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CONSTRUCTING SOCIOTECHNICAL TRANSITIONS TOWARD SUSTAINABLE AGRICULTURE:

LESSONS FROM ECOLOGICAL PRODUCTION OF MEDICINAL PLANTS IN SOUTHERN BRAZIL.

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Abstract — This paper provides an analysis of knowledge generation and 'novelty production' into new social arrangements within a sociotechnical transition scenario. The purpose is to contribute to the debate about convergences between creativity, learning and collective action for enhancing the sustainability into agriculture. By raising a Multilevel, Multi-actor and Multi-aspect analytic framework, built with elements from Multilevel Perspective and Actor Oriented Approach, we have examined emerging 'novelties' generated by family farmers who have been producing medicinal plants under ecological systems in the Southern of Brazil. This production system was considered as a novelty, being composed by a 'web of novelties', *i.e.* as integrated whole of new techniques and social practices that are at odds with prevalent sociotechnical regime. The 'novelty production' depends on dynamic learning processes, related to knowledge contextualization, enabled through the mobilization of social networks, crucial for creating opportunities to bring together different bodies of knowledge. Farmers and other actors are creating spaces of autonomy in which we recognized some characteristics of 'niche of innovation', a social space where rules and institutional apparatus can be ignored; it is a privileged *locus* for innovativity. Otherwise there are difficulties in stabilizing specific networks around 'medicinal plants', in this way it will be necessary to create political and social conditions in order to involve actors from several domains, like researchers, extensionists, consumers and policy makers. Farmers in seeking autonomy are renewing the agriculture as an agriculture rooted locally and contributing to generate potential transitions to prevalent sociotechnical regime.

Key words : technological transition, innovation, sociotechnical regime, Agroecology.

Résumé — Construction de transitions sociotechnique vers une agriculture durable: leçons prises de la production écologique des plantes médicinales dans le sud du Brésil. Cet article présente une analyse de la production de connaissances et de «la production de nouveautés» dans un contexte de nouveaux arrangements sociaux et de transition sociotechnique, en contribuant au débat sur la convergence entre la créativité, l'apprentissage et l'action collective pour accroître la durabilité dans l'agriculture. En utilisant une approche multi-

niveaux, multi-acteurs et multi-aspect, construite à partir d'éléments de la Perspective Multi-niveaux et de Perspective Axée sur les Acteurs, nous examinons les «nouveauautés» émergentes, produites par l'agriculture familière qui produit des plantes médicinales sous des systèmes écologiques dans le sud du Brésil. Ces systèmes de production ont été considérés comme une nouveauté, intégrant un éventail d'autres nouveautés, formant un «réseau de nouveautés», ce qui représente une interconnexion entre des nouvelles techniques et des nouvelles pratiques sociales développées contre le régime sociotechnique dominant. La «production de nouveautés» dépend de certaines dynamiques d'apprentissage, liés à la contextualisation des connaissances et à la mobilisation des réseaux sociaux, cruciaux pour la création d'opportunités qui approchent des différents corpus de connaissances. Les agriculteurs et d'autres acteurs sont en train de créer des espaces d'autonomie, où l'on reconnaît certaines caractéristiques de «l'innovation de niche», un espace où les règles sociales et l'appareil institutionnel peut être ignoré, car c'est un lieu privilégié pour l'innovation. Par contre, il est difficile de stabiliser des réseaux spécifiques autour des plantes médicinales. Pour y arriver c'est nécessaire de créer des conditions politiques et sociales pour engager les acteurs des divers domaines impliqués, tels que les chercheurs, les agriculteurs, les consommateurs et les décideurs. Les agriculteurs, en cherchant de l'autonomie, renouvellent l'agriculture comme une activité ancrée localement et contribuent pour générer des transitions vers la durabilité.

Mots clés : transition technologique, innovation, régime sociotechnique, Agroécologie.

INTRODUCTION

This discussion presents and pinpoints the processes involved in producing novelties, not through attempting regularities but by understanding the social construction of knowledge and different practices in agriculture. The theoretical framework takes some structuralist elements and constructionist patterns as an integrative approach to obtain a better understanding of the transition processes in ongoing sociotechnical changes.

These issues form part of an academic cooperation between the Rural Development Programme (UFRGS-Brazil) and Rural Sociology Group (WUR-The Netherlands)¹, whose concerns focus on socio-technical interfaces, environmental practices and political-institutional processes associated with rural development.

This paper provides an interdisciplinary analysis of knowledge generation and novelty production involving a range of different actors into new social arrangements within a sociotechnical transition scenario. The purpose is to contribute to a general debate about convergences between creativity, learning and collective action as elements for enhancing the sustainability into agriculture.

We consider that the local actions of farmers might contribute to the global process of transition to sustainable development and to the advance in ecological farming as a significant expression of novelty production in agriculture, but, even though there is good potential to shift the dominant sociotechnical regime, these novelties are still relatively isolated or hidden.

Since the 1980s, the idea as regards medicinal plant production has been to increase the scale to meet the industry standards, and in order to achieve this requirement the path seems to be to innovate under the same framework of modernized agriculture, seeking homogeneity in plant genetic base, in technical protocols, in market operations and so on. Nevertheless, a system of innovation with these specific aims has never gained space in Brazil. Thus, in order to produce medicinal plant, solve bottle necks, discover or create new markets, farmers have been innovating to mobilise different knowledge, resources and social networks, developing novelties within a counter-tendency. By highlighting the novelties produced by family farmers who are producing medicinal plants, this paper aims to identify

¹ The agreement between universities is supported by CAPES (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*) agency of Brazilian Education Ministry.

and analyze learning processes and social network building observed within innovative processes carried out by farmers and other actors enrolled.

1. METHODOLOGICAL AND THEORETICAL PATTERN

The current analysis is based on empirical research carried out during 2007; the investigation forms part of the first author's thesis work. Using a Multilevel, Multi-actor and Multi-aspect approach, qualitative in-depth studies were carried out, covering five cases of family farmers who have been developing ecological production systems in different localities in the states of Santa Catarina and Rio Grande do Sul (in the extreme south of Brazil). The fieldwork basically consisted in open interviews and systematic observations and registration of farming and social practices.

The Multilevel, Multi-actor and Multi-aspect approach is characterized by multidisciplinary and is built taking elements from Multilevel Perspective (MLP) and Actor Oriented Approach (AOA). It is an integrative approach useful for analyzing the 'novelty production' in agriculture and for offering analytical possibilities which lead to a better understanding of structural changes in technological development. At the same time it enables the exploration of the cognitive processes spurred by social action, considering specificities coming from local and heterogeneous backdrops. Both perspectives arise from a multi-dimensional understanding of 'agency', assuming that the actors have their own interests, act strategically but are limited by profound social structuring.

Combining aspects from the sociology of technology and evolutionary economics the MLP proposes to explain technological transitions by the interrelationships between processes at three different heuristic levels, the analytical concepts of niche of innovation, the sociotechnical regime and the sociotechnical landscape (GEELS, 2004). The Niche is considered the privileged *locus* for innovation and for shifting the regime (BERKHOUT et al., 2004), it can be featured by small networks of actors and is often recognized as a protected environment for innovative processes. The Sociotechnical Regime refers to a semi-coherent set of rules carried by actors linked to different meta-coordinated regimes (technology, science, market, socio-cultural, policy) that guide the whole complex of practices associated to technology generation, infra-structure and use (GEELS, 2005). The broadest level is the Sociotechnical Landscape, which forms an exogenous environment beyond the direct influence of niche and regime actors (macro-economics, deep cultural patterns, macro-political developments). The institutional and social structuration degree increases from the micro level (niche) to macro ones (landscape) (GEELS e SCHOT, 2007). The constructionist pattern from AOA derives from a large tradition in rural development studies, whose theoretical advances are oriented by careful empirical investigations. Taking the agency as a 'root-metaphor' (LONG, 2007), the AOA has been involved specifically in knowledge encounters with the purpose of going beyond dichotomized representations of knowledge form (*i.e.* modern science *versus* popular; exotics *versus* local knowledge) (LONG, 2001).

Considering 'Novelty Production' as a key term related to the emergence of something new: a new practice, a new insight, new artefacts, innovative social or institutional arrangements and so on (PLOEG et al., 2004), the potential of the associated processes can demonstrate ways to promote sociotechnical transition towards sustainable agriculture.

Understanding the ecological production of medicinal plants as a novelty that generates others, their investigation places the analysis at the micro level (niche) first, then, for appreciating social engagements and conditions for amplifying cognitive processes, multiple life aspects were considered which involved actors strategies, artefacts, resources, discourses and struggles about means and identities (PLOEG e LONG, 1994; LONG, 2001).

2. WEAVING THE WEB OF NOVELTIES

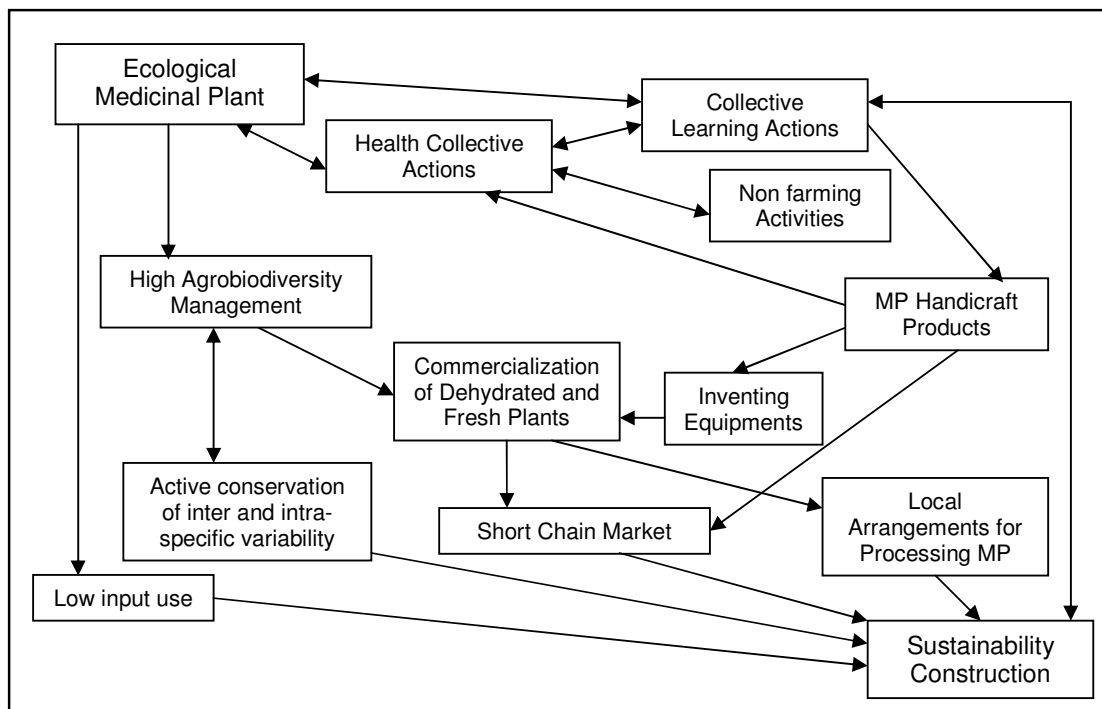
Brazil is very well known for its huge biodiversity, which includes around one and a half million species of animals and plants, and many medicinal plant species associated with a

very variable ecosystem and different cultural repertoires. Even with many different popular systems in use and with strongly rooted consumption habits among the Brazilian population, medicinal plants are not a traditional agricultural product. On the other hand, the cultivation of these kinds of plants is an increasingly urgent requirement, at least to avoid the over exploration of native species or to achieve improved quality levels. Products from this biological diversity are often seen as a resource to be directly explored by the market due to increasing demand for natural products, in-line with world wide tendencies; and also because there is interest and market opportunities for these products, because plant species containing bioactive compounds have a strategic role to play in industries such as the pharmaceutical, food, chemical and cosmetics industries. It is important to make clear, however, those medicinal plants as a promising new crop or a market niche are not enough to identify the farm activity as a novelty.

Fundamentally, to be considered as a novelty the generation of new configurations must be associated with the encounter between different bodies of knowledge, deep grounded in local contexts and steered against the established codes and background of the sociotechnical regime of conventional agriculture. In this way, medicinal plant production under ecological systems can be recognized as a novelty because it is associated with the emergence of contextual knowledge as much as with shifting the boundaries established by modern agriculture as an 'expert system'.

Many other novelties are related to ecological medicinal plant production and the interconnection between them enables the composition of a 'web of novelties' that embraces, for instance, differentiated practices of soil management, large agrobiodiversity² use, the development of equipment and methods to process and dry raw material, arrangements in partnerships to fabricate new products with increased added value and the creation of alternative markets or non farming activities such as tourism and education actions associated with schools or extension organizations. A representation of the interconnection between such novelties can be seen in Figure 1.

Figure 1. Web of Novelties on producing medicinal plants under ecological systems.



Source : especially designed for this paper.

The web depends on dynamic learning processes, because every new process, new species, new marketing opportunity introduces impacts and feed backs which demand from farmers an unending re-patterning of factors such as technology, symbolic means, work, organization, time, knowledge and marketing strategies. However, it is a undeniable fact that farmers are mixing 'old' knowledge and expertise (*i.e.* practices before modernization or knowledge associated with local biodiversity) with elements from a 'new' set of inputs to achieve future goals, promoting what Stuver (2006) calls "retro-innovation".

For instance, one of the farmers has worked with medicinal plants through the social mobilization into the Peasant Women Movement³. She explained "*I knew many things about the plants because I learned a lot from my mother and uncles [...] along the time, I've specialized in this subject [...], first we organized meetings in the church, now we're offering courses for neighboring communities and even for groups in other States, far, far from here*". The women, in the Chapecó region in the state of Santa Catarina, work continuously to improve the quality of life in the community by education processes in nutrition and health. In addition they organized an association, acquired space in a local market, and now they are commercializing handicraft medicinal plant products and generating incomes, not without a permanent struggle with the authorities in the face of almost impossible adaptation to health standards.

Another case shows how it is possible to manage 260 different plant species in a production system with the capacity to generate more than 80% of the income of a family of four and two other workers, sufficient to maintain a very good standard of living. To encompass the whole production system, farmers in Gramado, in the state of Rio Grande do Sul, are combining single cultivation and intercropping using many different species arranged in several designs. There is also spontaneous herbs management (before seen as weeds), cultivation in levels, special buildings for processing the crops, equipment specially adapted to dry raw material and a myriad of other practices and techniques. In addition they are organized together with other farmers in an association (originally it was a cooperative) that for more than twenty years has maintained a special market for ecological products in Porto Alegre (the state capital), putting them 'face-to-face' with the consumers.

Perhaps, many of these re-patterning or re-combinations between production factors can be seen as an incremental process of innovation implying just improvements in ordinary practices related to agriculture. Nevertheless, following Ploeg (2008:192), "novelties occur as change agents in disguise: as undercover agents", this because the really novel thing sometimes is not an artifact or a practice by themselves (the material proof), but the learning process, the construction of new values, the finding of alternative ways in doing, in organizing, in acting or even in changing behaviors.

Thus, the links between novelties show a complex web of relations, whose emergence is possible only by mobilizing diverse expertise and resources, including both new and old knowledge, but taken together the practices (including social ones) and techniques have been developing resistance against the dominant sociotechnical regime, essentially by seeking autonomy.

² Agrobiodiversity refers the interaction between human activities and natural diversity, is used to represent the total variability of living organisms and any element that carries some function or ecosystemic services into an agricultural system.

³ MMC – Movimento da Mulheres Camponesas, Brazilian social movement oriented mainly by feminism and socialism that takes part of *Via Campesina* (international movement of peasants, small- and medium-sized producers, landless, rural women, indigenous people, rural youth and agricultural workers).

3. CONTEXTUALIZING THE KNOWLEDGE

It might be argued that 'novelty production' is ontologically part of agriculture, for sure it is; agriculture is a locally embedded co-production process. But, the more the technical 'world' was withdrawn from the social one through 'scientification' of agriculture⁴, the more de-contextualized farming work became. The disconnections caused by modernization took knowledge out from the local context. By considering that generating novelties is linked to creating conditions for the agriculture re-grounding, the process of novelty production also means giving back 'context' to the knowledge.

The analyzed families' trajectories are marked by a kind of permanent reflexive process which allows confrontation of their own actions with the wide scenario into which they are inserted. As a result, they always seem willing to experiment, to try something different, paying total attention to information they receive from 'outside', but keeping a continuous dialogue with their 'equals' and in the same intensity with the 'different'.

One of the studied families has changed from tobacco conventional cultivation to the production of medicinal plants. The farmer explained that he was very sick due to the constant use of pesticides, so diverging from relatives and neighbours opinions, and also against the regional productive trend, the family converted their farm into an 'ecological' one. Practically, it is difficult to do this conversion, it was necessary to completely change the internal organization as well as the relationship with the market (including adaptation to get organic certification). This is a very complex process which involves, not just changing practices, but a fundamental re-alignment of work and even of nature. He said "*before, I used to keep everything clean; nowadays, I understand the value of these little plants that I used to name weeds [...] nowadays, I have a conscience, I had a little before, because we've always used medicinal plants in our family*".

It is worth noting that, especially in the most southern region of Brazil, 'to keep clean' means to take out all the spontaneous vegetation from a cultivation area and this practice is seen as being that of a 'good farmer'.

Examining this simple example it's possible to understand the efforts made by farmers in learning and in contradicting well known and accepted rules. In doing this they are also waging a struggle with themselves, changing their 'conscience' and searching back to look forward to the future. As a consequence, the construction of tacit knowledge is inseparable from other actions and the construction of repositioned means. This knowledge is fundamentally related to a constant dynamic learning process and 'doing better', so there is no static aspect, nor knowledge nor general rules guiding their action trajectory related to learning (ENGEL, 1995). There's no doubt that these processes are related to 'learning by doing', involving cognition and practice, which results in effective applied knowledge developed by farmers through observation, experimentation and/or analogy. Such procedures, although highly consistent, are not systematically organized and codified, thus they enhance or transform the tacit knowledge, which means that they are partially contributing to the generation of novelties.

Along the different trajectories, it was possible to identify that farmers are improving resources or re-patterning resource use, developing fine tuning in using different production factors to develop innovative processes; the generation of these new configurations is linked to local contexts.

On the contrary, technological innovation in agriculture has been seen to be a direct result of codified knowledge accumulation in which the context can be far removed from where the innovation takes place. 'Codified knowledge' can be understood as an abstract and

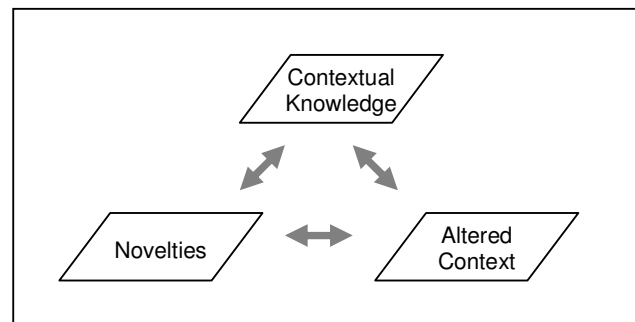
⁴ Scientification can be understood as an ongoing re-organization of work processes according to outline developed by agricultural science (PLOEG, 1994).

objectified knowledge, related to theoretical understanding and general scientific principles (BELUSSI and PILLOTI, 2000). Fundamentally, the novelties are linked to the contextual knowledge created from the combination of tacit and codified knowledge flowing together through different learning processes (OOSTINDIE and BROEKHUIZEN, 2008). The contextual knowledge can be described as a result of an historical accumulation process of technological capabilities and skills, and if it occurs in a specific territory, the mechanism of the mobilization of knowledge is activated (BELUSSI and PILLOTI, 2000:14). These authors reinforce the notion that the contextualization of knowledge is 'territorial', in this case, related to specific areas, mainly because it involves contact between agents (or even experts). Oostindie and Broekhuizen (2008) also emphasize the territorial nature of contextual knowledge.

However, we can point out two aspects about the territorial nature of contextual knowledge and, consequently, about novelty production. The first aspect concerning the transformative potential of novelties, considers that their emergence apart from enlarging contextual knowledge stock, can modify the context itself, even though there has been no change at broader or more structured levels, as in the regime. Therefore, altered context creates new conditions to contextual knowledge as much as for the production of other novelties, related or not to the prior ones (Figure 2).

The second aspect relates to the possible non-territorial flows of contextual knowledge. The production of medicinal plants has been developed without the characteristics of regionalized economic activity, but it seems to generate 'contacts' between distant agents involved in one way or another with learning processes. Not all actors (farmers or not) are sharing a common locality, creating an 'extended territoriality', possibly due to the mobility of actors.

Figure 2. Reciprocal changes between contextual knowledge, novelties and context.



Source: adapted from Marques (2009).

This 'knowledge socialization at distance', for example, occurs by experience exchanges between farmers during encounters in political or union meetings, technical events, courses organized by themselves or other organizations, participation in fairs (or expositions) far from their original regions and other occasions. It also happens between consumers and farmers, especially during the commercialization activities in 'face-to-face' markets. The flows have been facilitated by the creation of spaces for collective learning, promoted by researchers (for instance, through participative research), extensionists, ecologist organizations, social movements and many other different distinct social relations.

The 'learning by doing' and 'doing by learning' have renewed meaning, because besides the objective knowledge that actors are exchanging and experimenting with, there is something very new happening, it's the ongoing dynamic and diverse collective learning processes that can be seen as a novelty too. Particularly with ecological production of medicinal plant, the contextualization is being generated through social relations and the mobilization of networks, crucial to creating opportunities and the environment to bring together different bodies of knowledge involved in novelties emergence.

4. NURTURING NOVELTIES THROUGH NETWORKS

The farmers are creating autonomous spaces in which we recognize some characteristics of 'niche of innovation' by the identification of the already mentioned active learning processes and the creation of networks between actors (WISKERKE, 2003). The niche represents the micro level of action, where rules and institutional apparatus can be ignored, providing some possibilities exist to create a protected space to invent, search or test novelties

From the viewpoint of evolution in novelty production in agriculture, the strength of social relations constituting the networks, or even individual engagements of minor scope and complexity, seems to be a factor that provides the conditions for promising innovative niches. The farmers along their life trajectories have created work and political and social links, which emerge from their engagements in social and ecologic movements, alternative market construction, healthcare programs promoted by the State or by organized civil society, communitarian services and formal and informal education activities. These links create conditions for social network establishment, which can extend the scope and/or modify the character of action. As Long (2001) states, the range of a network can reach even new economic investments. Thus, networks are not important by themselves, but by the objects and relations flowing through them (MURDOCH, 2000).

For example, the existence of different cooperation between actors acting through networks was observed. For instance, a family produces one type of native plant that only occurs in the ecosystem where they live; part of this production is exchanged for seedlings with a non-governmental organization, because they can not produce for lack of adequate facilities. In other cases, the social network built by farmers because of their participation in social movements generates sufficient empowerment to guarantee market spaces with special rules which allow them to sell some products with local labels. The label acceptance also has consumer participation, a fact that reinforces the network.

"The technological niche is formed against the background of the existing regime and landscape" (GEELS, 2001:8), thus to 'protect' spaces for novelty production means to 'win allies'. In other words, to be successful it is necessary to generate coordinated networks between actors who are willing to go out from the mainstream and take risks or face the disadvantages of new technologies (ELZEN et al, 2004) and unusual social configurations. The actors involved in some way with 'medicinal plants' are acting in different 'domains' like: emancipatory movements, ecological agriculture, urban consume, health care programs, non farming activities and technical-scientific. Domain identifies areas of social life which are organized by reference to specific values; although not perceived the same way by all those involved, they are recognized as places of certain rules, norms and values that imply a degree of social commitment (LONG, 2001).

The action and actors' mobility through or inside these domains is sometimes constrained by the prevalent sociotechnical regime of conventional agriculture, driven by the modernization principles. In a very practical view, some actors have your action linked to organizations, *i.e.* state extension services, private enterprises, universities, research institutes, public development agencies, NGOs, other ones are farmers, consumers, activists, rural dwellers, then they commitments and even cognitions are responding to different institutionalities or individual interests and trajectories. In this sense it is possible to identify difficulties in developing alignments between strategies and the expectations of different actors positioned in different domains.

An additional difficulty is that the mentioned networks mobilized to support the novelty production are not specifically created with the aim of protecting the medicinal plant niche. The case of medicinal plants is showing that actors to be 'recruited' to stabilize specific networks still are driven by individual motivation, with big difficulties to overcome institutional barriers. However, the relations' features to be established and developed over time, even starting from simple bilateral links, should move towards multidirectional interactions that might be intentionally mobilized to nurture novelties.

5. LESSONS TO LEARN ABOUT

The technical modifications required in contemporary agriculture are highly complex, under the influence of globalization and immersed in contexts with deep internal disparities and serious socio-environmental problems. This entire backdrop is related to social structures whose change processes towards sustainability move forward slowly and are dependant on sociotechnical transitions, presupposing material, symbolic, institutional and cognitive flows between levels (niche, regime and landscape).

Several approaches to innovation emphasize 'technological artefacts', because they are interpreted as a result of a series of actions, relations and meanings, whose acceptance in society requires knowledge evolution. This interpretation is the same when the results are 'agricultural artefacts', but the innovation process related to the agricultural world (referring to an agriculture identified by agro-ecological principles and by the re-foundation of co-production) seems partially to withdraw the importance from the artefact itself. Many learning processes which lead to knowledge generation are sometimes manifested in artefacts, however, articulated learning processes acquire greater relevance. Pointing in another way, dynamic, diverse and social inclusive learning processes represent by themselves an 'innovation'.

The niche is considered the privileged *locus* for innovativeness and regime change (BERKHOUT et al., 2004), but to protect spaces for innovation it will be necessary to create, expand and establish political and social conditions in order to involve actors from several domains of social action and to promote encounters between different bodies of knowledge. The web that interconnects novelties in medicinal plant ecological production represents, besides a set of promising new technologies, the emergence of new perspectives in promoting or constructing rural development, because it promotes new production factors arrangements such as land, work, culture, nature, social networks, institutions and markets (PLOEG et al., 2002). As a final consideration we can state that, when the farmers are proposing 'new' or 'substitute' activities in their farms, the knowledge generation and the development of different attitudes go beyond the discovery of an untapped market niche or of the simple acquisition of different technologies. In fact, they are renewing the agriculture as an activity rooted locally and contributing to generate a learning process with the potential to promote transitions in the prevalent sociotechnical regime in agriculture. This is a good lesson to learn from the novelty of medicinal plants.

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