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► To cite this version:

Marc Barbier, Aurélie Cardona, Marianne Cerf. Organising the generalisation of distributed and decentralised technological innovations: Distributed and decentralised ex novation. : The critical phase of the deinstitutionalisation of pesticide uses in France. EGOS Colloquium 2019, European Group for Organizational Studies (EGOS). DNK., Jul 2019, Edimbourg, United Kingdom. hal-02282291

HAL Id: hal-02282291

<https://hal.science/hal-02282291>

Submitted on 2 Jun 2020

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EGOS 2019 - Call for Papers.

Sub-Theme 34 https://www.egosnet.org/2019_edinburgh/colloquium

Organising the generalisation of distributed and decentralised technological innovations

Distributed and decentralised ex novation.

The critical phase of the deinstitutionalisation of pesticide uses in France

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Abstract

This communication is grounded on previous elaboration of the notion of out-novation (Levain et al., 2015) or ex-novation (Wolff et al., 2007; Martin et al., 2016) after the seminal inputs of reflection about de-institutionalization process (Maguire et Hardy, 2009) and the idea of detachment in innovation process (Goulet & Vinck, 2012). The aim is to tackle the pending issues of sustainability transition where intermediaries have a key role in “pushing and tracking” transformative policy towards the abandonment of established but weak practices within a stable sociotechnical regime. Many sustainability transition paradox and challenges are at stake in the present agri-food system, calling for more research on intermediation and learning processes in a call for generalization of sustainable practices (Elzen et al., 2012 ; Hermans et al. 2013 ; Klerkx et al. 2010).

The role and function of intermediaries in concomitant deinstitutionalisation process of certain practices and out-scaling process of novel practices has not been that much put under empirical investigation and intermediation in transition suffers from a lack of theorizing (Steyart et al., 2016). This communication intends to frame an answer based on the case study of intermediation of pesticide use in France during the last decade (Cerf et al., 2017). It reports about a longitudinal study with participatory momentum inclined to elicit the views, practices and conditions of action of those sustainability transition intermediaries.

Some key findings point the need to open the understanding of the chasm of out-novation. In many circumstances the dynamic of sociotechnical regime and *de facto* governance of transformative process, do not mean only *de novo* creation, nor substitution, but more often a subtle agency and structure of de-framing, re-agencing and including critical mind-sets, new sociotechnical agency and human practices (Turnheim et al., 2015). The chasm of innovation (Bernstein & Singh, 2008) has its counter part in what one could name the chasm of out-novation or ex novation. As a generalisation process relays on the often silent but determinant contributions and actions of innovation brokers, sustainability transitions supposes intermediaries that convey the uptake of a critical zone of out-scaling. This perspective has to be clearly put upper in the agenda of Transition Studies.

Comment citer ce document :

Barbier, M., Cardona, A., Cerf, M. (2019). Organising the generalisation of distributed and decentralised technological innovations: Distributed and decentralised ex novation. . The critical phase of the deinstitutionalisation of pesticide uses in France. Presented at EGOS Colloquium 2019, Edimbourg, GBR (2019-07-04 - 2019-07-06).

1 Introduction

During a decade many scholars and consultants have been looking and producing new ideas and proto-operational framework to address the gap of coordinating agents and structure in process of sustainability transitions. Generating changes in complex sociotechnical systems established on sectorial and incremental innovation regime requests to account firmly for the governance of those systems and processes as they are intimately coupled with science, technology and innovation policy (Borras & Edler, 2014). The mechanism and processes of governing complex system to have them changed is far from a kind of indolent trust in creative destruction. The governance of change being considered as *“the mechanisms by which societal and state actors interact and coordinate to regulate issues of societal concern, define the processes and direction of producing scientific knowledge, technological artefacts and innovation, and shape how these are introduced, absorbed and diffused into society and economy”*. Pillars to study this mechanism are more less shared among scholars: opportunity structures and capable agents, instruments of governing changes, legitimacy and acceptance struggles, and reflectivity and learning processes.

The account of discontinuation in sociotechnical regime is particularly useful to frame a specific type of regime change in the light of the technological substitution pathway described by Geels & Schot (2007: 410). The discontinuation can be thought of as the case when a technology drops off the present sociotechnical regime as the result of (or at least associated with) a specific moment of shock in the broader political-cultural landscape (Stegmaier, et al., 2014). The seminal and programmatic conceptualization of regime destabilisation (Turnheim and Geels, 2012) has established how far the enquiry should go the tackle with the multidimensionality of destabilisation and consequently to frame new insights for transition studies.

Therefore this orientation towards the understanding of the governance of changing STI means also an open-ended conceptualisation of present phasing-out processes. So to say, retrospective accounts and understanding of innovation process as structuring changes (success or failure symmetrically addressed) are by essence finalist: the end of the story is known! As many scholar of transition studies, the intellectual challenge stand between finalism and wishful thinking and it is particularly subtle to find and established. Within the Studies tradition such a purpose suppose empirical investigations on agents and structures of destabilisation that are purposefully looking for novel sociotechnical arrangement, institutional features, policy mix and other sophisticated agencies to phase out and still carrying the idea of achieving sustainable goals differently. Ex-novation, out-novation are candidate concepts to carry this idea of coupling the study of destabilisation phenomenon with that of novel innovative sustainable arrangements.

In light with this reflection, this communication is grounded on previous elaboration of the notion of out-novation (Levain et al., 2015) and earlier (but lately discovered) conceptualization of ex-novation (Wolff et al., 2007; Martin et al., 2016). Our aim is to tackle the pending issues of sustainability transition where intermediaries have a key role in “pushing and tracking” transformative policy towards the abandonment of established but wicked practices within hyper-stable sociotechnical regime such as the sectorial system of food, feed, fibre and fuel agricultural production. Many sustainability transition paradox and challenges are at stake in the present agri-food system, calling for more research on intermediation and learning processes in a call for generalization of sustainable practices (Elzen et al., 2012 ; Hermans et al. 2013 ; Klerkx et al. 2010).

After the seminal inputs of de-institutionalization thinking (Maguire et Hardy, 2009) and the idea of detachment in innovation process (Goulet & Vinck, 2012), we think it is time to open the studies of the role and function of intermediary activities in concomitant deinstitutionalisation process of certain practices and out-scaling process of novel practices. This purpose requests the mutual and

inter-disciplinary thinking of STS, Activity theory and innovation studies (Barbier et Elzen, 2012), and particular attention to learning process and reflectivity in the governance of change to achieve sustainable farming systems (Elzen et al., 2012). Of course the role of brokering, scientific mediation and other spinning actors have been pointed and studied to explained how innovation process work in the innovation knowledge infrastructure (van Lente et al., 2003; Klerkx and Leeuwis, 2008). But intermediation as an activity has not been that much put under empirical investigation and intermediation in transition suffers from a lack of theorizing (Klerkx et al., 2012; Steyeart et al., 2016). This communication intends to frame an answer based on the case study of intermediation of pesticide use in France during the last decade (Cerf et al., 2017). We reports about a longitudinal study with participatory momentum inclined to elicitate the views, practices and conditions of action of those sustainability transition intermediaries.

2 Broadening the scope of ex novation

2.1 Ex novation as an outcome of policy mix thinking

Berkhout et al. (2004) had already pointed the “ *need to be more explicit and specific about the relationships between contexts and processes of change in socio-technical regimes*” and proposed a “*schematic distinction based on the degree of coordination of regime change between actors, networks and institutions, and the locus of resources required to respond to selection pressures acting on the regime*”. Their framework established four different contexts for regime change, distinguishing between ‘*purposive transitions*’ (deliberate change caused by outside actors), ‘*endogenous renewal*’ (deliberate change fostered by regime members), ‘*re-orientation of trajectories*’ (spontaneous change resulting from relationships and dynamics within a regime) and ‘*emergent transformations*’ (the unintended consequence of changes wrought outside prevailing regimes).

The type of transformations like pesticide use reduction precisely articulates transformative policy in sectorial policy and research & extension policy with complex processes of collective action: from grass-root radical changes to greening lock-in sophisticate resistance to this reduction goal. As they put it to define purposive transitions (op.cit. p.85): “*While emergent transitions have an autonomous quality, we seek to distinguish these from purposive transitions which have in some senses been intended and pursued to reflect the expectations of a broad and effective set of interests, largely located outside the regimes in question*”. It appears that this dynamic of regime change suppose a certain boundary destabilisation: incumbent interests within the regime to be contrasted by many innovative attempt to frame pesticide free pesticides and external interests outside the regime based on sustainable vision of agriculture also contrasted between the “*feed-the-world*” industrial promise and the “*local-fair-healthy*” agroecological or organic promises. Clearly, phasing out pesticide use is not that simple, and corresponds to many types of changes at different layers of articulating policy, market and research & extension. But who articulates what? Here stand many types of intermediation agents and structure.

This challenge is particularly isomorphic to the expected shift in energy transition, where the notion of ex novation has been put on the agenda of policy mix thinking (Kivimma et al., 2016; Rogge and Johnstone, 2017; Rosenow et al., 2016; David, 2017) to promote deliberative policy and politics that target the end of fossil-based technological trajectories. This attention to ex novation results from previous investigations about “*green economy*” from an ecological point of view (Wolff et al., 2007; Spangenberg, 2015) and from embarked subpolitics in promoting the phasing-out at the heart of

policy mix design (David et al., 2015; Arnold et al., 2015; Heyen et al., 2017; Heyen, 2017). The claims and recommendations are of course by construction of political nature, and suppose that phasing out results from the organized and political disappearance of infrastructures. Martin (2017) defines explicitly exnovation this way as *“a process in which a given technology is currently no longer used because its physical infrastructure has been deliberately removed; this distinguishes exnovation from concepts of discontinued use”*.

This focus on technology policy regimes issues stimulating and sophisticated design principles of policy mix, insisting on the coherence of policy goal, consistency of instruments bundles and the congruence of instruments and goals (Martin, 2017:). These propositions of course echoes previous work about the art of policymaking and more specially about innovation policy instruments (Borras et Edquist, 2013) and the pragmatic idea that: *“the design and implementation of systemic innovation policy depends on the extent to which innovation policy instruments are defined, customized and combined into instrument mixes that address the ‘problems’ related to the activities of the system “* (Op.cit., 1519).

2.2 Looking at ex novation from the intermediation lenses

This perspective of governing by and through instrument design deserves certainly a lot of attention, but many empirical works and critical reflection about the practices and structural constraints of public action tend to be still sceptical about a pure political definition of ex novation. We might even claim that there is an excessive belief in the efficiency of policy mix thanks and because of their systemic nature. But how far principles of collective action can be effective and how does it work that policy instruments enact practices of change in sectorial lock-in? How can it work when the policy makers and decentralized policy actors who claim for ex novation are the same one as those who claimed for what the legacy and efficiency of the technological fix that should be phased-out? The possibility of such a shift is based on an extremely strong confidence in the fact that the practices of changes have only a political agency. Could this policy mix imaginary face some unpleasantness if we do not study how ex novation work in practices?

Intermediation has been studied in a variety of scholar fields and under a variety of contexts of innovation studies (Howells, 2006). Intermediation recovers a large variety of terms in used to name individuals or organizations involved in innovation processes such as ‘innovation intermediaries’, ‘knowledge or innovation brokers’; ‘systemic intermediaries’ (and ‘boundary spanners’ in education, public management and in business organization management (Steyeaert et al. 2014). The use of intermediation has also to do with the theoretical foundation of this notion in the sociology of science and technology with the notion of boundary object (Star and Griesemer, 1989) or in anthropology of development with the idea of “development brokers” (Olivier de Sardan, 1995) or knowledge brokers in medicine (Ward, House and Hamer, 1997).

As we have portrayed them (Steyeaert et al., 2014): “In most of these studies, intermediaries are commonly portrayed as ‘match-makers’, as entities that somehow align two (or more) entities and bring them into contact. By naming the intermediaries, scholars mainly try to identify the new actors at the boundary of organizations and the ways they to act as a third party in one-to-one or many-to-many relationships”. Authors such as Bussant and Rush (1995), Howell (2006), Guston (1999) or Klerkx and Leeuwis (2009) proposed to characterize the functions, which intermediaries fulfil within innovation systems, in which brokering mainly concerns business information or technological issues. But how does this enable to address intermediation at play in sustainability transitions, where what could be innovative is ill-defined and contested? More over what could the practices, the meaning and the function of intermediating ex novation?

Based on a previous cross-cutting analysis of various case studies we have proposed the following definition of the functions of intermediation, introducing a distinction between intermediation that foster collective action efficiency and functions that to support collective action dynamics (sse table 1a and 1b, taken from Steyaert, Barbier et el. op.cit.).

Table 1a: Functions of intermediation to foster collective action efficiency

<i>Intermediary roles in collective action efficiency</i>	<i>Outputs</i>
Boundary work around problem definition	Stabilized agreements
Problem finding and problem solving	Permanent iteration between goals and means of action
Co-generation of knowledge	Reduced uncertainties and explored controversies
Networking of human and cognitive resources	Enhancement of collective action capabilities
Networking of various deliberative arenas	Out-scaled and up-scaled outcomes of action

Table 1b: Functions of intermediation to support collective action dynamics

<i>Intermediary roles in collective action functioning</i>	<i>Outputs</i>
Convince people through pedagogy	Enrolment of stakeholders and ownership of action
Reduce fears, resistances and contestations and contain overwhelming processes	Space and time for deliberation
Build new interpretative frames	Transformation of identities, legitimacies and social asymmetries. Changes in values and systems of interest
Stimulate individual and collective reflexive consciousness	Build a shared understanding of the situation

Sustainability transitions “are goal-oriented or purposive” (Smith & al., 2005), i.e. strongly related to political or social expectations in terms of management performance and measurable results and effects. In regard to “wicked problem”, this constitutes a kind of “environmental paradox”: the generic characteristics of pesticide reduction problems make these expectations partly unachievable). Following such a perspective, we argue that intermediary activities may not be separated from the various conceptions people hold on action and knowledge and, as a consequence, on the various expectations they have in linking knowledge to action.

In our perspective (Barbier and Elzen, 2012; Steyaert, Barbier et al., 2014), sustainability transitions do not only rely on innovations supporting economic viability of knowledge based bio-economic firms, such transitions also rely on the exploration of new governance principles, institutional arrangements at both local and global levels to cope with issues that heavily concern citizens at their place of living, such as maintaining or restoring water quality for human consumption and aquatic life, avoiding biodiversity erosion, improving food security and sovereignty, increasing social equity etc. Such issues imply both complexity and uncertainty, leading to tackle with “wicked problems” (Batie, 2008; Levin et al., 2012).

They imply socio-political choices in which intermediaries can hardly claim their neutrality and have thus to express their engagement. Therefore intermediation cannot be described as only transferring knowledge and objects in a given web of interests for technological innovation, or playing a strict functional role within the social web of innovation to fulfil knowledge gaps of system failures. It also performs specific functions which are related to the kind of problems at stake, and which support the dynamic at work between problem finding, goals and means setting within a high changing world.

Considering transformational change, the future remains unpredictable and mostly unknown. In other words, intermediation is not supposed to produce the means to reach some predefined goals, but also to foster interactive processes in which goals and means definition are at the core of public or collective action and in which, in doing so, cultural changes are allowed to occur.

3 Governing pesticide use reduction

3.1 The European landscape¹

Linked to crop protection strategies, the issues of pesticides has been tackled by “regulatory science”, an emerging strand of studies centred on regulatory processes and the forms of knowledge involved (Irwin and Rothstein, 2003). These authors highlight the dominantly private institutional character of agrochemical regulatory science based on companies’ product testing routines but also on their involvement in expert committees, leaving wider public groups such as NGOs with very limited opportunities of participation – at least, national NGOs, as opposed to European-wide NGOs such as Greenpeace and PAN (Hood et al., 2001). Such approaches have been applied in comparative studies, confirming a common idea that Scandinavian regulatory standards are stricter (Rothstein et al., 1999). These works analyse the positions of the different categories of “experts” and lay-people and notice an evolution towards much more cooperative relations between the main stakeholders (i.e. agriculture, industry, NGOs) than before, which reflects a more general process of “ecological modernisation”, within the historical background of the major shift in crop protection that the phasing out of the DDT illustrate (Maguire & Hardy, 2019; Levain et al., 2015).

In this historical background the adoption of the European “Pesticide Package” in 2009 has triggered a long process of designing and implementing dedicated National Plan to reduce pesticide uses. During the 2010’s, the structuration of public action was intense while at the same time claims and political contentions if not trials against manufacturers spurred from the mobilisation of NGOs. Public debate about pesticide types of uses has become very consistent in relation to diverse sustainable challenges (climate change, biodiversity loss, sustainable food system). The question of the relation of pesticide with cancer has turned into a sanitary public problem, with contentions, controversies and trials. Therefore the pesticide phasing out appears to be high in the agenda and it is particularly the case in France, where the use of pesticide per hectare is on the top list of European countries.

Other works have shown how the agricultural industry strategically repositions itself over the last decades by changing its messages in response to changes in the socio-cultural setting and in public concerns (Kroma & Flora, 2003). Economists but also marketing science and sociology of consumption have studied crop protection issues as they are supposed to be taken into account by consumers, that is, in terms of risk perception or labels and quality. In a very different perspective rural sociologists have emphasized the producers/consumers links and broader visions of the impact of crop protection strategies at the level of the food chain. The interaction between farmers and consumers and the chances of negotiation around farming practices have been studied in the case of short circuits like local markets or box-schemes and has recently gain an extraordinary success. Biological and agricultural scientists contributed to this debate by suggesting approaches that would go beyond a restricted agronomic vision limited to the field or at best to the farm, and encompass natural phenomena such as climate changes and social aspects linked to food consumption. The interactions between social and agricultural sciences in participatory projects have also led to inform the question of the evaluation of farms sustainability.

But the sustainable use of pesticide is not that much governed directly by research and extension systems, matters and issues, and indirectly strongly affected by the late trend of “privatisation” of

¹ This section is taken from a report we produced within an European NoE called ENDURE, see Barbier and Haynes (2010).

extension knowledge. This might be explained by the fact that the level of lock-in of the crop protection systems is rather governed by technological trajectories of farming practices and by business plan of farming model (cost structure prevails against exploration).

The emergence and implementation of a public policy instrument designed to promote significant changes in crop protection practices through the reduction of pesticide uses follow previous national regulation to limit the toxicity of pesticide or to protect certain catchment area. The instrument stems from a European regulation defining a general framework and obligations pertaining to a reduction of the use of phyto-sanitary products and to change crop protection strategies. Of course, one can notice much difference between the implementation of National Action Plans, basically related to the governance structure of agriculture, but also to the existence and the intensity of consumers' movement and NGOs mobilisation and alignments. During the 2000's and early 2010's, with some exception (Denmark and Sweden notably), national situations had shown a lack of repositioning the agricultural research and extension systems towards the objective of the European directive. It was not because of a lack of knowledge, sounds sciences and defined extension activities - like the Integrated Pest Management or the Organic farming standard could be taken as master frames, but much more because the production of knowledge and practices in relation to sustainable pesticide use were requesting the existence of innovative milieus and situations of exploration of alternative paths that would trigger radical changes at the heart of the dominant regime of crop protection, particularly for major industrialised field crops.

3.2 Pesticide use reduction in France

In this European context – meaningful as such since food provision and pesticide sails are organized at that level by firms and corporate strategies- the French case represents an interesting situation for a transition studies of ex novation, since it entails three loosely articulated pathways of discontinuation when France had announced pesticides consumption by a rate of 50% for 2018. The adoption of the European “Pesticide Package” in 2009 has triggered a long process of designing and implementing a dedicated plan to reduce pesticide uses, which as correspond to a mobilisation of agronomic research (Pesticide Expertise Report in 2005, Ecophyto R&D report in 2009) concomitantly to the participatory national Grenelle Environmental Forum. During the 2010's, the structuration of public action was intense while at the same time claims and political contentions if not trials against manufacturers spurred from the mobilisation of NGOs and phytovictims (Jouzel & Prete, 2014). The plan Ecophyto 2018 was launched in 2011, with the expectation of reducing pesticide use by a rate of 50%, “if possible”. This National Plan has been integrated has one instrument of a significant ecologisation of public agricultural policy under the “Agroecological project for France” launched in 2014 by the Ministry of Agriculture Stéphane Le Foll. The National plan appears then to be an element of this policy mix to turn the Productivist French Farm into an Agroecological farm. Moreover the construction of ignorance about pesticide toxicity (Dedieu & Jouzel, 2015) did also defleat the sanitary dimension of reduction for farmers, and the situation of pesticide use reduction appears to be particularly wicked problem.

The Plan Ecophyto 2018 relies centrally on a national policy instrument, called DEPHY, supporting the voluntary mobilisation of groups of farmers and engineers of agricultural extension services from various organisations (but mainly Agricultural Chambers) towards the exploration of alternative crop-protection strategies, notably through the design of innovative cropping systems (called SCEP) inherited from a current of agronomic research and extension that promote sustainable farming systems (Cerf et al., 2017). This dispositive called DEPHY is a kind of network organisation with

distributed arenas of action and discussion spaces, which is fuelled by the circulation of knowledge. Local groups of this DEPHY voluntary scheme were placed under the responsibility of two intermediary actors: Networks Engineers (NE), who are local facilitators and information gatherers, and more local Technical Engineers (TE) that gather information being directly attached to groups and managed by the NE. The DEPHY national core team not only absorbs local knowledge but also addressed farmers through communication packages that consist of formatted leaflets describing cropping systems which could successfully reduce their use of pesticides while maintaining their level of income (format called SCEP). This SCEP format represents a cognitive artefact that has been designed by agronomist experts, extension services representatives and public officers of the Ministry. More than a communication tool it also represents for individuals and groups of farmers a kind of informal contract to engage actors in a concrete way of transitioning towards pesticide use reduction.

A second type of knowledge is organizing the collective action of this DEPHY dispositif but more largely all the pesticide reduction policy: the measurement of pesticide use reduction through agro-ecological indicators that evaluate farming system. This indicator (called *Indice de Fréquence de Traitement*) has been designed by agronomists, largely before the action plan had started (Bockstaller et al., 1997). But it has been rendered within the public action plan in order to enable a legitimated instrument of measuring the number of pesticide doses realised per year and per hectare. The use of this indicator has spread in all extension practices in the last decade. The trajectory of this boundary object from the scientific stance to an administrative stance is very relevant in accounting for the structuration of a capacity to inform local efforts by farmers within local or regional groups, and at the same time building a public account of efficiency of the national action plan ECOPHYTO.

Thus, two types of knowledge production catalysers (a cognitive artefact and an indicator) have taken part in building an infrastructure of knowing and acting toward the reduction of pesticide use. This organisational texture has an institutional face because of a dedicated device. Moreover, knowledge that flows out of this device are also reversely used to inform scientific accounts of agro-ecological changes, with of course matters of dispute in their definition or scope of use. What is relevant for our cross-cutting perspective here is how much the knowledge infrastructure is embedded in on-going scientific experiments, expertise parties, public administration affairs and local experiential knowledge about sustainable crop protection strategies. This knowledge infrastructure is also a more or less formalised network of farmers, practitioners, engineers, intermediaries and public officers in which the sub-politics of building futures with pesticides reduction is at play.

4 Intermediation of pesticide use reduction as a collective experimentation of ex novation

4.1 Methodology

Our approach consists in examining the dynamics of change as they play out in the construction and implementation of the ECOPHYTO 2018 plan (from a diachronic point of view), and the variations of this implementation in situations of collective action in rural territories or supply chains while also studying other types of situation of change that were including pesticide use reduction.

We draw on an approach that focused on the activities of intermediaries, which is centred on the study of situated design processes – i.e. anchored in systems of activities- with a view to investigating the implications of changes in practices. This middle-range approach aims to understand how the instruments of public policy are implemented in order to induce transition, and how they evolve over time in relation to the obstacles, the sociotechnical and professional experiments, and the habitus of the actors they encounter. In this way we seek to ensure that public policy is not interpreted from a strictly political point of view only (Lascoumes et le Gallès, 2004). We also wish to understand how the demand for transition “reworks” these instruments, reshaping them and changing the content to some extent. In this respect it is essential to clearly understand the wide variety of existing agricultural technologies. Some involve the withdrawal of ancestral techniques such as plowing (Goulet and Vinck, 2012), while others call for organic solutions associated with lessons drawn from experience and granted increasingly more consideration by research as the agri-ecological stream emerges (Lamine, 2011). If there are transformative capabilities in this wide range of techniques, they play out in tandem with the adaptive capabilities or, on the contrary, with the lock-in peculiar to this sector which is rich in a wide variety of institutions.

The study of these organizational, structural and institutional, as well as technological, transformations is therefore of particular importance to take into account as context of action for intermediaries because they are at work in multiple ways, depending on diverse action logics. Not only do the logics of agricultural supply chains (grain, fruit, vegetables, etc.) have their own particular characteristics, they also vary profoundly in relation to territorial challenges of local agriculture. We posit that the instruments designed to perform change have to be understood from the point of view of the activities of intermediation that contribute to building this interface between public policy instruments and local situations. This is all the more necessary as these situations are already caught in the dynamics of change aimed at translating a demand for ecologization into technical practices and systems of sustainable production, before the arrival of recommendations based on a directive on pesticides. This intermediation is analysed in local situations, in two respects. First, we seek to account for situated design processes encompassing the exploration of new sustainable agricultural systems and the mobilization of the instruments of public policy. Second, we seek to understand the processes of generalization and institutionalization (up-scaling and out-scaling) of these local explorations, and the way in which these processes participate in the transformation of public policy instruments.

To study the process of situated design or the work of intermediation, we have held interviews with the agents involved in design or intermediation work. We have also been involved in local situations through participant observation or by accompanying these processes and this work ourselves. In particular, we propose spaces for reflection on the intermediation work, and approaches in which agricultural systems that meet territorial challenges can be designed, with the twofold requirement of a broad exploration of possibilities, and directly operational propositions.

Our analytic grid was based on the description of intermediaries’ activities with a rather simple empirical approach of observed situation of promoting pesticide use reductions:

- Thick description of organizational configurations in which intermediation actors act: how they discuss the transformations targeted, how they facilitate the evolution of agricultural practices in order to achieve a targeted transformation, how they create the conditions for the inclusion of new actors;
- Sociological account of the cognitive and normative support of intermediation actors to engage and legitimize a deliberate change and the tensions inherent to the difficult position they occupy

- Socio-technical description of the intermediary objects which are conceived, debated, and mobilized within the situations where reduction of uses is discussed, measured and values and which express a technological reasoning of change (indicators, Dashboard, on farm visits, trials, etc.)

In order to explore how intermediation activities take place and what the diversity could be, we have investigated them in 5 cases of extension situations that represent a good sample of ex novation at play (see table 2).

Table 2: The observed situations

Case 1 "BASE" Farmers Groups of Conservation Agriculture	Self organized groups based on experiential knowledge production with intermediaries playing a role of expert or technological promoters of specific techniques within a master frame of soil fertility conservation.
Case 2. RAD-CIVAM – Farmer Supports Association	Farmers that are assembled in groups that are followed-up by intermediaries who develop a support of sustainable development based on the idea of the autonomy of farm development in a common peasant vision of local agriculture
Case 3. Cooperative Extension Support Services	Individual Farmers (sometimes joining in ephemeral group) that corresponds to the organizational feature of extension services run by cooperatives
Case 4. Farmers Group of Water Catchment Area	Farmers groups that are committed to realize efforts and changes to ensure the protection of water catchment Area under the supervision of an agricultural advisor
Case 5. DEPHY. Famers group of the DEPHY Instrument	Farmers groups that have joined the DEPHY voluntary scheme in local groups placed under the responsibility of Networks Engineers (NE), who are local facilitators and Technical Engineers (TE) that directly attached to groups and managed trials

4.2 Results

First of all, our study reveals the variety of intermediaries: Technical and Networking engineer of the the DEPHY scheme (often appointed by Agricultural Chambers), regular extension advisors of departmental Agricultural Chambers, rural project managers from associations, agri-environmental scheme managers from public local organization or national water agency, R&D managers of cooperatives. None of those label themselves an intermediary actor; this label is analytical for us. All these intermediaries involved in pesticide use reduction – either very directly within the DEPHY scheme or in other dispositives- were directly concerned by the national plan of pesticide use reduction, but each of them with specific goals of their organization, and specific rules and skills.

Our account of intermediation activities in the 5 situations, enable to identify some of the features of intermediating pesticide use reduction (see table 3). We have noticed various values and ethos of intermediation activities in relation to the type of farmers' group, and according to their goal and their exploratory activities for pesticide use reduction. Each situation is also showing differentiated organizational setting to be managed by intermediaries. Finally we also report that reducing

pesticide use is not a something that supposes a unique topicality of action. They are many ways of entering the reduction.

Table 3

Features of intermediation Case	Values and ethos of intermediation activities	Farmers' practices to be activated	Organisational Setting to be managed	Topicality of pesticide use reduction
Case 1 "BASE" Farmers Groups of Conservation Agriculture	Technophilia experimentation of soil management	Free individual experiential knowledge production	Sponsored network of individual experience	Moving away from a dependence to conventional package
Case 2. RAD-CIVAM – Farmer Supports Association	Autonomy of farmers' development based on common values	Exploration of sustainability changes within a peasant referential	Self organisation of situated networks	Full autonomy of agricultural inputs (on farm production) and organic target
Case 3. Cooperative Extension Support Service	Technico-economic rationalisation of cropping systems	Datafication and valuation of field measurements	Professional bureaucracy of extension	Measuring reduction possibility in relation to impact on yields
Case 4. Farmers Group of Water Catchment Area	Environmental modernization of cropping systems	Testing and applying technical specification	Loose territorial coordination within groups	To limit the impact of pesticide on resource
Case 5. DEPHY. Famers group of the DEPHY Instrument	Experimenting reduction agronomic package for diffusion	Generalisation of cropping systems format	Administrative and technical adhocacy of instrument	Targeting the reduction of the IFT Indicator (Nb of Pest. Treatment) and sustaining margin

Thanks to individual interviews but also to regular discussion group with all the intermediaries, we could better understand their specificity but also try to see if some communalities in intermediating pesticide reduction. It appears that working with farmers on this reduction supposes a type of boundary activities between institutional and professional logic the one hand and on collective action logic of farmer's group on the other hand. Therefore our comprehensive analysis has issued two dimension of intermediation:

- The dimension of engagement of intermediaries at the crossroad of these three tension: the functional values of their vocation, the adaptability to farmers' group and a sense of more or less intense publicness.
- The dimension of the technique of intermediation for which he have noticed three bundles of skills which we labelled "technae": a communicational technae (how to move a group to have it going forward), a pedagogical technae (how to help the person or the group to have something experienced) and the social engineering technae (how to design and enact promising situations for learning to take place).

But these dimension were not particularly new for them. A new dimension was less obvious for them and time to time expressed as an annoyance, something that perhaps "should not be there". In fact

the agroecological project - in which pesticide reduction was a component- was receiving contentions and critics if not disdain from conventional farmers and political opposition, with concomitant pressure of social movement and of the public controversies about glyphosate. This atmosphere that connect the “political landscape” directly at the heart of their intermediation activities did establish a third dimension: they had to position themselves as professional within this pressure. In different ways, all of them expressed a sense of publicness to characterise this embarrassment, even though the public sphere stood at a distance for some of these situations. Therefore the nature of these tensions had to be clarified.

An in depth analysis of discourse and patterns of argumentation shows that their practices of acting within groups question themselves about the legitimacy of their discourse about farming practices and techniques of using pesticide. How to have various actors that expect to realise changes sufficiently committed around a different possible future, if the technological features of a new system is poorly advocated? They all feel to play at the boundary of their own knowledge about the objectivity of practical realisation and their possible impacts on pesticide reduction.

A second tension was also discovered under their embarrassment. Paradoxically to the previous tension, they also feel tensed by the necessity to keep the group in a very subjective relationship to their reality, in order to have the reduction put as a sociotechnical imaginary.

It appears that being an intermediary of pesticide reduction assemble many tensions. Brokering is not an easy game and what we discover is the combination of rather technical issues of intermediation practices but also a subtle cocktail of a sense of publicness and of a profound paradox mixing the objectivation of the reality to be changed and the necessary subjectivation process to carry the imaginary of doing with less or even with no pesticide.

If these observations are relevant, we might have here shown a component of the chasm of exnovation, this particular momentum of dynamics of change that exist after the proof of concept done by lead-users. In the case of pesticide use reduction, we might conclude that there is no generalisation of phasing-out within a discontinuation policy without solid intermediaries, and above all a clear connection between policy instruments and the practicality of intermediating robust changes.

5 Conclusion

Our findings about intermediation of pesticide reduction point the need to open the understanding of the chasm of out-novation. In many circumstances the dynamic of sociotechnical regime and *de facto* governance of transformative process, do not mean only *de novo* creation, nor substitution, but more often a subtle agency and structure of de-framing, re-agencing and including critical mind-sets, new sociotechnical agency and human practices (Turnheim et al., 2015). The chasm of innovation (Bernstein & Singh, 2008) has its counter part in what one could name the chasm of out-novation or exnovation. As a generalisation process relays on the often silent but determinant contributions and actions of innovation brokers, sustainability transitions supposes intermediaries that convey the uptake of a critical zone of out-scaling. This perspective has to be clearly put upper in the agenda of Transition Studies.

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