How to break out the lock-in on crop diversification in France?

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Abstract: Crop diversification is often presented as a way to improve the sustainability of agricultural production systems (reduction in the use of inputs and environmental damage resulting from their excessive use - pesticides, fertilizer, water). However, despite these benefits and various incentive programs, crop diversification is gaining little ground in France.

The objective of this study is to identify: i) the main obstacles to crop diversification at agro-industrial supply chain and farm levels; ii) the levers that can be employed to encourage these stakeholders to integrate greater crop diversity within their production system.

An interdisciplinary analysis framework was used, integrating farming system agronomy, socio-technical transition approach and new institutional economics. This theoretical framework is centred on the "technological lock-in" theory, derived from the innovation economy, and socio-technical transition theory, which proposes potential "break-out" avenues.

This framework is tested on twelve crop diversification cases studies with three in-depth analyses. Our results show that the socio-technical system organized on the basis of dominant crops and the simplification of cropping plans is therefore an obstacle to the development of diversification crops as a result of various closely interlinked processes: (i) genetic progress that is less rapid than for "major crops"; (ii) a lack of crop protection solutions (agrochemicals one but also genetic and agronomic ones); (iii) a shortage of technical references concerning minor crops to explain low yield or quality defects at regional scale; (iv) a competition with "major crops" on the raw material market not only due to price but also accessibility and homogeneity differences (v) the diversity of coordination methods between the different stakeholders in the supply chains Finally, to encourage the development of diversification crops, it would appear to be essential to act simultaneously on three levers supported by public action: (1) Promotion of new market outlets, (2) Coordination of stakeholders and structuration of supply chains and (3) getting R&D, advisory and plant breeding actors involved on a national and regional level to develop innovative technologies and varieties.

Keywords: Crop diversification, lock in, supply chain, minor crops, farming system

Introduction

The post-war agricultural revolution led to a significant intensification of French agriculture in the use of the mechanisation and the inputs accompanied by the progressive specialisation of farms. Furthermore, the parallel structuring of agro-industrial sectors has promoted a high level of regional specialisation of agricultural systems, aiming to be more effective quality control, volumes and supply logistics (Chatelier & Gaigné, 2012). This specialisation of farms and regions has been accompanied by a decrease in the variety of crops, a shortening of crop rotations, with as a consequence the growing efficiency of plant health (chemical) products reducing the detrimental effects of short rotations and monoculture (Schott *et al.*, 2010; Fuzeau *et al.,* 2012).

Several recent studies and expert reports conducted by French National Institute of Agronomic Research (INRA) at the request of the public authorities have highlighted crop diversification – meaning the diversification of the crop types grown within a farm or region as a way to reduce the use of pesticides or pressure on irrigation water (Butault *et al.,* 2010; Amigues *et al.*, 2006). The effect of crop succession on input use has been widely studied by agronomists (Debaecke 1997; Medième *et al.,* 2011). Despite its contribution to the production systems in terms of ecological and economical sustainability (risk-spreading) and its integration in various incentive plans and regulatory frameworks, diversification of crops is growing very slowly. While French agriculture needs to become more sustainable, it also needs to remain competitive within the context of a global market economy. If there is a burgeoning literature studying the economic effects of a broader diffusion of the "integrated production systems" (Jacquet *et al.*, 2011), the analysis of economic benefit that may generate crop diversification is still underinvested. Hence the market outlets of diversification crops are underpinned by agro-industrial strategies, consumer demand and the technological innovations.

In this context this paper aims to answer two questions: i) what are the main obstacles to crop diversification at agro-industrial supply chain and farm level? ii) what are the levers that can be employed by the public and private stakeholders to develop crop diversity in the production system?

The novelty of our paper is to implement a cross-disciplinary analysis framework, combining integrating farming system agronomy, new institutional economics (e.g. Williamsom, 1998; Coase, 2005) and the multi-level approach developed by Geels (e.g. 2011) to understand the transition of the dominant agricultural socio-technical regime toward a more sustainable socio-technical regime of production and consumption. We present the method in section 2 with the analysis framework and the choice of case studies tested. In section 3 we present the results and local discussion with a subpart on obstacles and another one on levers to crop diversification. In section 4 we conclude on the main levers for public action.

Method

The theoretical framework

The term "technological lock-in" is used to describe a situation whereby the technology initially chosen remains the norm, despite the fact that a more efficient technology exists. The original technology has become so standard for society that it appears to be difficult to change it (Arthur, 1994). This "lock-in" effect can concern a technical production, product, norm or paradigm choice. Lock-in of a production system leads to a sorting process between innovations: those that are completely compatible with the reference technology have a chance to develop, while those that differ from either the reference technology of the relationships between the main stakeholders of the supply chains, have less chance/potential to develop. Lock-in does not result from a deliberate strategy on the part of one or another stakeholder, but from self-reinforcement mechanisms created around a technological solution (David, 1985): the initial training of the stakeholders involved, the accumulation of knowledge and complementary technologies, and the links that structure the various stakeholders in a supply chain are built up in line with the standard technology and increase the cost of adopting an alternative technology (Arthur, 1994). In agriculture, situations of lock-in have been analysed for pest control (Cowan & Gunby, 1996; Lamine, 2011), agroecological innovations (Vanloqueren & Baret, 2009) or advisory service (Labarthe, 2012).

According to the socio-technical transition theory (Kemp, 1994; Geels, 2005)), the dominant production system, also called socio-technical system, is generally not totally/completely uniform. Innovation niches may appear creating a space partially isolated from the normal operation of the system and, in particular, from the processes that select markets and technological innovations (Schot, 1998). Operating with different norms and institutional rules, niches allow learning and the construction of economic networks that may support innovation development. But to generate the same self-reinforcement effects than the one developed by the standard socio-technical system, the niches need to be tightly coordinated. That is, a minimum level of coordination between the different stakeholders involved in a niche supply chain is a necessary condition to ensure this development.. New Institutional Economics provides a theoretical framework to analyse the different modes of coordination (or governance structures) between the stakeholders involved in a supply chain (Williamson, 1998; Sykuta and James, 2004; Fares, 2006; Fares *et al.,* 2012)..These different modes of coordination need to be aligned with the specificity of the investments developed by the stakeholders in the supply chains. When this specificity is low, the Market is the most efficient coordination mode to choose. In contrast, when this specificity is very high, only an integrated s

tructure (a unique firm) or a quasi-integrated structure (long term contractual relationships between the stakeholders of the whole supply chain) can secure those very specific investments. When this specificity is intermediate, a hybrid form (intermediate term of contractual relationships with possible spot relationships) is efficient.

Since the transition towards a sustainable agricultural production regime induces a high specificity of the investments undertaken in the innovation niches, our hypothesis is that only an Integrated or a Quasi-Integrated Form can ensure the development of these investments. A second best solution is the Hybrid Form and the worst solution is the Market.

In the subsequent sections, we first analyse the different obstacles to the transition of the whole supply chain, and thus the necessary investments needed to support the development of niches supply chains, using twelve case studies of crop-diversification. Then, we select three case studies, among the twelve, that illustrate our three coordination modes. Our objective is to test the main hypothesis derived from our theoretical framework.

The Case studies

This hypothesis was tested on specific crop diversification cases studies we have chosen to cover a large overview of obstacles and levers. Three main factors drove the choice of the twelve cases. To concentrate on the fields crops systems we avoided the diversifications associated to too obvious obstacles for the farmers or the supply chains as mixed, vegetables or tree cropping. To study mechanisms of sociotechnical lock in, we avoided very new plants without any agronomic or economic references in France as *stevia rebaudiana*, *camelina sativa*, *panicum virgatum*. Finally, to be able to survey farmers and other supply chain stakeholders in different agronomical situations we fixed a minimum area of 2000 ha in France.

The twelve crops studied are: alfalfa, chickpea, faba bean, hemp, linseed and flax, lupin, condiment mustard, pea, sorghum, soybean and sunflower. These crops are all marginal in France in terms of surface area[239] (compared to major annual crops), whereas outlets exist in France for their development (either in place of other crops or in place of imports). In addition, these crops offer a diversity of situations: they differ in terms of their current surface areas and trends (surface areas decreasing, relative expansion or highly fluctuating) and their potential outlets, on a variable number of markets (each variable in terms of size and dynamics). Some of these crops are concerned by large, highly competitive markets for "standard" agricultural raw materials (production of livestock feed, in particular), whereas others have niche markets in the human nutrition sector (condiment mustard, chickpea, soybean, etc.), eco-construction sector (hemp, flax) or animal feed sector (linseed oil). To perform the comparative analysis of those cases we studied scientific, grey and extension literature and expert analysis collected by surveys in the main French Agricultural and Agro-industrial Technical and Scientific Institutes.

Of these twelve cases, three were then selected for in-depth analysis of the way the supply chains operate (pea, hemp and linseed). We selected them because they illustrate the three types of coordination modes we would like to study. The objective of the in-depth analysis was to examine the whole supply chain (from downstream to upstream) in order to understand the influence of its organisational structure on the development of the crop. The analysis focused on all the production processes (at agricultural and agro-industrial level), the coordination between the stakeholders involved (contracts, specifications, market structure) and their capacity to generate enough incentives to adopt the crop at the various links in the chain. For this purpose we completed the general first study of each supply chain by surveys in farms and firms in one or two local supply chains concerned by the three crops (table 1). Semi structured interviews were performed in both firms and farms. In farms we asked for the evolutions of their crop rotation, the reasons why the diversification crops were adopted, abandoned or kept in the farm, and the main adaptations, constraints and difficulties (agronomic and economic ones) farmers had to face. In firms we asked for strategic, logistic and economic organisation of the production, collection and processing of those crops with a particular view on the coordination means (contracts, prices, specifications …).

Table 1: summary of in-depth case studies local surveys

	Hemp		Linseed		Pea	Three
Region of France	West	North-East	West	Centre	Centre	France
Extension services	Chamber of agriculture (CA)	CA	CA	CA	CA	Agricult. Managt. Council
Seed producers	the only one		1		1	INRA
Farmers	6	7	5	6	6	UNIP CETIOM
Disposal company (collector)	1 coop	1 coop	1 coop	1 coop	1 coop	National Group of cooperatives
Processor	Insulation	Paper	Feed & labeled meat		feed	

[239] Less than 100 000 ha, except for sunflower which is a major crop in the south of France, but a marginal crop in the north, and pea (120 000 ha in 2013) which areas have been divided by five for twenty years.

Results

We get two kinds of results. First, we characterize the three main (agronomic) obstacles to the development of crop diversification in the niche supply chains (3.1). Then, we show how the different coordination modes may impact on the efficiency of the niche supply chains of diversification (3.2).

Three main agronomic obstacles to the crop diversification

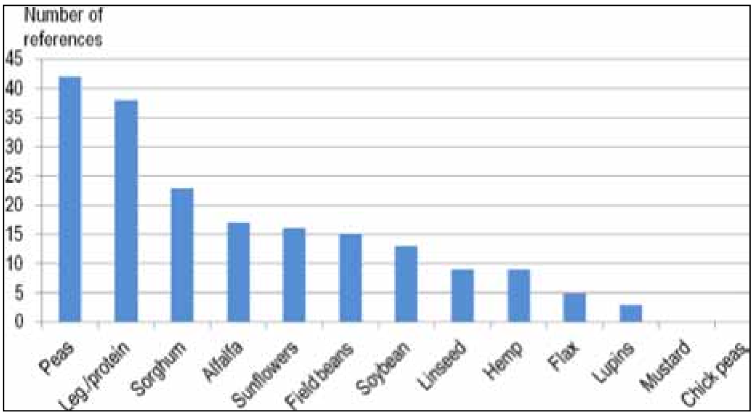
Genetic progress is less rapid than for major crops. One of the obstacles frequently cited by farmers and cooperatives is the limited range of available crop varieties, with varieties not always adapted to the soil and climate conditions, plant health risks and qualities demanded by the market. The markets for these crops are too small to guarantee a return on the substantial investments required for their genetic improvement. However, the creation of varieties does not appear to be uniform between crops: very low for some (Chickpea), it can also remain relatively active for crops in which the surface area is barely more extensive (field peas), or be boosted (lupin, mustard) when the economic actors invest in the development of a market outlet (the CAP regulation on winter cover crops has boosted the seeds production for mustard involving condiment ones).

For a plant breeder, investing in an emerging supply chain is a major risk, particularly if the quality criteria sought have still not been clearly defined (hemp for example). The public authorities undoubtedly have a role to play by helping plant breeders (as was done for peas or lupins in the 1970s and 80s) to invest in a few strategic crops, within the framework of a coordinated European process. There is a strong demand on the part of the stakeholders in the supply chains for a reinvestment of public research in the field of "minor crops" genetics and selection.

A lack of crop protection solutions. Paradoxically, pest control in diversification crops appears to be an obstacle to their development, even though it is one of the reasons for seeking to diversify cropping plans and rotations. The approval of plant health products suitable for diversification crops is impeded by the low economic value represented by these crops for agrochemical companies and by the difficulty the supply chains concern funding their approval. The absence of a chemical solution to address parasite or weed problems is perceived as an additional risk by farmers and therefore constitutes an obstacle to the development of diversification crops. Other biological or agronomic solutions often exist (although not always), but these are very little used, partly, undoubtedly, because they are still little known, but also because they are based on temporal (agronomic principles in terms of the rotation) and spatial (collective management on a regional scale) approaches that are more complex to implement.

A shortage of technical references. The lack of technical references available to farmers represents an obstacle to develop most minor crops (Figure 1). In particular, these deficiencies concern management of the crops in various soil and climate conditions, their effects on the subsequent crop and the causes of poor yields. These shortcomings affect the competitiveness of production. In addition, when a new crop gathers momentum, competition between growing areas can also delay the development and dissemination of these references.

Figure 1: Number of references disseminated on the internet by technical institutes and in the farming press over the period 2009-2012 concerning each of the diversification crops studied



Very often, diversification crops are less well mastered than major crops from a technical point of view or confronted with as yet unresolved problems. This is the case for pest control, as well as for planting and harvesting. Crops wrongly reputed to be undemanding are thus sown in low-potential fields, leading to harvests falling well short of the yields expected. For the majority of diversification crops, given the inadequate knowledge of their physiology, farmers and their advisers do not have the diagnostic capacity to explain a low yield or quality defects of a harvest. The inability to identify the reasons for a failure can further reinforce rejection of the crop, sometimes for several years. The regional adaptation of references requires the performance of agronomic trials and the long-term implementation of networked observations, something that is often too expensive for "small supply chains".

While several of the experts consulted identified the low availability of references concerning the effect of diversification crops on the subsequent crops as an obstacle to their development, a bibliometric analysis of the technical publications (2009-2012) demonstrates the existence of knowledge that is sometimes extensive (pea, alfalfa, linseed), but often incomplete and of highly variable quality depending on the crops. The accounting and management bodies that calculate for the farmers (their customers) average profit margins per crop in their region, do not have the data required to perform calculations over a period of two or several years. While price fluctuations encourage the adoption of a short-term approach to cropping plans, farmers tend to lose sight of the benefits of a rotation-based approach, which would be favourable to diversification.

The supply chain modes of coordination as obstacles/"break out" mechanisms

Competition with "major crops" and the inefficiency of Market. Numerous diversification crops have outlets (real or potential) in the animal nutrition sector. However, the production of compound feeds, based on the constant optimization of the nutritional composition and feed costs, leads to competition between numerous raw materials (grains as well as by-products of human nutrition or agrifuel sectors) and is mainly supplied by "spot" markets. These economic approaches select raw materials on the basis of their nature as "commodities", i.e. the fact that they constitute standardised products with perfectly defined and known characteristics and hence are easily substitutable. The criterion to choose between commodities is therefore primarily based on their price per tonne, but also their accessibility (availability, logistics costs). Despite the high level of substitutability of raw materials, the result of these approaches is a tendency to simplify, favouring the wheat – soybean meal pairing.

Disadvantaged due to their limited production in terms of volume (depending on the year) and geographically dispersed, diversification crops are only able to compete with commodities if they present specific properties such as nutritional ones, known and valued by the market. This is the case for linseed, the seeds of which have a fatty acid composition (high omega 3 content) bringing that of animal products (milk and meat) more into line with current nutritional recommendations. Other crops have beneficial properties (high protein content of lupin seeds, etc.) but still remain little known.

Diversification crops are faced with similar competition in other industrial sectors, particularly the building insulation segment, in which hemp (and flax) fibres compete with glass wool, which is less expensive.

Organisations that collect and store harvested crops, be they brokers or cooperatives, favour the most profitable markets and tend to specialise in a small number of crops in order to reduce their logistics costs. Once again, diversification crops have to compete with dominant crops for transport and silo space, again difficult to make profitable with low volumes.

From Market to Quasi-Integration: the efficiency of coordination modes. The various supply chains illustrate three great types of modes of coordination announced by the literature and so-called as: “market”, “hierarchy” and “hybrid” forms (Ménard 2012). As regards agricultural sector, we can define “market” coordination links as the ones on spot markets (i.e. Commodities markets) with common quality standards. The “hierarchy” form, also called integrated form, refers to strong links between stakeholders, such as financial links (properties rights) or long-term contracts. Such links are necessary to secure specific investment for high quality standards. Between those two forms we can find “hybrid” forms for intermediate investments: some links through the supply chain are spot market links and some other are more integrated ones, depending on the specificity of the standards through the supply chain.

The majority of animal feed supply chains in which diversification crops are used (except for linseed) are characterised by a spot type organisation. Hence the obstacles to the development of peas, faba beans, lupins and sorghum originate from this type of market organisation, which pits them against dominant raw materials (soybean meal, wheat, maize, rapeseed cake, etc.). Consequently, it is difficult to effectively encourage farmers to incorporate these crops in cropping plans and the same is true when it comes to encouraging downstream stakeholders to use them.

A vertical integration-type organisation is found in the case of linseed oil for animal feed and several human nutrition supply chains (condiment mustard, field beans for the Egyptian market, lupins, chick peas). These supply chains are characterised by strong vertical coordination, through the introduction of production contracts and specifications to guarantee traceable production, but also reflecting the need to ensure the specific quality of the raw material. The market and technological risks are shared between the farmer and the other stakeholders in the supply chains.

For the “hybrid” organizations we met (hemp, linen, alfafa), upstream of the supply chains are generally highly vertically integrated (production contracts between collecting and storing agencies and farmers), but the downstream products are subject to competition on a less differentiated market, confronted with other products with similar properties (for example, hemp panels compete against glass wool, linen clothing against cotton clothing, alfalfa pellets against soybean meal, etc.).

Discussion

The network of stakeholders, the innovations and the skill acquisitions that have accompanied the construction of major crop supply chains give them assets to strengthen their competitive position on markets. To give a chance to diversification crops, it would appear to be essential to act simultaneously and in a coordinated manner on three levers: market outlets, coordination of stakeholders and improvement of production techniques and varieties.

To create new outlets for crop diversification, a constant factor revealed in the case studies is the importance of basing the differentiation of products derived from specific qualities that are recognised by the market, such as: nutritional quality (promoted by the *Bleu-Blanc-Coeur* label in the case of linseed); technological quality, often associated with a new patented process (for instance: thermo-extrusion of oil and protein seeds by the industrial firm Valorex, production of lupin protein powder by the cooperative Terrena, extraction of pea starch by the firm Roquette, etc.); environmental quality in the use of the product (hemp in the eco-construction sector); quality related to the source (official labels already present or to be created). Promotion of these qualities by the market brings extra added value liable to encourage and support the production of these diversification crops in the early stage. However, this differentiation can lead to transaction costs (collection, storage, traceability, etc.) that might reduce the economic value, particularly in the presence of a fragmented diversification crop offer across the territory. The supply chains related to these crops must manage the various transaction costs that could affect them at various stages (Charrier *et al.*, 2013): upstream production (choice of management techniques, choice of varieties, etc.), processing (choice of technological processes, choice of additives and ingredients, etc.), marketing (choice of distribution channel, etc.). For a farmer, adopting a new crop requires specific investments (in terms of equipment, as well as training and new knowledge in order to master management techniques). Opting for diversify is a risky strategy and these investments can therefore be considered. To encourage farmers to make these choices, it is essential to guarantee an adequate and stable return on their investments. To achieve this, it is important that the supply chain providing access to the diversification crop market be highly coordinated, for instance on the basis of contracts, to guarantee farmers technical support and an outlet for their product, and securing supplies for processors in the long term. Generally speaking, contracts signed for a period of several years help to encourage the long-term commitment of the various links in the supply chain to the specific production process set up (Aghion *et al.*., 1994 ; Fares, 2006). This approach thus provides greater transparency in terms of production choices, from the upstream to the downstream, ensuring that added value and knowledge are more effectively shared between the various stakeholders. However, to ensure the efficiency of a long term contract-based approach public policy regulations may be useful.

This coordination between the involved stakeholders is crucial. The case of flax perfectly illustrates the risk of a market outlet opening up and then being filled by imports, due to a lack of adequate coordination between production and processing stakeholders (Said Yami Yami, 2008). This coordination requires specifications to guarantee the quality of the agricultural product and its traceability. It must also include the development and dissemination of references, as is demonstrated by the case of peas: it has been shown that it is possible to encourage farmers to produce a crop with a low annual profit margin by making them aware of the benefits of evaluating their cropping system over a period of several years. Inadequate structuring of supply chains and poor coordination between the various upstream and downstream stakeholders appear to represent a major cause of failure for the building of new chains, as could also suggest the analyses of Rastoin and Ghersi (2010).

In most of the case analyses, the impetus for diversification was initiated on a local level, ideal scale for the emergence of coordination between the stakeholders. Sometimes the supply chain remains limited to this scale (chick peas, mustard) and sometimes it is extended to other regions (flax, hemp). Cooperatives play a major role in the construction of these local supply chains, by mobilising farmers and negotiating agreements with downstream stakeholders, opening up market outlets. But the in-depth analysis of the three cases demonstrates the importance of simultaneously mobilising other stakeholders: agricultural R&D, plant breeders, management bodies. What can be done to ensure that the various stakeholders involved in the supply chains (cooperatives, processors, distributors) and in agricultural R&D (research bodies, technical institutes, chambers of agriculture, cooperatives, Civam (French centres that promote agriculture and the rural environment), etc.) and the farmers coordinate their strategies with respect to a diversification crop? Would it be possible to create original partnerships inspired by the industrial clusters developed in other fields (such as aviation or satellite system? The latter, which are supported by long-term public policies (10 years, with assessment midway through the period, for example), could promote the application of technological, agronomic and organisational innovations and capitalisation on the experience (technical and economic) required for the construction and long-term future of new agro-industrial supply chains. To this end, European Innovation Partnerships (EIPs) in the area of "agriculture", as envisaged by the European Commission, could offer the ideal framework. These EIPs aim to develop "local innovation groups", uniting the various stakeholders in an area around local issues, while encouraging capitalisation on knowledge and experience.

Although the impetus for coordination between the various stakeholders often originates at local level, an investment on the part of national research and development bodies, working in a coordinated manner with their European counterparts, is essential, both to create knowledge relative to diversification crops (genetics, ecophysiology, agro-ecology, processing technology, economics of supply chains, etc.) and to provide methodological support to the stakeholders involved in the emerging supply chains (selection methods, support for the construction of cropping systems or industrial processes, for example). Investment in some diversification crops is already significant, as demonstrated by the bibliometric analysis conducted in this study (Meynard *et al.* 2013b). However, several crops do not appear to be the subject of any real Research & Development (R&D) investment at present, for French conditions: lupins, condiment mustard, chick peas, as well as lentils, buckwheat, etc.; others are relatively well known on an agronomic level, but very few basic genetic studies have been conducted: hemp, flax, oats, etc. Setting a national objective of curbing the specialisation process implies questioning the balance of R&D investments between major crops (wheat, maize, oilseed rape, etc.) and minor ones. Reinvestment focusing on the latter needs to be carefully thought out and coordinated on a regional, national and European level.

On a regional level, it would appear to be essential to consolidate and adapt the references relative to productivity, profit margins and the effects of diversification crops on subsequent crops. Although, nationally, the scientific literature often highlights the beneficial effects of diversification crops on subsequent crops (and sometimes quantifies these benefits), the references rarely have a regional focus (Meynard *et al.* 2013a p19). A sustained effort (on the part of R&D, advisory and accounting/management bodies) to disseminate quantified information, concerning the comparative profit margins of rotations diversified to varying degrees, was shown to be essential. This has to be done along with the organisation of support offered to farmers to help them learn about new crops, via the reinforcement of trial and advisory networks as well as innovative experience-sharing between farmers' groups. The production contracts offered to farmers could schedule the incorporation of simple mechanisms to collect indicators suitable for explaining performance variabilities (between fields, between years) and guiding practices. Thus, as stakeholders in the collective innovation process related to the development of the diversification process, farmers would be more inclined to invest in the new supply chain for the long term.

However, tensions were revealed between competing regional trajectories (hemp), which could be detrimental to the setting of consensual selection objectives and the sharing of references. While the development of diversification crops remains the domain of local stakeholders, unco-ordinated on a regional level, it will rapidly reach a ceiling. From the moment that several production areas are formed with different stakeholders, it would appear to be essential to construct a solid structure linking these stakeholders in order, firstly, to initiate dialogue with plant breeders regarding the selection objectives to be favoured and, secondly, to organise exchange and the adaptation of references between areas.

Conclusion

One of the major conclusions to emerge from the study, supported both by the scientific literature (lock-in and transition theories) and the results of the field survey, is that any process towards diversification is necessarily dependent on the simultaneous and organised mobilisation of numerous stakeholders. The theory of socio-technical transitions provides a useful grid both for the agronomist and the economist to diagnose the obstacles to the extension of diversification crops and to propose the coordination of two major categories of levers: (i) develop innovation niches, places for the implementation of learning processes and the construction of new economic networks; (ii) encourage the standard socio-technical system to evolve, to open up new windows of opportunity, through which certain diversification supply chains will be able to grow and expand beyond the niche status, or even to form a hybrid with the standard system, thereby contributing to its evolution, i.e. its transition.

Both levers could be supported by specific means. To encourage the standard socio-technical system to evolve, in order to more effectively integrate diversification crops, the levers are CAP and national regulations on the diversification of crops itself or reduction of input use on one hand and promotion of diversification supply chains via public contracts on the other hand. To support the development of innovation niches the means are rather different. It needs relatively long-term (for example 10-year) partnership mechanisms between supply chain, R&D, advisory and public research actors, plant breeders and local authorities, aimed at constructing diversification supply chains on a local or regional level, with means as promotion of labeling, observatories to monitor minor crops in regions and their role in cropping plans and rotations and sustaining technological and genetic innovation.

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