multifunctionality, on what other criteria should scenarios be assessed? And how to assess a combination of criteria?

- the need to show a pathway of change, to highlight the different innovation patterns followed by each scenario, and also to identify some conditions for change.

4.2 Building a different assessment framework

Being able to give an idea of the potential effects of the changes considered in AE scenarios is an important condition for them to be audible in the debate. It starts with assessing the final image in the scenario that should be credible and desirable. However, the issue of assessment is always tricky in foresight exercises, because of the uncertainties (i) on the future state of systems, (ii) on the future salience of assessment criteria, when compared to

[15] The addition of the dotted line suggesting a collapse in the BAU in terms of environmental efficiency is ours.

present. To what extent the matters of today will still matter in the future? The choice of those criteria, and of the assumptions on the future state of systems, has major consequences in terms of results of the scenario analysis. For instance, an agricultural scenario considering by default that soil fertility will remain constant in the long run ignores some current signals on soil quality degradation and possible negative long-term effects of current practices, which would argue for including already now soil quality as a key criterion. Assessing scenarios only in terms of crop production may favour productivist scenarios, while criteria on employment, environmental issues, farm dependency on inputs… are critical for alternative radical scenarios and are indeed the reasons for building such scenarios. Therefore, assessing an AE scenario implies to build a specific assessment grid. In fact, those two activities (building a scenario / an assessment grid) are intrinsically linked. Indeed, scenarios, as they reflect underlying worldviews and values carry (more or less explicitly) an assessment grid. Comparing scenarios is a way to reveal sometimes implicit criteria, and is in itself a form of assessment. In the case of AE transition, building an explicit business-as-usual (BAU) scenario, in order to formalise the project underlying the productivist paradigm, therefore appears as crucial point of comparison, and also a necessary intermediary step to reverse the burden of proof: is the BAU really sustainable, feasible? Under which conditions ? Alternative scenarios are not the only ones that have to be submitted to thorough scrutiny and assessments.

4.2.1 The importance of the business-as-usual scenario

If the productivist paradigm is clearly explicit on some assessment criteria (the amount of food production, competitiveness), mostly quantitative, it leaves aside numerous blind spots such as the number of farms and farmers, key environmental issues such as biodiversity and landscape and climate, health risk management. Therefore, we believe that building a “business-as-usual” scenario, according to the productivist paradigm assumptions, is a key methodological requirement in a foresight exercise on the future of European agriculture. Indeed, formalising this BAU scenario, in the same systemic approach as the one advocated in the previous section of the document, would reveal the positive and negative outcomes of the productivist paradigm. Many studies have argued that business as usual is not an option and therefore that the negative impacts outweigh the positive ones but the effort of formalisation required by building a BAU scenario is a relevant way to check this implicit assumption.

From a methodological point of view, a forecasting approach is the best suited for building the BAU scenario, in order to extend current trends and processes of evolution in the dominant agro-food regime. However, this “extension” is not about drawing future lines based on the mere continuation of past trends. It is more about identifying the changes to come, if the current regulation system that has accompanied those trends is maintained. Therefore, an attentive analysis of communication documents published by organisations that play a key role in this regime, explicitly or implicitly embedding an image for the future of agro-food systems, should be realised to identify their underlying assumptions. For instance, the sustainable intensification paradigm can be considered as a plausible way of evolution of the agro-food regime, already present in the discourse of powerful organisations within this regime. It could provide a relevant basis for a BAU scenario, even if it implies significant changes. Current “weak” signals on the evolution of the state of

agroecosystems should also be integrated into such a BAU scenario, even if their evolution cannot be simply considered as an extension of past trends, as some disruption or tipping points might be reached in a close future. For example, the current trends can put high pressure on soil functioning that could undermine the basis of the conventional or sustainable intensification production systems.

To sum up, formalising a BAU scenario for European agro-food systems is important to show what the possible deadlocks of the dominant regime are. Communicating the analysis of this BAU scenario in the policy debate is fundamental given the space and legitimacy such a scenario continues to have in the future-oriented debate about agrifood systems in Europe. This explicit analysis of the BAU should lead participants to the policy debate to assess to what extent this BAU scenario is feasible and desirable, and highlight who would be the losers and winners if such a worldview prevails in the implementation of changes in the agrifood system.

The BAU scenario is also important in an assessment perspective, as its analysis will reveal the assessment criteria considered and those that are neglected by the dominant regime. It will therefore provide a basis from which to build an assessment framework for an AE transition scenario. Indeed, in order to have a place in the policy debate, an AE transition scenario should be explicit, as much as possible, on the criteria addressed in the BAU scenario, otherwise it will not be audible. That is the reason why we discussed the way AE scenarios have to be credible on the global food security issue. But its added value would lie mostly in making explicit what are the blind spots of the dominant paradigm, through a comparison between an AE transition scenario, taking those “forgotten” issues as important issues on board, and a BAU scenario. We need a holistic comparison of the two competing scenarios: how should it be conducted?

4.2.2 The narrative of the transition pathway as a social assessment

An AE transition scenario represents a radical change of the existing agro-food system. While a “classical” comparative economic analysis could help to compare the AE transition scenario to the other scenarios (cost/benefits, benefits/risks, and even distributive impacts: who wins and who loses in each scenario), it is often insufficient to address all the issues that are relevant for the policy debate. For example, the disappearance of jobs in the agro-chemical industries in an AE transition process must be confronted against the creation of new jobs at farm and retailing levels. Changes of prices/costs reflect new shares in the whole value chain and thus new winners and losers: what is considered as a “cost” today can also be a gain in the future.

However, one needs to take a broader approach to fully describe those changes. It implies to propose another perspective on the goals of the agro-food system as a whole. We propose to complement this economic approach, with an approach based on the very content of each narrative describing the transformation pathway from the current situation to the future state of the agrifood system. The narrative embedded in a scenario indeed expresses a worldview, that is, values and meaning, on which the assessment framework should be designed. Compared to a BAU scenario, an AE transition scenario would encompass a greater variety of dimensions, from technical to social and political issues (see previous section) and new forms of organisations to address the issues faced by the current dominant

agro-food regime (environmental, social and economic current challenges). The consistency, credibility, desirability of the scenario and its capacity to address those challenges is in itself a form of assessment. The challenge is to ground this credibility and desirability in concrete transformations of the agro-food and political systems, not only in general principles (as it is often the case for the productivity narrative), but in revealing how all the types of actors are impacted. This is why the articulation between micro, meso and macro scale changes is particularly important (see previous section), as well as "giving flesh" to AE, as outlined in the introduction.

Another criterion for assessing an AE scenario lies in its feasibility: is the image reachable? A way to address this question is to build a transition pathway from the current situation towards an image of an AE Europe, to show that a credible path can be built.

4.2.3 Addressing the values in the scenarios

The above discussions lead to the issue of values, in the sense that changes in the assessment frameworks mean changes in the main matters of interests of a society, themselves linked to values system. As Tara Garnett points ""[…] *the different narratives that people construct about the food - and specifically the meat - 'problem', explore the values and beliefs that underpin them, and show why we need to pay more attention to these same values and beliefs*" (Garnett 2015).

In our particular case of an AE transition scenario, this general statement questions the necessary value changes in order to make AE transition happen. Indeed, if we assume that the AE scenario breaks with the BAU one, we need to better identify what makes it possible that what is today a social priority (e.g. cheap food, minimum time devoted to cooking) becomes secondary when compared to different emerging demands (e.g. environmental quality or nutrition). In this paper, our intention is not to go in the detail of the complex analysis of (a) the influence of values on the socio-technic system and (b) the processes behind values changes (e.g. the "chicken and egg" discussion about who is influential between policy makers, lay people or opinion-formers or unintended events such as technological changes and/or catastrophes). Nevertheless, as our intention is to sketch a relevant methodological approach for an AE scenario—and the correlative BAU one—we need to emphasize the fact that values analysis is a necessary component of the scenario analysis, as they are part of the sociotechnical regime. There is a need to acknowledge what are the values changes underpinning both the image and the transformation pathway of an AE transition scenario.

4.3 Addressing the difficulties: what transition pathway for AE?

Some scenarios (most of them in fact) focus on describing a future image of a system, but do not propose an explicit representation of the pathway between the present and this image, leaving possible transition pathways implicit. However, in the case of an AE scenario, built on a normative objective and therefore belonging to the backcasting type of scenario analyses, considering seriously transition issues is essential. Firstly, it participates in the robustness and credibility of the final image by showing its feasibility as well as the main issues concerning the credibility of the pathway. On another level, an explicit transformation pathway is also a condition of access to the policy debate on European agriculture: an AE

transition scenario tends to be discarded by the dominant actors of this debate, claiming it is impossible, and there are no pathways to get there. In order to make an AE scenario exist in the debate, showing its feasibility through the rigorous formalisation of a transition pathway is therefore a key condition. It would open the "field of possibilities" by consolidating a scenario that is currently too often a taboo in the future oriented debate about EU agrifood systems. One could note that the actors supporting the agro-food regime and the associated productivity narrative do not provide such an effort of formalisation for the BAU scenario that they support. This is actually because stakeholders supporting AE are less powerful than the dominant actors in the future-oriented and policy debates, which is why they have to provide more efforts in terms of formalisation, as they bear the burden of proof.

However, building transition pathways is far from obvious. It requires identifying the levers of action that could undermine the current dominant regime, and organising them in a coherent temporal sequence. The multi-level perspective, developed for the studies of socio-technical transitions (see Figure 1) is very helpful in this regard, as it offers a heuristic framework to organise the reflexion on transition. A retrospective analysis, and the BAU scenario building, is also valuable in this respect, as they can reveal the mechanisms at play in the evolution of the dominant regime, and the lock-ins explaining its self-reinforcing dynamics.

While it is difficult to give a complete and precise overview of the factors that should be considered to build a coherent transition pathway, three key points can already be highlighted.

The first is that we will need to look "beyond the CAP" to craft an AE transition pathway. While it is clear that the current CAP is not sufficient and is even an obstacle to an AE transition, this document has tried to shed light on the need to consider other policy frameworks, such as health, energy, research and education, trade policies… The case of the research policy fully illustrates this idea. One could think that its contribution to AE development mainly depends on the amount of funding that can be directed towards AE-oriented research programs. However, as highlighted by (Stassart *et al.*, 2012), AE requires participative research programs, with applied results, which do not necessarily meet current standard academic assessment criteria, disadvantaging researchers in a more and more competitive research context. Therefore, the contribution of research to AE transition is much more than a funding issue: it is about at least protecting "research niches" for people involved in AE-oriented projects as a start, but more deeply about a redesign of the whole research and innovation system, with new steering criteria, new processes and partnerships. This redesign should be extended to a deep reform of knowledge transfer organisation and extension services, giving more room to bottom-up processes and local knowledge. These changes could not be complete without a redesign of education, with a reorientation of programs towards AE principles and methods, a development of continuous training, new teaching methods…

This leads us to our second point: the need to adopt a systemic perspective to reflect upon socio-technical regime changes. Common features of the different types of changes is that they imply designing new assessment and steering frameworks, associated with new distributions: a new distribution along the value chain, a new distribution of farmers on

lands as the AE transition can not be reached with exactly the same farmers, a new distribution of activities between urban and rural areas, a new distribution of power relations… Which to sum up means a new distribution of winners and losers between the existing and coming/future actors. However, if new regulatory or organisational frameworks organising those new distribution patterns can already be designed, the main difficulty lies in the processes leading to those new frameworks. The challenge of building a transition pathway is particularly strong for the very first steps: what can be the triggering event(s) able to deviate the agro-food systems from their path dependency? If it is quite convenient to think in terms of crisis (e.g. a safety or sanitary crisis linked to pesticides, trigger of a broad mobilisation, that gains enough power to impose a ban on pesticides), past experiences has shown that crises do not systemically lead to significant changes in socio-technical regimes. The framing of socio-technical transition studies helps to reduce the weight of specific triggering events, showing that transition happens when a conjunction of conditions, that can take place in the landscape, regime or niches, is gathered (see Figure 1). It also emphasises the time frame of transition processes: it usually takes decades for a transition cycle to be complete.

The question of the time frame constitutes our third point. In this respect, the example of agricultural modernisation in the 20th century is particularly enlightening. Indeed, after World War II, it took a generation (30-40 years) to radically change the structure of European farming and food systems. However, the policy model that set the basis for this radical change, that went beyond the agricultural sector as it was embedded in national post-war reconstruction processes, was designed in a short period of time. It took only ten years to go from the Marshall Plan to the Treaty of Rome founding the Common Agricultural Policy. Having this in mind, one can realistically thinks that the time frame of the transition pathway of an AE scenario could similarly be around 40 years. A major obstacle towards such a quick transition is however the existence of strong path-dependencies in current policies. A transition pathway towards an AE image should therefore start with quick policy changes in the ten to fifteen first years. A second lesson to be drawn from the “modernization story” is that change of the socio-technical regime depends of a shift in the priorities of both private and public actions. Agricultural modernisation happened because of a conjunction of interests between private firms, farmers’ organisations and governments. A shift of priorities, towards the ones an AE project can actually address (such as environmental, health, social… issues), requires a new framing of what matters in our worldviews.

5 Conclusion: the spirit before the figures

The reading of the previous pages might cause dizziness when considering the complexity of the challenges that need to be addressed to build the proper scenario analysis. Not only are the themes to apprehend numerous and complex; but the question of how, practically, to describe European and local dynamics, considering ecological, sociological and economical aspects altogether, is a truly challenging one. If one tries to figure out the format of the ideal document, it should be analytic and holistic, detailed and synthetic, narrative and quantified: in brief, short and long. To quote Paul Valéry,[16] the AE transition scenario enterprise has to deal with this intrinsic difficulty: "*what is simple is wrong, what is complicated is useless*".

In identifying this fundamental difficulty, our intention is not to say that there is no point in initiating any AE scenario enterprise. On the contrary, it is to stress the fact that it is more than ever needed. Any work/research contributing to this future oriented vision is welcomed, all the more when considering the risks and the unaddressed issues associated with the continuation of conventional farming and food systems. Our intent in this document has been to propose a balance between the wider view in the understanding of AE scenario challenges and precise socio-technical issues dealing with a European vision of agroecology. By doing so, we want to propose a holistic frame in which different kinds of works can be undertaken. Local/global; based on farming systems, on food chains or on governance; emphasising one particular environmental aspect (e.g. climate and carbon) or maintain a more holistic perspective: one can envisage different entry points. The important issue is to be able to position any work in a wider frame; what, we hope, this document can help for.

Coming back to our initial question—"*how to make an AE transition scenario convincing?*" our conclusion can however be more specific regarding the two different ways—but by no means opposed—one can choose to answer it. The first one is more quantitative, considering that decision makers and stakeholders can only be convinced by figures derived from robust models. Indeed, quantification is needed to check that fundamental laws of nature are obeyed (e.g. the fact that one cannot produce more than what fertility cycles allows); and such checking can mobilise a lot of effort in order to be fully equipped.

The second way of addressing the question is to point to values. The above discussion on transition pathways concludes on the necessary changes in worldviews in order to make another food system happen. To us, this social perspective is prior to any further valuation, notably of socio-economic order. The value of agroecology, even when converted in monetary terms in order to convince the above stakeholders, will firstly depend on its social interest. Quantification is needed to show that an AE scenario is feasible and, in many ways, more efficient that the BAU. In our case, it is useful in order to prove that we are not to eat only vegetables or local grazing beef in the future. But this alone does not allow showing that it is desirable, which is its first condition to happen—and thus making it worth of being quantified. In this perspective, the spirit—i.e. the values—of the scenario must precede the effort of quantification in the logic of the enterprise.

[16] French poet and essayist (1871-1945).

Working on the values might seem unconvincing, as if it seems "too easy" to assume a change in these values to give consistence to the AE transition scenario. But, not only is it not that simple to correctly apprehend what can be the future values of a complex society (avoiding any rosy simplification), it would also reversely be a mistake not to consider changes in values and their consequent effects. History has shown that similar changes took place in the past. The present situation is blurred and bears anxiety in many perspectives, but there is at least one robust conclusion: it is very unlikely that the values and governance systems based on the assumption of an "infinite world", and the related belief in growth, will be able to sustain for long. In a scenario perspective, we are then entitled to elaborate on alternative values. This does not mean that it is enough to tell a utopia to make it real; but it is all the same likely that there is no way for such a utopia to take any consistency if it is not properly designed, discussed and put in the debate on future. How to make it, in which *fora*, is a discussion out of the scope of this document, but it is clearly its final perspective.

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