

**SOCIALLY ACUTE AGRI-ENVIRONMENTAL QUESTIONS AND CHANGES IN
SOCIETY: EDUCATIONAL TRANSITION FOR SOCIETAL TRANSITION VIA
THE AGRO-ECOLOGICAL TRANSITION**

LAURENCE SIMONNEAUX

laurence.simonneaux@educagri.fr | Université de Toulouse, France

JEAN SIMONNEAUX

jean.simonneaux@educagri.fr | Université de Toulouse, France

NADIA CANCIAN

nadia.cancian@educagri.fr | Université de Toulouse, France

ABSTRACT

The debates on the evolution and impact of agriculture on health, on the natural or socioeconomic environment lead us to consider agri-environment issues as socially acute questions (SAQs). The agro-ecological transition towards a more sustainable system, supported by the political authorities, faces a lock-in socio-technical system. Maintaining a teaching of intensive agriculture contributes to this socio-technical lock in. The teaching of socially acute questions can contribute to unlocking to move towards agro-ecological transition, firstly, through innovative educational engineering and participatory learning which constitute niches for innovation and secondly, by entering teaching in a socio-technical landscape within late modernity. Late modernity obliges to distance from the idea of progress or rationality and to consider the political and economic dimensions, uncertainties and risks and the values in agri-environmental issues.

KEY WORDS

SAQ, Agro-ecological transition, Socio-technical regime, Innovation, Late modernity.



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**QSV AGROAMBIENTAIS E TRANSFORMAÇÕES NA SOCIEDADE:
TRANSIÇÃO EDUCACIONAL PARA A TRANSIÇÃO SOCIETAL VIA
TRANSIÇÃO AGROECOLÓGICA**

LAURENCE SIMONNEAUX

laurence.simonneaux@educagri.fr | Université de Toulouse, França

JEAN SIMONNEAUX

jean.simonneaux@educagri.fr | Université de Toulouse, França

NADIA CANCIAN

nadia.cancian@educagri.fr | Université de Toulouse, França

RESUMO

Os debates sobre evolução e os impactos na agricultura sobre a saúde, sobre o ambiente natural ou socioeconómico levaram-nos a considerar as questões agroambientais como uma questão socialmente viva. A transição agroecológica para um sistema mais durável, suportado pelas instâncias políticas, é confrontada com um bloqueio do regime sociotécnico. A manutenção de um ensino de uma agricultura intensiva contribui para este bloqueio sociotécnico. O ensino das questões socialmente vivas podem contribuir para o desbloqueio orientado para a transição agroecológica, por um lado, graças às ingerências didáticas inovadoras e participativas que constituem as inovações de nicho, e por outro lado, inscrevendo o ensino numa paisagem sociotécnica relevante da «modernidade tardia». A modernidade tardia obriga a considerar alguma distância relativamente à ideia de progresso ou de racionalidade e a considerar as dimensões políticas e económicas, as incertezas e os riscos, assim como os valores, nas suas problemáticas agroambientais.

PALAVRAS - CHAVE

QSV, Transição agroecológica, Regime sociotécnico, Inovações, Modernidade tardia.



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LAURENCE SIMONNEAUX

laurence.simonneaux@educagri.fr | Université de Toulouse, France

JEAN SIMONNEAUX

jean.simonneaux@educagri.fr | Université de Toulouse, France

NADIA CANSIAN

nadia.cansian@educagri.fr | Université de Toulouse, France

RÉSUMÉ

Les débats sur l'évolution et les impacts de l'agriculture sur la santé, sur l'environnement naturel ou socio-économique conduisent à considérer les questions agro-environnementales comme une question socialement vive. La transition agroécologique vers un système plus durable, soutenue par les instances politiques, est confrontée à un verrouillage du régime sociotechnique. Le maintien d'un enseignement d'une agriculture intensive contribue à ce verrouillage sociotechnique. L'enseignement des questions socialement vives peut contribuer au déverrouillage pour s'orienter vers la transition agroécologique, d'une part, grâce à des ingénieries didactiques innovantes et participatives qui constituent des innovations de niche, et d'autre part, en inscrivant l'enseignement dans un paysage sociotechnique relevant de la « late modernity ». La late modernity oblige à prendre quelques distances avec l'idée de progrès ou de rationalité et à considérer les dimensions politiques et économiques, les incertitudes et les risques ainsi que les valeurs dans les problématiques agroenvironnementales.

PALAVRAS - CHAVE

QSV , Transition agroécologique , Régime socio-technique , Innovations , *Late modernity*.



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Socially Acute Agri-environmental Questions and Changes in Society: Educational Transition for Societal Transition Via the Agro-Ecological Transition

Laurence Simonneaux / Jean Simonneaux / Nadia Cancian

Agriculture has become considerably intensive since World War II thus increasing both its production and productivity. Intensive farming emerged when food was short and gradually profitability became the dominant focus.

Various negative impacts were denounced in the early stages as is the case with so many Socially Acute Agricultural (environmental or health) Questions but despite the fact that this form of farming was called into question, a socio-technical lock-in stunted the development of alternative agricultural models. It is only recently that French agricultural policy has started trying to generalize a different socio-technical regime, that of agro-ecology which in turn has become a Socially Acute Question. In this paper we analyse how the education system, in particular the teaching of SAQs, contributes either to the lock-in or, on the contrary, to a societal transition within the agricultural, agri-food and environmental fields.

THE THEORY OF TRANSITIONS TO SUSTAINABILITY

Within the framework of the theory of transitions, Geels and Shot (2007) propose a multi-level and structural perspective (MLP) for analysing transitions to sustainability. They define three analytical levels: i) niches (the locus for radical innovations), ii) socio-technical regimes (the locus of established practices and associated rules that stabilise existing systems), and an exogenous socio-technical landscape. Transition is a non-linear process that results in the shift from one socio-technical regime to another under the pressure and the interactions of the other two levels (cf. fig1).

A socio-technical regime is a process consisting of « cognitive routines and shared beliefs, capabilities and competences, lifestyles and user practices, favourable institutional arrangements and regulations, and legally binding contracts » p. 27. In the farming context, the routines are characterised by the actors' adherence to a particular professional genre, in this case the efficient farmer genre, which prevents the emergence of an alternative socio-technical system (Frere, 2014; Lipp, 2014; Vidal & Simonneaux, 2013). These technical, socio-cultural, economic and political systems develop alongside each other in a manner consistent with the equipment, organisation and skills. The socio-technical regimes are characterised by the lock-in mechanisms which restrict innovations and transitions.



According to Geels and Shot (2007), at the micro level, niche innovation is developed within protected spaces (laboratories, demonstration projects, new markets...) by small, often marginal, actor networks. These niches are crucial to the emergence of socio-technical transitions. In the case of the agro-ecological transition, niche innovation does not necessarily occur within protected spaces but rather takes place on innovative farms where a network of actors co-construct new distributed knowledge with or without the collaboration of researchers or agricultural development agents.

Increasing structuration
of activities in local practices

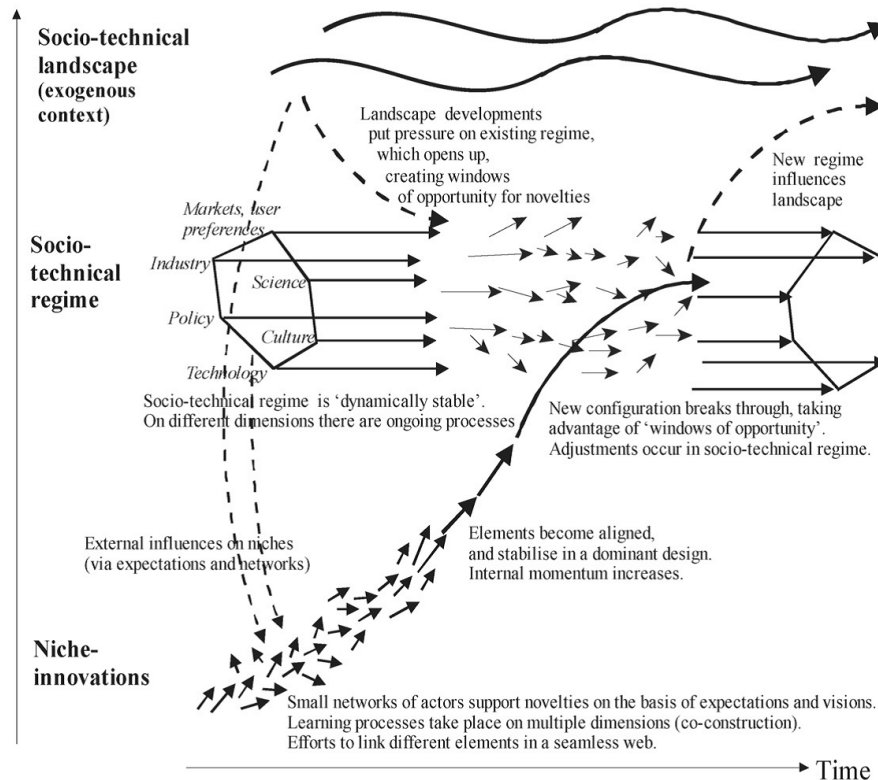


Figure 1. Multi-level perspective on transitions.
[Geels & Shot (2007) adapted from Geels, 2002, p. 1263.]

The socio-technical landscape represents a macro economic, cultural and political context with a high force of inertia. This theory is based on a systemic approach which sheds light on the processes at play over time in the choice of a technological trajectory. Each system is characterised by the tension between technologies, politics, an economic context and society's values which gradually establish a dynamic balance that will guide its development. The interests of each individual stakeholder on the same trajectory are strengthened by the others' choice. This lock-in is thus characterised by "a wide range of stakeholders at all levels of a specific sector and within the institutions concerned, a socio-technical trajectory which "locks-in" over time and prevents certain loopbacks

because of the close coordination between the various components, despite the impediments that may characterise it, and marginalise alternative trajectories” (Lamine et al., 2011, p. 124).

The agro-ecological transition represents a change of socio-technical regime. The socio-technical regime may be unlocked by an incremental diffusion, in the form of transition, of niche innovations which can emerge in farm production systems (Meynard et al., 2013).

By questioning the economic and political rationale we are able to identify and analyse the socio-technical lock-in points of an agro-ecological transition (Baret et al., 2013; Meynard et al. 2013). These authors identify the lock-in mechanisms of socio-technical systems by analysing the network of stakeholders, the norms and the knowledge. Lock-in is a situation in which “a dominant technology prevents the development of alternative trajectories” (Baret et al. 2013, p. 6).

INTENSIVE FARMING: A LOCKED-IN SOCIO-TECHNICAL REGIME

ESTABLISHING A SOCIO-TECHNICAL LOCK-IN

Since World War II, French agricultural development has been based on a mechanised, motorised and “chemical” farming model. This socio-technical system targets, first and foremost, an increase in productivity, an improvement in technical aspects, an intensification and integration of farming into the rest of the economy. Scientific, technical, economic and political means have been mobilised to this purpose.

The paradigm of agricultural modernisation and the paradigm of productivism

The paradigm of productivism refers to a way of organising the economy with production as the primary objective and is based on the large-scale use of (renewable and non-renewable) resources and inputs. From this perspective, in order to be lasting, the system needs sufficient outlets for its products and a significant mastery of farming techniques (Allaire & Boyer, 1995; Lowe, Murdoch, Marsden, Munton & Flynn, 1993).

The notion of a technological paradigm (Dosi, 1982; Gaffard, 1990) was introduced to discuss the processes of technological change. Thus, the technological paradigm represents a model of solutions to selected technical and economic problems. Technological innovation design is regarded as an activity for solving a particular problem. The technological paradigm defines how these innovations emerge and how they develop. Following on from this work, the chemical or pesticides paradigm was put forward to describe the heavy reliance of wine growing systems on chemical inputs including pesticides (Saint-Gès, 2006; Ugaglia, Del’Homme & Filippi, 2011).



In the area of pest control, agronomy gave way to the industrial pesticides industry (international firms and their research and development departments). In this way, crop protection management was modernised and split into different sectors (insect, disease and weed management). Agronomy was applied to the task of intensifying crops by introducing a growing number of techno-scientific innovations based increasingly on the chemical paradigm: using pesticides is both implicit and systematic in crop protection strategies. These orientations led to a massive increase in standardised production. Productivist systems endeavour to reduce production costs resulting in increased labour productivity. To do so they integrated techno-scientific innovations (mechanisation, chemicalisation) via specialisation and intensification, producing a large quantity (maximisation of returns) of standard foodstuffs.

Research then began on genetically modified « pesticide-plants »: firms and groups involved in biotechnology joined forces to find new ways of increasing plant resistance particularly to herbicides. In the 1970s, parallel to the advent of the farm supply and agri-food industries, the development of supermarkets accentuated this process of standardisation. So we shifted to a farming system, regulated to an increasing extent by a market dominated both upstream and downstream by industry and accompanied by the standardisation of food consumption habits. Agricultural policy progressively, detached itself from market management.

However, this intensive system raises questions. When evoke productivist systems, it is effectively a derivative of intensification we are highlighting: the negative externalities (pollution, the uniformity of landscapes, deterioration in the sanitary quality of food due to pesticide residues for example) adversely affect the benefits / risks balance of the intensification process. One can even consider that this type of approach in itself contributes to the lock-in effect inducing an economics-based reasoning. We should not forget that yield and the economic margin were two indicators used to validate the logic of intensification for farmers. Yet they reveal signs of weakness in the conventional intensive systems: on the one hand yields are stagnating and profit margins declining for arable crops amongst others, and on the other hand price volatility means that prices no longer cover production costs within the context of a reduction in direct payments for production. How can we explain that the intensive farming model, based on the use of chemicals in crop protection management, has not yielded to criticism, to the proof that it has detrimental effects even on the very health of farmers and to the evidence of the success of alternatives to pesticides? It is this question we discuss in the next section.

The socio-technical lock-in mechanism

At the origin of a coherent socio-technical lock-in system, five salient features can be identified (Bonneuil & Hochereau, 2008; Lamine et al., 2010 , 2011; Vanloqueren & Barret, 2009) i) the notion of a single model of development supported by the positivist roots of the sciences and an idea that techno-scientific innovation is associated with progress; ii) the “mining” of water, soils and biodiversity considered to be raw materials and the use of certain types of inputs (synthetic fertilizers, pesticides, irrigation, elite varieties,...); iii) the limitation of system complexity iv) the modes of support offered in



Northern countries which have fostered “industrialised” farming; v) a tightened governance of the agricultural profession sharing the vision of an industrialised form of agriculture open to export.

With the advent of post war industrialised farming, a socio-technical system developed locking out the alternatives to synthetic pesticides. In keeping with the global agricultural intensification policy based on maximizing returns, chemical pest control took the upper hand because of its user-friendliness, its efficacy and also its cost-effectiveness. Nevertheless, the underpinnings of this system pushed to its limits were to be progressively discredited. The use of pesticides as an exclusive remedy soon revealed its limits. But the socio-technical system developed coherence over time, reinforcing stakeholders’ interests and resisting criticism in a large number of production systems. This resulted in a trajectory lock-in: alternative solutions to synthetic pesticides, even though they were based on robust evidence of their relevance, fail to impose themselves and are ruled out thus becoming inaccessible (Lamine et al., 2011; Vanloqueren & Baret, 2009). This lock-out still prevents the socio-technical system (the farmers, the farming sectors, the research-development-training framework, politicians and consumers) from reorienting farming practices.

Lock-in is a situation where « a dominant technology prevents the development of alternative trajectories” (Baret et al., 2013, p. 6). The introduction of alternative techniques comes into confrontation with an existing socio-technical organisation. For example, although technical solutions exist, growing associated crops such as durum wheat / leguminous vegetables comes into conflict with the marketing and processing system in the plant sector because the latter is organised by product (Magrini et al., 2013). It’s the same for many innovations (mechanical weeding...). The dominant agricultural advisory council is formatted and often funded by agrochemical firms that lock-in any change in agronomic practices for economic and technical reasons. We cannot change farming practices without considering what happens at the upstream and downstream levels, that is to say, what happens in the farm supply industry, but also in supermarkets and with consumers.

To go beyond the traditional economic approach to intensification, Bonny (2010) points out that other factors are also relevant, such as knowledge, information, ecosystem services. As far as knowledge is concerned, traditional knowledge and local knowledge have been discredited in favour of scientific and technical knowledge (Jas, 2005). The prevalence of the latter can be explained both by the idea of progress, of which they were considered to be the driving force, and also because they were incorporated into goods and services (advice, decision-making tools). Farmers broadened their knowledge of plant needs, of how to recognise pests, and how to use phytosanitary treatments during the course of the crop season. Their knowledge of chemical pest control became more and more sophisticated; knowledge of alternatives to pesticides and ecosystem dynamics was set aside. This drift was reinforced by the type of information made available and accessible to them:

- on the one hand Information on chemical pest control, on phytosanitary products and on their mode of action for target groups and by crop type, were widely distributed by firms and agri-supply technicians;
- on the other hand, information on ecosystem services, especially those which contribute to pest control, was mediocre for arable crops (the action of biological



control agents, interaction processes). Information on alternative systems remained confined to specific networks (i.e. organic systems). Information on environmentally friendly systems did not filter easily into professional circles.

SUPPORT FROM THE EDUCATION SYSTEM

The specificity of the French agricultural education system lies in the fact that it is part of the Ministry of Agriculture and not of the Ministry of Education. Moreover, the agricultural education system has always relayed the Ministry of Agriculture's political and economic choices concerning the development of farming. In the early 1960s and the Pisani Laws, agricultural education was already considered as a lever for the implementation of agricultural policies it being one of the training channels for future farmers and a means of getting them to adhere to the modernisation and intensification of farming. Agricultural education was engaged in and indeed institutionalised, the entire process of an intensive and chemical form of agriculture. The aim of agricultural education was to promote intensification techniques which were also backed by firms, banks and professional organisations. The generalization of the techno-sciences was supported and relayed by schools ensuring that the farmers adhered to the intensive model of the thirty year post war boom.

We can consider that, over a substantial period of time, agricultural education was one of the elements involved in the lock-in of an intensive agricultural system since education helped to reinforce the various (political, scientific, technological, etc.) dimensions of the socio-technical regime as well as the agricultural extension system as a whole.

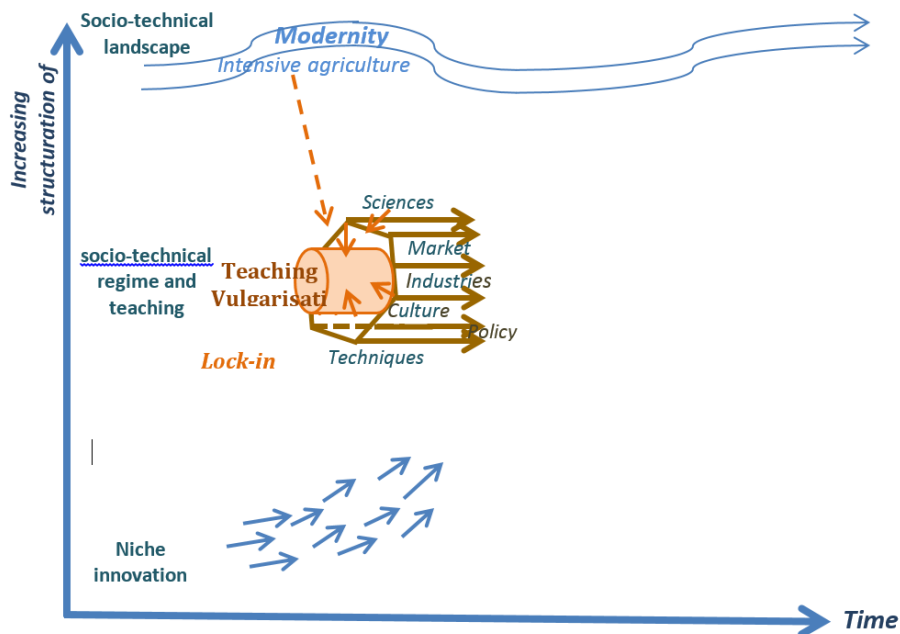


Figure 2. Contribution of agricultural education to the socio-technical regime.

THE AGRO-ECOLOGICAL TRANSITION

FROM THE EMERGENCE OF AGRO-ECOLOGY TO THE AGRO-ECOLOGICAL TRANSITION

The limits of the intensive agricultural system emerged very quickly (impacts on the environment, food quality, farmers' and consumers' health, agricultural employment, and farmers' dependence on agro-chemical firms). In the field of agronomy, new pesticide molecules also revealed their limitations; examples of resistance to pests are multiplying all over the world. However, because financial stakes are so high, the environmental or health risks are played down in the dominant political discourse. Society began to express strong concern, in particular about the increase in pollution, the media coverage of breeding conditions and the emergence of crises such as that of BSE in the early 2000s. The pressure of social demand has given rise to a new kind of institutional activism (European or French, as the case may be) in the defence, for example, of animal welfare or a reduction in the use of pesticides.

It is within this context that the concept of organic farming emerged becoming officially recognised in 1980 with its own set of specifications. The notion of sustainable agriculture followed in the late 1990s parallel with the concept of sustainable development and then more recently in 2014 "producing otherwise" emerged as the political ambition of the Minister of Agriculture and was approved in the French Act for the future of farming as a support for agro-ecological agricultural systems. This legislation introduces the notion that agriculture must make sure that economic, social, and environmental and health performances converge. Furthermore, this project can be assimilated to a form of sustainable agriculture, since organic farming is considered to be one of the forms of agro-ecology.

The evolution, complexity, multidimensionality and variation of the situations in which the concept of agro-ecology is used, make it an SAQ, just like sustainable agriculture or organic farming. Strictu sensu, it would certainly be inaccurate to talk in terms of a weak or strong agro-ecology in the same way we talk about weak or strong sustainability. However, the term agro-ecology is used and viewed from different perspectives. With a view to food and energy sovereignty, the principles put forward in agro-ecology are: the respect for natural resources (biodiversity, ...), social equity, a reduction in the use of inputs, particularly those of non-renewable origin, and the resistance to external economic vagaries (Altieri, 2002; Koohafkan, Altieri & Gimenez, 2011).

Agro-ecology should make it possible to develop both an agro-food system which is autonomous vis-à-vis the exterior and systems which are resilient to external hazards, whether these hazards are natural or socio-economic. Amongst other aspects, agro-ecology corresponds to (i) the notion of organic farming, bio-dynamics or permaculture (ii) conservation agriculture (concerning soils), which advocates no-till, simplified cultivation techniques and establishing vegetation mantles (iii) precision farming, (iv) promoting the expression of ecosystem services such as the production of oxygen from the air, water purification, biomass production and recycling, improvement of biodiversity, reduction of water or nutrient losses, pollinator activity, etc., v) ecologically



intensive or double-green farming, which must be economically efficient, vi) areas of biotechnology such as the production of transgenic plants designed to reduce the use of pesticides.

Depending on our how we look at agro-ecology, it may or may not carry alternative principles in the field of agricultural development or in the socio-economic domain in the face of the consumer society integrating social and ethical dimensions. In this case, agro-ecology corresponds to an emancipatory social movement, but it can also be used as a "green" slogan to defend transgenic agriculture and its financial interests.

In the light of the theoretical framework presented here, the agro-ecological transition may be regarded as a change of socio-technical regime. The socio-technical regime can be unlocked by a gradual spread, in the form of transition, of niche innovations that may emerge in agricultural production systems (Meynard et al., 2013). By questioning the economic and political rationales we are able to identify and analyse the socio-technical lock-in points of an agro-ecological transition revealed through a socio-technical approach (Baret et al., 2013; Meynard et al.). These authors identify the socio-technical lock-in systems by analysing the network of actors, the norms and the knowledge.

CHANGES IN THE AGRICULTURAL EDUCATION SYSTEM

With the changes in European and French agricultural policies beginning in the 1980s and the surge in environmental policies, the agricultural education system gradually integrated the new orientations, particularly those concerning the environment. Integrating, for example, organic farming, sustainable agriculture and finally agro-ecology into educational programmes is a significant aspect of the process of innovation and change: this process was first based on a few individual initiatives, then encouraged on specific or optional courses and finally recognized in the majority of diplomas and on the majority of the farms found in French agricultural high schools (see box below). Although these innovative additions were initially marginal or sometimes optional, significant changes occurred; first in the late 1990s then in the years 2007/2008 with the generalisation of support for sustainable agriculture and development and more recently, the "teaching to produce otherwise" scheme launched in 2014 in line with the new French Act for the future of farming. These changes are noteworthy insofar as they have led to changes in all the curricula, to the introduction of various support measures, to training and to teacher networking (the organic farming network, the education for sustainable development network, etc.) and also to specific actions (carbon footprint assessment, pesticide reduction plan, etc.).

The techno-scientific, social, political and economic choices made by the Ministry of Agriculture when (re)designing the curricula, may occasionally reflect a kind of schizophrenic attitude as a result of the need to accommodate economic interests and a farming system which remains largely intensive. Indeed, parallel to the new agro-ecological rhetoric, the dominant productivist model is still largely prevalent today, especially in the fields of economics and management. This raises the question of the driving force, the magnitude and the nature of techno-scientific and educational change.



THE CONTRIBUTION OF THE TEACHING OF SOCIALLY ACUTE AGRI-ENVIRONMENTAL QUESTIONS TO UNLOCKING

If we place our reflection within the frame of Geels and Shoot's (2007) model of the transition to sustainability, a change in the socio-technical regime occurs only when niche innovations and a new socio-technical landscape are combined. In this paper we propose to demonstrate how the teaching of agro-environmental SAQ (AESAQ) acts as both a niche innovation and as a new socio-technical landscape.

THE NICHE INNOVATIONS OF AESAQ

The teaching of SAQs is based on different forms of didactic engineering. The term "engineering" used here may be similar to or incorporate what some call modalities, didactic systems, or didactic strategies depending on the ambitions and the specificities of the didactic situation. These forms of didactic engineering are specific and are based on a variety of levers and tools. Among these engineering types, research on SAQs has covered:

- debates and role plays (Simonneaux, 2001) developed from the perspective of a well-argued position and which were the first engineering devices often associated with SAQs,
- epistemological disturbances (Simonneaux, Simonneaux & Chouchane, 2014) which operate on the basis of the presentation of scientific data or results considered reliable but contradictory. This introduces an element of doubt by calling into question the opinions and previous knowledge of participants,
- intercultural student exchanges (Morin et al., 2013) that facilitate the emergence of and reflexivity on value systems,
- collaborative writing (Morin, Simonneaux & Simonneaux, 2013) to facilitate interaction at distance,
- meetings between researchers and students (Molinatti, 2011; Panissal, Brossais & Vieu, 2010), which question the representations of how research functions and the role of researchers,
- serious games (Simonneaux, Leboucher & Magne, 2014; Simonneaux, Simonneaux & Vidal, 2010) to motivate students, encourage interactions and simulations,
- problem situations (Simonneaux & Cancian, 2013) to encourage the students to use the process of problematisation,
- the Forum Theater (Bérard & Simonneaux, 2015) to foster co-construction and critical engagement,
- dilemmas (Lipp, 2016) to introduce ethical questions,
- the 'démarche d'enquête' (research under way within the framework of the European PARRISE project).



Although these didactic techniques have been used to tackle different AESAQs and are based on a variety of didactic situations, their implementation is in fact more frequently an association of several modalities (debate + collaborative writing, debate + meeting with researchers ...). But above all, what all these techniques have in common is that they encourage interaction between learners integrating what is "already there" into the process of knowledge construction and develop a critical reflexivity on knowledge, principles and values. These didactic devices actually correspond to niche innovations insofar as they are implemented on the initiative of individuals or by a network of actors and are limited in time and space. All these techniques are combined in the process of innovation and the dynamics of change, to question the different components (economic, cultural, scientific, political ...) of the socio-technical system.

THE SOCIO-TECHNICAL LANDSCAPE OF THE AGRO-ECOLOGICAL TRANSITION IS IN KEEPING WITH LATE MODERNITY

These techniques and SAQ didactics in general, have a specific epistemological framework in common which is new to the school environment and which in fact constitutes a new socio-technical landscape.

The link between the technosciences-companies, farming systems-companies, and their connections with education can be viewed from a socio-historical perspective. This amounts to positioning education within the ternary framework of pre-modernity, modernity and post-modernity. Does the ternary framework of pre-modernity, modernity, postmodernity reflect the gradual emancipation of the individual in society? Pre-modernity is based on tradition and / or religion. Modernity is connected with the ideal developed by the philosophers during the Enlightenment period. Authority and tradition are replaced by reason and science, which will allow progress based on so-called true and objective knowledge. Modern science should allow Man to dominate nature. Capitalism appears as a new mode of production and consumption supported by technological innovation. Modernity goes hand in hand with a growing trend towards individualisation. Education should free the individual through rational knowledge. Overestimated scientific knowledge is transmitted in a top-down process. Scientists, techno-scientists, hold a privileged position; they are the experts who replace the priests of pre-modernity. The link between scientific reasoning and social, moral, ethical reasoning is not questioned. Modernity has favoured the emergence of the socio-technical regime of intensive agriculture, which seems to be the finalised version of man's control over nature.

We observe that the following period is more difficult to define, that authors have proposed different models or "ideal-types" (post-modernity, late-modernity, reflexive modernisation, advanced modernity, second modernity, etc.). For some, modernity is still prevalent and must be defended (Habermas). Others consider that we have entered into a period of post-modernity. The hope set on progress has been shaken up by the dangers associated with the technosciences (nuclear weapons, pollution, health

Table 1

From modernity to late modernity (Table produced with the contribution of Levinson).

	Time	Main ideas	Educational Regime	Socio-technical agricultural regime
Pre-modernity	Antiquity and medieval times	Search for models in nature. A hierarchical view of society	Elitist and scholastic	
Modernity	From 17th to 20th century or even up to today	Global idea of Enlightenment, of rationalist science. Rationality is superior to other ways of thinking. Logical positivism, Karl Popper. Empiricism. Mertonian sense of the important values of science such as the search for truth, objectivity, impartiality, etc.	The laypersons need to know more science to appreciate and support good politics. Necessity to think scientifically. Understand science first, then apply it to society. Social, moral, ethical reasoning is not questioned.	Intensive farming
Late modernity	Since the mid 20th century	Science is considered to be impregnated with power relationships. The link with society is problematic and complex. Science has a role, but is sensitive to economic, political and cultural dynamics. Ideologies, values are recognized. Post-normal science (Funtowicz and Ravetz) and even relativism. Risk Society (Beck)	Contextual and situated Education Complexity and uncertainty taken into account. Socio-scientific Reasoning, moral reasoning SAQ Sustainability education Scientific, economic and political education	Agro-ecological transition

problems). Hope in the future has been replaced by a concern for the future linked to the worries associated with the harmful effects of the capitalist model especially its effects on the environment. The link between the technosciences / agriculture and companies has become problematic and complex. It has been acknowledged that research and its applications, cultural norms, socio-political and economic contexts influence each other. Scepticism, even pessimism, has replaced the optimism of modernity. Relativism has developed alongside the recognition of true and objective knowledge. The traditional image of science has changed. Research is criticised because it has become increasingly affiliated with the financial interests of firms. According to Latour, modernity's arrow of time and its consequent progress is not moving in a straight line. "The old idea of progress, which we have recently abandoned, allowed us to throw caution to the wind; it freed us from all prudence and precaution. The new idea seems to prone caution,



selective choice and careful consideration of the possible outcomes "Latour, Le Monde, August 24, 1996.

Beck refuses the post-modernist approach. He considers that we are in a period of new modernity, but that we remain within the modernity era. He considers that we are shifting from industrial modernity to reflexive modernity. He describes this period as the "risk society". Beck (1986, 2001) suggests that society is preoccupied with the risks related to the technoscientific solutions found to solve to our problems. The production of new scientific knowledge, particularly in the field of agriculture, ultimately addresses the multiple impacts (waste, pollution, new diseases) that have been generated by the technosciences. The negative effects of intensive farming were denounced very early on, but because of the socio-technical lock-in, the alternatives were not considered or even heard about. The agro-ecological transition project is in keeping with reflexive modernity, whilst the emphasis is increasingly placed on the accumulation of the environmental and health risks. Following on from Beck's analysis, in our society, scientific rationality is not sufficient to justify a technoscience; it needs to be accompanied by reflexive criticism of its potential impact. Beck believes that confronted with the risk society, crises and uncertainty, individuals will develop a reflexive modernity, alternative rationalities will come to light and new social movements, what he calls 'subpolitics' will emerge in the interstices of what is held to be the official society. Beck's ideas are sometimes criticised for being strictly theoretical, unsupported by empirical work. Jensen & Blok (2008) put his theory to the test in a case study on how the use of pesticides was perceived in Denmark. Their aim was to study whether or not the Danes lived in what Beck refers to as a risk society. They observed in their study that laypersons had different "risk habitus" (p.755), in particular they were less worried if they were confident that a form of ecological modernity existed guaranteeing control. « While a majority of lay-people (and a minority of counter-experts) may be said to broadly inhabit a 'risk' society, a majority of experts (and a minority of lay-people) rather inhabit an 'ecological modern' one ». They consider that « as a societal narrative, 'risk society' is therefore clearly contested » (Mol & Spaargaren, 1993, p. 773) and by the same also contest Beck. They advocate an alternative paradigm of "ecological modernisation" with green lobbies to secure environmental interests. Ecological progress would therefore prevent the risk society from existing. If this is the case, the techno-economic progress of modernity will take place, under the control of ecological progress.

Giddens (1994) also rejects the notion of post-modernity. He refers to advanced modernity to describe where we are today. For him, no knowledge is definitively stabilised and progress is a myth. According to Therborn (2003) "multiple modernities" coexist, that is to say that people live different lives (traditional, modern, "late" modern) although they share the same society. This is similar to Douglas's (1985) point of view which highlights the cultural impact, judgment and risks. She considers that, people within the same culture, may not all have the same appreciation of risk. Thus, social prejudice influences a person's perception of risk. According to Lipovetsky and Charles (2004), a hypermodern society has emerged and replaced postmodern society because of the anxiety linked to an awareness of the serious problems caused by environmental, socio-economic, or health disorders.

SAQs can be situated within the field of post-normal science (PNS) as defined by Funtowicz and Ravetz (1993) because they are a science closely related to human needs, involving significant uncertainties, problems and values, and requiring urgent decision-



making. According to Ravetz (1997), the question "what if?" justifies taking all available data into consideration, including that which comes from sources outside orthodox research. These authors emphasize that the decision-making process in the field of PNS should include an open dialogue with all parties concerned. They introduce the notion of an "extended peer community". It is important to train students to participate in this "extended peer community". As the word of the experts is not taken as gospel everyone must get involved in the decision-making and act both individually and collectively. "We have no choice but to choose how to be and how to act" (Giddens, 1994, p. 75).

From the point of view of the reflexive modernisation desired by Beck (1986/2001), we have to go beyond « successive attempts to rescue the "underlying rationality" of scientific knowledge » (p. 360) implemented whenever science is faced with failure or adverse effects. In the research cited above, Jensen & Block (2008), referring to Latour (2003), conclude that the value of Beck's work lies in its 'performative' dimension. Indeed, it is with this in mind that we view SAQs with great interest because reflexivity on modernisation is not straightforward. It is necessary to create an awareness of the vital importance of this reflexivity through "educ-action", that is to say an education that focuses on how we function and act collectively and individually. This is in keeping with SAQs which advocate that citizens should remain vigilant, that they should not shirk this responsibility by relying on an ecological governmental form of control. To what extent should this reflexivity be developed? Should education prone exercising reflexivity on "expert knowledge" or allow students to generate their own knowledge on risks? The aim of "educ-action" is to encourage not only the involvement of students and teachers, but also their engagement in individual and collective action, what Beck described as 'sub-political' engagement. In this respect, the SAQ approach defends an education which is humanistic, scientific, political and economic.

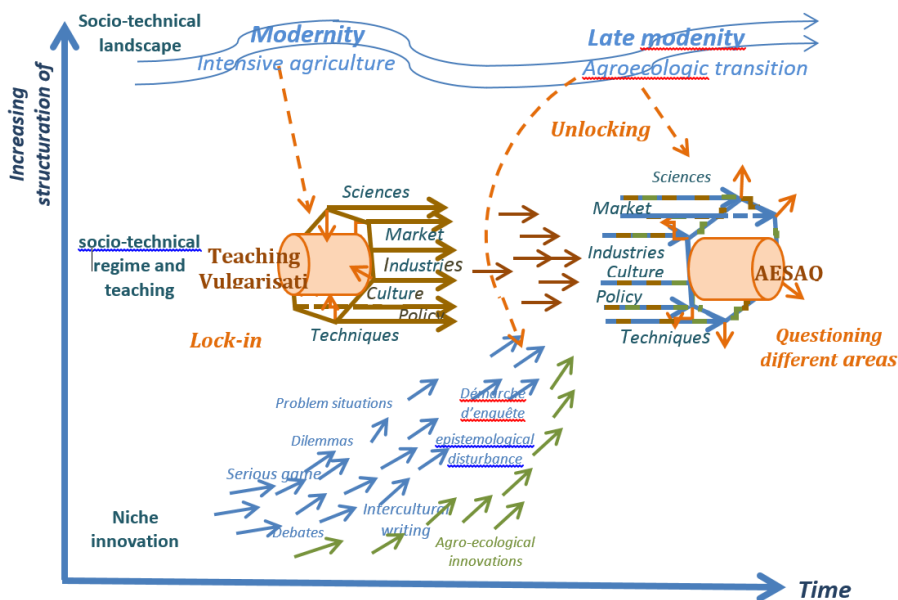


Figure 3. Contribution of SAQ to change the socio-technical regime.



CONCLUSION

Geels and Shot's (2007) model of the transition to sustainability is interesting because it regards change from a global point of view, integrating different levels of analysis (niche, regime, landscape) and different foci, (technical, political, the sciences, the market ...). It seems to us that their model can be extended to the possible and / or desired educational transitions towards increased sustainability concerning agriculture and food.

In terms of SAQs, their model shows how, from a "late modernity" perspective, SAQ didactics are consistent with the agro-ecological transition. Promoting the transition to the "teaching to produce otherwise" model, desired by the ministry in charge of agriculture should lead us to systematically question the different areas of the socio-technical regime. Therefore, the SAQ approach should not only contribute to scientific culture, but should also aim at developing students' political culture by including topics such as risk analysis, the analysis of political and economic governance, decision-making and action. A threefold educational orientation is necessary: a scientific, socio-economic and political "educ-action". SAQ didactics should contribute to the emergence of the critical education which is, in our opinion, essential to the development of emancipated eco-citizens. Curricula should be transformed in accordance with this critical education. We see this as a crucial step in addressing the challenges facing today's society as well as those it will face in the future.

We see many similarities between the SAQ approach and the STEPWISE programme (Science and Technology Education Promoting Wellbeing for Individuals Societies and Environments) in terms of their scientific, social, political and economic education objectives (Bencze, Sperling & Carter, 2012), but we also observe similarities with the humanistic approach to teaching science advocated by Freire. "This (humanist) argument brings to discussion to the need of transforming scientific and technological modern society through human values, preparing the students for a society in which sustainable knowledge and responsible action are the norms. This is not an anti-technology movement, but a movement against a particular model of economic development and technological practice" (Santos & Mortimer, 2002, p. 646). The inclusion of SAQs in education is necessary, but it should integrate not only questions on scientific content, but also "the understanding of environmental risks; the power of domination that the technological system impinges in culture; the difference between human needs and market needs; and the developing of attitudes and values consistent with a sustainable development" (Santos & Mortimer, 2002, p. 647).



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