Farmer-researchers – how to promote knowledge acquisition in Participatory Plant Breeding?

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Farmer-researchers – how to promote knowledge acquisition in Participatory Plant Breeding?

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List of abbreviations

AIAB	Associazione Italiana per l'Agricoltura Biologica
AKST	Agricultural Knowledge, Science and Technology
AMAP	Association pour le Maintien d'une Agriculture Paysanne
AOC	Appellation d'Origine Controlée
CGIAR	Consultative Group on International Agricultural Research
CIVAM	Centre d'initiatives pour valoriser l'agriculture et le milieu rural
CNDSF	Coordination Nationale pour la Défense des Semences Fermières
CNRS	Centre National de la Recherche Scientifique
COBRA	Coordinating Organic Plant Breeding Activities For Diversity
CPVO	Community Plant Variety Office
CSA	Community Supported Agriculture
CUMA	Coopérative d'Utilisation de Matériel Agricole
EU	European Union
EUCARPIA	European Association For Research On Plant Breeding
FADEAR	Fédération Associative pour le Développement de l'Emploi Agricole et Rural
FAO	Food and Agriculture Organization of the United Nations
FRAB	Fédération Régionale des Agriculteurs Biologiques de Bretagne
FSC	Fondation Sciences Citoyennes
FSO	Farm Seed Opportunities
GEVES	Groupement d'étude et de contrôle des variétés et des semences
GMO	Genetically Modified Organism
IAASTD	International Assessment of Agricultural Science and Technology for Development
INRA	Institut National de la Recherche Agronomique
LLD Forum	Let's Liberate Diversity Forum
PBR	Plant breeders' rights
PDO	Protected Designation of Origin
PGI	Protected Geographical indication
PPB	Participatory Plant Breeding
RSP	Réseau Semences Paysannes
SOLIBAM	Strategies for Organic and Low-input integrated Breeding and Management
TEK	Traditional Ecological Knowledge
UN/ UNO	United Nations Organization
UPOV	International Union for the Protection of New Varieties of Plants

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Introduction

Food sovereignty – this word is getting more and more used today. Some call it the solution to the actual context of ecological, social and economic crisis and it seems as if most of the challenges society faces today are interconnected. Agriculture is appearing in the middle of those topics and has become a key factor for sustainable development. If farmers, which have been withdrawn the means for autonomy, could regain their independence from dominating modes of production, problem solving could start at regional level. Food cultivation is basically relying on soil, water, sunlight and seeds, four essential factors of which the last is provided by humans. Essential to survival, seeds have been guarded over centuries of continuous cultivation (Bachleitner 2012). The diversity of seeds is the foundation of farmers' autonomy which is not easy to regain. The following pages will illustrate a situation full of obstacles that farmers can find themselves in (legally, technically, economically and socially) when devoting themselves to a sustainable agriculture and self-fulfillment. Recognizing that these farmers need more knowledge, it is necessary to go beyond the boundaries of defined disciplines and to show how their social networks and participatory research contribute to knowledge sharing and new findings. Taking into consideration the constant interaction of society, science, economy and agriculture this Bachelor thesis is devoted to answering the following questions, using the example of the French seed sector:

Why, what and how do farmers research and how can this knowledge acquisition for a sustainable future be promoted?

After presenting the material and methods used, a closer look will be taken at the development of the genetic progress and plant breeding in France that have shaped the current agricultural system and modes of thinking. This will lead to the second part in which farmer-researchers and their methods will be presented using collected empirical data and literature. Before the final conclusion, the third part will illuminate the underlying mechanisms of knowledge acquisition and discuss possibilities and hurdles of their promotion.

Material and Methods

This Bachelor thesis aims to call attention to the existence of farmer-researchers and their active contribution to shaping a sustainable future. During my internship in the SAD-Paysage unit[1] of the national agricultural research Institute of France (INRA) in Rennes, which works on cultivated biodiversity and participative research, I was confronted to this subject and became interested. In order to describe their situation, I found it important to look back into the general historical context (Part I). The following pages will show that the human aspect and social relations are influential, path giving and very important to any kind of research. Therefore I found it inevitable to integrate empiric data into this work (Part II) on a reflection on farmer-researchers, a topic that is based on sociology, ethical and epistemological reflections. Before and during my internship I seized many opportunities to meet the diverse actors implied in the subject of farmer-researchers, knowledge sharing and related to the seed sector. Some important occasions were the following:

- The attendance of the module 'Seeds and Plant Reproduction' at the ESA Agronomic College in Angers (Ecole Supérieure d'Angers) during my ERASMUS exchange. It included: internal lectures, visits of plant breeding companies with branches in the Angers region (DLF Trifolium, Vilmorin, Béjo), a seed multiplier, a nursery, and official institutions such as the GEVES (control and testing agency for seed and varieties) and the CPVO (Community Plant Variety Office which protects Plant Breeders Rights (PBR) and delivers the PBR certificate).
- The harvest threshing festival of the association Triptolème in Daoulas (31st August 2013), the general assembly of the association 'Université du Vivant' (30th August 2013) and the regional fair for organic Products and Production in Guichen (12th October 2013) were occasions to meet artisan seed breeders, innovative farmers, consumers, researchers, seed networks and actors in social movements.
- The Let's Liberate Diversity Forum in Basel, Switzerland (20-22 September 2013)
- The general assembly of the Réseau Semences Paysannes (RSP) in Aiguillon (13-14th December 2013)
- The EUCARPIA Conference 'Breeding for Nutrient Efficiency' in Göttingen, Germany (24-26 September 2013)
- Working in the INRA

To be able to understand the farmer's side of the issue I have encountered three farmers on their farms in north-west France for informal interviews, conducted in French and or English. They were chosen for reasons of geographical distance but also for their farms and personalities that are exemplary for the RSP, French peasant seed movement.

[1] Science pour l'action et le développement (Science for action and development)

- Nicolas Supiot, on 21st November 2013, in Maure-de-Bretagne (Ille et Vilaine)
- Florent Mercier, on 7th December 2013 in Bouchemaine (Maine et Loire)
- Dominique Bourdon, on 7th December 2013in Tréal (Morbihan)

By choosing an informal spoken interview, using a questionnaire (see annex 1) I wanted to learn about their personal history, ideas, motivations, methods and sources for innovation, the functioning of their farm system, commercialization of products, social rapports, experiences with Participative Plant Breeding, expectations, and about their social relations. F. Mercier and D. Bourdon were interviewed in cooperation with Livia Ortolani, Italian researcher from the Scientific Board of the Italian Association for Organic Agriculture (AIAB). The application of a participatory mapping technique allowed us to understand how the farmer's social network contributes to the acquisition and construction of knowledge needed for the realization of innovation; but also how a farmer situates himself/herself in his/her social environment and how the situation of being a farmer-researcher is conceived. In the participatory mapping technique, the interviewed person draws a map of his/her social network. Everybody who is somehow related to his/her work is connected by lines that represent information, monetary and material exchanges. For this, an A1 sheet of paper, post it notes and different colored markers are used. While explaining the content of exchanges, the contacts are classed in categories of geographic location, types of action and frequency of exchanges. The statistic and analytic data resulting from the participatory mapping method will be presented in the PhD Thesis of L. Ortolani, as part of the European SOLIBAM program and under the supervision of Universities of Pisa (Italy) and Copenhagen (Denmark).

Part I: Seeds – Farmers deprived from autonomy?

The following section will anticipate the need for farmer-researchers to re-acquire knowledge (e.g. on seeds) and furthermore the reasons for farmers collective actions. To work with the title of this section, history has to be lighted up and the development of the French seed sector needs to be discussed in order to understand decisions that were taken in both, past and present times. Plant breeding aims at the 'improvement' of varieties and therefore implies that objects are given. These goals are certainly not neutral but product of dynamic social, economic and political processes as the following pages will show (Bonneuil & Thomas 2012: p.11-15).

1. A brief history of plant breeding and varietal selection

1.1. In the start peasants are breeders

"The seed in its essence is all of the past evolution of the Earth, the evolution of human history, and the potential for future evolution. The seed is the embodiment of culture because culture shaped the seed with careful selection […]. So from one grass you get 200,000 rices.

That is a convergence of human intelligence and nature's intelligence. It is the ultimate expression of life […]" (Vandana Shiva in van Gelder 2013: p.1)

Scientist agree today that the earliest domesticated grain crops were found in south west Asia from archeological sites of the Neolithic (Zohary et al. 2012). The locally domesticated species include ancestors of our modern cereals such as emmer wheat, einkorn and barley, accompanied by grain legumes like lentil, pea, bitter vetch and chickpea. Food plants seem to have first been domesticated in the places where the highest diversity of their wild ancestors can still be found today (Zohary et al. 2012).

Domestication has been a long process, making plants more and more dependent on humans, finally leading to cultivated crops. In this process, humans more or less "unconsciously" bred plants by selecting the ones in their favor in order to facilitate cultivation and harvest, making the plants lose some of their natural habits. Along with this co-evolution of plants and humans came the wisdom of cultivation and selection that accumulated over years and was passed on to following generations as the basis of survival. Further on seeds were exchanged and brought to different places all over the world by means such as human settlement and migration or animals. The results are some main characteristics of crops. First: spontaneous germination which had already been affected by pre-domestication sowing activities. Second: an increase of seed size in cultivated plants (Fuller & Allaby 2009). Third: reduced grain shattering which is the plants' effective seed dispersal. It has been reduced to synaptospermia, making diaspores containing more than one seed disperse as a unit (van Rheede van Oudtshoorn & van Rooyen 1999). In connection to this, a further trait is the automatic loosening of the edible part of the grain from its surrounding chaff (Willerding 1969). Since the Neolithic, farmers were breeders and seed savers that grew so called primitive varieties, providing them with autonomy. Selecting for phenotypic criteria, the healthiest, the highest plant or the most beautiful or biggest ears, had great effects on the evolution of cultivated plants and is called mass selection today. This evolution was slow compared to today's technologies but provided the basis of varieties used in agriculture nowadays (Bonneuil & Thomas 2012).

So in traditional agricultural societies and still in some contemporary societies, seed supply was internalized. Farmers got seeds by keeping a part of their harvest or from their neighbors for re-sowing (Turner 2010). Seed resulting from this practice, taken apart from the personal harvest and re-sown, is called 'farm seed' (Bocci et al. 2012). Different circumstances in different regions of cultivation enabled a profound natural adaption of the plants to local constraints such as the climate, richness of the soil, or diseases. Plants retrieve elements they need from the soil and dependent on what they receive, they evolve. Because seeds were exchanged with neighbors and selected by the farmers for individual needs, plants were and are the product of an adaption to the local constraints including personal preferences of the grower, laboring methods, the societal, cultural constraints and traditions; this is how "landraces" emerged (Kastler 2007). To summarize the way of wild to domestic plants Fuller

& Allaby wrote: “The transition between wild plant forms and domesticated species can be considered an evolutionary adaptation by plants in response to a human driven ecology” (Fuller & Allaby 2009: p.238).

1.2. Industrial seed and genetic progress

A commerce of seeds had established quite early, with some farmers specializing in seed production and seed from different regions was exchanged and distributed via local markets (Turner 2010). Slowly splitting the activities of reproduction and of plant production, at the end of the 19th century, the profession of seed producers appeared (Kastler 2006) and separated plant breeding from other activities related to the “living/vital”. Little by little, the 19th century industrial mode was applied to agriculture, adding disciplines to agricultural research, still rather occupied with chemical aspects than with biological ones, that were not part of natural sciences (Bonneuil & Demeulenaere 2007). An agricultural research sector developed in France, with the major aim to ‘modernize’ the country. First approaches of experimentation in 1884 and laboratories analyzing seed quality were followed by the establishment of regional chambers (1920), vulgarization campaigns for chemical fertilizers and agricultural banks supporting farmers in their investments. Soon after, national schools were created to promote the latest knowledge: in 1921, “agricultural research was institutionalized” and the first public chair for plant genetics established in 1936 at the INA (National Institute of Agronomics), ancestor of today’s INRA department of ‘plant breeding and biology’ (Bonneuil & Thomas 2012: p.20).

It was only after the development of genetics and technological innovations in the 20th century that a violent change occurred in the existing scheme of farmers producing their own seeds in closed seed production cycles (Bonneuil & Demeulenaere 2007). After the basis for scientific methods was given, ‘plant breeding’ accelerated. It didn’t take a long time for enterprises to turn towards specialization and invest into big laboratories for agricultural research (Turner 2010). The first half of the 20th century in France though was marked by the domination of private selection enterprises dominating the market, particularly the company Vilmorin. It was not only holding the monopoly on commercializing their numerous released plant varieties but was also leader in scientific research at the time, with the first laboratory for genetics in France established already around 1900 (Bonneuil & Thomas 2009). Half a century after, in 1946, the creation of the national agricultural research Institute of France (INRA), developed public research and integrated it into the economic system. It was deeply orientated towards the demands of the ‘connected distribution network’ which first was the agrarian world and later became the agro-business (Bonneuil & Thomas 2012). Seeds were conceived as an element of the great momentum of technological progress, boosted and initiated by the needs of a society marked by the wounds of the Second World War. Reconstruction and remodeling a functioning food supply system were priorities and justified the rigorous approach of the

manufacturer's worldview during the Thirty Glorious [years][2] that still influences agricultural structures today. Centralized research and indicative economic planning of a standardized agricultural production seem to have supported the directive, capitalist economic system in post-war France (Bonneuil & Thomas 2009).

2. Farmers become users: excluded from breeding by new knowledge and practices

In the development of this agricultural production system, the farmer had quickly become a simple agent that applies production factors, more or less voluntarily delegating an important part of his/her work. Seed had become one of these rational factors, taken from farmers' fields and hands, placed in experimental stations in research units. It was mainly through technologic and legislative restrictions, that farmers were withdrawn from producing their own seed and from having their say in it, finally making them dependent on an emerging industry managed by a few, practically depriving farmers from autonomy.

It was in that same 20thcentury, that a severe separation took place from an epistemological and social viewpoint: what was once farmers' selection and methods was now called 'profound knowledge' and regarded as inferior to the newly acquired, exclusive genetic knowledge that quickly advanced thanks to costly equipment. At the same time, this very separation was spatial, given the placement of scientists in controllable laboratory atmospheres and farmers in their natural environment (Bonneuil & Thomas 2009). According to Callon et al. (2001), the specific laboratory approach consists of a reduction of complex issues by simplification, manipulation and observation of their relation to assumed realities with a final confrontation of new results to the real world in field experiments. Laboratories isolate the microcosm, aiming for an exclusion of the social macrocosms and its interactions in order to produce repeatable experiments (Callon et al. 2001). Concentration and institutionalization of plant genetic research, fueling the "fantastic progress", actually increased independence and distance from natural environments (Kastler 2006: p.53). Aiming for maximum yield and productivity, research vaults environmental limits by using chemical fertilizers and pesticides that homogenize but also sterilize the plants' environment. The example of wheat shows how productivity influenced selection. A 'triple compaction' is the result of selection, under high-input conditions, for dwarfism[3] (more efficient use of fertilizer, less straw), compact ears (more, heavier grains per ear) and high protein content. "This process in plant breeding introduced and distributed a kind of distancing scientific culture in the social body, marked by separation and even rupture towards nature, in order to know, transform and use it.[…] The particularity of plant breeding is that this phenomenon has

2 From the French term 'trente glorieuses' associated with the 30 year period between 1945 and 1975, marked by strong economic growth and demographic boom in France. It is also referred to as 'postwar economic boom' or the 'Golden Age of Capitalism' in contact with other countries.

3 Traditional varieties were up to two meters high, while modern varieties are rarely taller than 70cm (Bonneuil & Demeulenaere 2007). Because of dense sowing, the plants tend to tilt over, making harvest difficult, this is why sometimes additional growth regulators are sprayed.

clashed with a vision of nature inherited from peasant societies" (Hervieu 2004: p.1). Plants, adaptable as they are, leave the specific conditions of cultivation in breeding stations and are released on the market. Promising high yields and stability, they slowly infiltrate the farmer's fields and minds with this production model. The following pages will show that this model imposed the same conditions of cultivation on farmers in order to be successful (Kastler 2006). It will be explained that in a rush of modernization, farmers abandon their traditional population varieties for performing new creations and hybrids.

2.1. Varietal Innovations

The change of roles and modes in agriculture, over the past 150 years can be traced regarding the appearance of varietal innovation supporting the relative mode of production. In the background of a war-marked countryside after 1945 and of governments trying to increase agricultural production and food security, the characteristics demanded from plant varieties were primarily controllability and uniformity. Population varieties were widely spread under farmers' cultivation at this moment and selection was affected within them. Incarnations of immanent heterogeneity, they were not responding to the new criteria (Gallais 2004). Many of these, mostly well adapted to locally conditions, 'ancient' population varieties would soon be marginalized and replaced. To eliminate the factor heterogeneity in plant material, research focused on creating pure line varieties (Bonneuil & Thomas 2009). Pure line varieties[4] are genetically similar[5] and "possess [a] narrow genetic base so they are more susceptible to diseases, and have poor adaptability. A pure line breeding method" or "individual plant selection" isolates "desirable types [that] already exist in [the] population" "through careful testing procedures" (Theagricos 2013). The introduction of individual plant selection (intra-population) in 1859 by Louis de Vilmorin has triggered important proceedings, leading to the 'purification of self-pollinating cereal populations'. Thanks to their intrinsic stability over time and space, pure line varieties seemed to be the perfect material for experimentation, subsequent to the a accentuation of standards of evidence and homogenization, a conception of the ideal varietal purity established (Bonneuil & Demeulenaere 2007). To achieve fixation of criteria in open-pollinating varieties, controlled hybrids were developed.

In 1903, George Harrison Shull and Edward Murray East independently rediscovered the inbreeding depression and that crossing two inbred lines results in a hybrid characterized by a vigor superior to the mean of its parents (Crabb 1993); an effect already observed by Charles Darwin and formally known as 'heterosis'. The introduction of hybrids in the start of the 20th century, brought along a 'biological product', produced by manipulations using forced inbreeding and controlled hybridization, that did not exist in nature beforehand (Duvick 2001). To be able to control this type of varieties, that take up 90% of maize grain in Europe and the United States today, took about 50 years (Gallais 2004). Maize (*Zea mays*) is a

4 Pure line is a self-pollinated descendent of a self-pollinated plant (Theagricos 2013).
5 They are homozygous and homogeneous.

common example and nowadays for many people a symbol for biotechnological progress and productivity but also emblematic of environmental destruction and monocultures. It's the most frequently used species for uncomplicated hybridization, because of its male (tassel) and female (ear shoot) reproductive organs situated apart and pollinated by wind (Duvick 2001). With this cross-pollinated species, pure inbred lines (mainly homozygous) are produced by artificially self-pollinating several generations. The first 'single cross hybrids' obtained from crossing two inbred lines, were weak and low yielding, therefore not profitable for large scale production. A rapid acceleration of maize hybrid production was guaranteed, after the problem of seed costs was solved. In making 'double cross hybrids' (by crossing two single cross hybrids) from parents with higher seed yield and lower seed cost, high returns on financial input could be made. Later on, as the inbred lines had advanced, the production of single cross hybrids was sufficiently seed producing and economic (Duvick 2001). So the advantage of these is their vigor, allowing extra yield. Furthermore the exact reproduction of individuals is possible, as they were obtained from parents that are stable, uniform inbred lines reproducible through self-pollination. Once defined, a specific hybrid can be mechanically reproduced on a large-scale. The vision of seeds as a manageable factor of production supported this process of the standardization of the 'variety' in itself; but also the advancement of other factors of production such as technical tools and chemical input, resulting in an adaptation of the 'modern' varieties to this increasingly mechanized mode of cultivation with high input but also to industrial transformation. Bouharmont (1995) estimated that only a part of the increase in cereal yields since modernization is really due to genetic improvement, a part equal in size to that of agronomic technologies. After Johannsen clearly demonstrated the obtaining of a 'pure line' on beans in 1903 (Gallais 2004) and due to the process of genetic inventions over the course of the 20th century, the notion of 'variety' had changed. In the societal consciousness it was no more the population wit intrinsic diversity but became symbol and source of standardization in agriculture.

Given the fact, that new hybrids were very expensive and needed all this input, were farmers not skeptic? What made them abandon their traditional varieties so quickly and was that easy? The social mechanisms and circumstances involved in this development will be examined in in the next paragraphs.

2.2. Adoption of new technologies

New varieties and innovations luring with increasing possible yields can be deceptive considering the loss of autonomy and turn towards dependency on a centralized sector. But what made farmers give up their "time-honored practice of saving their own varieties of seed in favor of annual purchases of hybrid maize seed" (Duvick 2001: p.69)? Giving up independency has happened before, when farmers considered that it was more profitable to do so. Duvick (2001) compares it with energy: shifting from horses to fossil fuel driven tractors; and he compares it with workforce: moving from manual harvest to machines which, both

brought along a higher level of comfort and 'efficiency' but also a higher grade of dependency. In the case of seeds, one could wonder if it was really to the benefit of all. Henri Mendras, a renowned French agricultural sociologist and former research director of the French National Centre for Scientific Research (CNRS) pointed out the tight interweavement of agrarian technology, societal relations and tradition in agriculture. From a sociologic view on 'traditional agricultural societies' all beginnings are difficult. Innovations regarded as 'progress' on the outside of a mentally closed societal frame might meet obstinate hard-bitten opposition (from inside of the frame), just because the outside opinion is a potential aggressor and discloses a weak point of the group in that frame. But once started in that frame, every transformation determines the transformation of the others (Mendras 1967).

At the beginning farmers were skeptical of improved varieties from research centers because they feared scientists to overestimate themselves and the impact of research (Duvick 2001). The generalizing scientific and technical knowledge produced opposed to the particular knowledge acquired from experiences over years by peasant societies. The application of economic concepts to agriculture forced farmers, who's ruling priority had been the family's well-being, to change their comportment. New economic circumstances needed them to act as an 'economic agent'[6], favoring high yields and revenues or to vanish (see annex 2)(Mendras 1967). Increasing economic pressure was accompanied by social pressure from the rural community (social frame) that was converting to 'modern' varieties, leaving behind those that deny progress or fail to keep up (Mendras 1967; Bonneuil & Thomas 2009). With the liberation of markets, this concept was extended over the planet but a majority of family farming systems still exists in the south (Kastler 2006).

In the course of the 'agronomic progress', in 1949 the French state encouraged its promoters: public campaigns, associations and agricultural labor unions. Demanding farmers to follow the states advice in advertising films was to assure the adoption of hybrids, on the mission to modernize (Bonneuil & Thomas 2009). Additionally, well-known, respected farmers were sent out into the fields as salesmen and advisors by seed companies. They were to persuade farmers to try hybrid cultivation and collect important information on farmers' needs at the same time (Duvick 2001). Bonneuil & Thomas (2012) speak of a "convergence of interest" between public and private seed companies, when it came to encouraging farmers to buy these 'improved' seeds "for hard cash" (Bonneuil & Thomas 2012: p.21). Duvick (2001: p.69) underlines the mutual contributions and exchange of resources between private and public breeders as a condition for the rapid success, because genetic material and knowledge were less explored in the early years of varietal innovation. The social acceptance of the 'genetic progress' was not as easy as one might think, but pushed forward and accompanied by a complex legislative strategy.

6 Like 'homo economicus', the concept (fiction) of a rationally acting person with full understanding of the market, that pursuits maximizing individual profit.

2.3. Complex legislations form a commercial seed sector

Once a common good, kept accessible to everyone (through money, exchange or for free), seed had been discovered to be a 'profitable good' and was regulated by law. A 'formalization' ensured for producers of improved seed to have returns on sales and therefore to be able to make it a professional activity and work with advanced means and technology (Elena & Bustin 2006). Farmers, in consequence had access to modern, high yielding varieties sold for a higher price but with a guarantee of minimum standards by certification (germination capacity, humidity, purity). This was meant to guarantee productive homogenous sources for long supply chains, on the move to industrialization and concentration. Made possible by the integration of a wide range of domains (plant physiology, pathology, agronomy, genetics) INRA was working "in the interest of the nation", "bringing prosperity to private enterprises and farmers" (Bonneuil & Thomas 2009: p.161, 162). It had for a mission the renovation of the plant breeding concept through the production of knowledge and to bring it up to 'modern standard'. The most modern techniques and methods were to be used as means to create high-performance varieties for commercialization. In cooperation with regulating organizations of the supply chain, it was to evaluate and diffuse them. Even more after the success of maize hybrids in America and importations to France due to a lack of this seed, the public and private institutions under pressure of seed multiplier unions put weight on the installation of a national seed supply in France (Bonneuil & Thomas 2009).

Framing this professionalizing seed market with property rights was increasingly demanded by actors situated in the start of the supply chain. For wheat, an optional national register of selected plants was established in the 30ies and gave the right to have a variety registered, like a brand, for twelve years. Placing a variety in it demanded detailed information about its origin, characteristics, and way of obtaining plus controls of identity and stability of this variety. For further information for farmers and to prevent the abuse of confidence by others, all bags containing wheat seed had to be labeled. The reserved inscription "wheat from selection" indicating pure lines or a rather homogeneous content can be seen as a first step to a devaluation of more heterogeneous material such as population varieties, and those from mass selection like traditional and local ones. A further constraint for the inscription of plant reproductive material in the register that was extended to all cultivated species (1932), was the addition of the criteria 'distinctness' 'uniformity' and 'stability' (DUS). For registration, a variety had to present 'genetic progress' as well. In 1949, it became obligatory to inscribe all varieties in that same register (or catalog) in order to exchange or sell them (Bonneuil & Thomas 2012). Especially thereafter it got harder to enter the profession of seed producers and farmers are no more part of innovation and creation of varieties. Introduced in the 1960s intellectual property rights on living organisms clash with the anthropologic vision of live and its reproduction, making them a means and resource (Azam 2008).

The ‘international convention for the protection of new varieties of plants’ signed in 1961, established the ‘Union for the Protection of New Varieties of Plants’ (UPOV), harmonized rules between European states and was revised three times after that, (in 1972, 1978, 1991) each time bringing a further extension of the breeders’ property rights. Important to retain are the establishment of Plant Breeders' Rights (PBR) and patents which constitute a further step in the exclusion of farmers and their role of users. PBR protect the creators of new varieties (for a limited time) in giving them exclusive control about production and sale. In order not to block research, they are accessible to other breeders which is not the case for patents (GNIS Pédagogique 2013). The obligatory inscription into the catalog today still is a real obstacle. Financially, scientifically, technically and first and foremost ethically: the vision of a variety as homogeneous and stable is not in accordance with the vision and aims of evolutionary breeding, adaptation of varieties to local conditions or even breeding for organic agriculture for which diversity (at all levels) is factor of resilience. The legislative ‘strategy’ developed into a big system of certification and quality control involving a number of organisms with different roles. The situation of farm-saved seed[7] as it was practiced for millennia was restricted little by little, leaving less and less space for diversity on the fields. Its regulation is ambiguous, forcing farmers into a system that is time consuming and confusing to understand. Differences can be observed between a natural and an industrial conception of the process of vegetative reproduction. Parallel to varietal innovation, a ‘formalization’ evolved. It is characterized by officially named varieties, to be found in listings or catalogs, that come from contractual seed production integrated in breeding programs controlled and guided by certification systems and sold in officially sealed packages only after specific treatment and purification (Turner 2010). All this entailed a development of experts and specific knowledge that takes up an increasing amount of space. Is that the reason for making it so incontestable?

2.4. About the legitimacy of scientific knowledge,

Science and technology have been playing a major role in the development of the actual agricultural vision. Certain groups like agronomic sciences and the ‘agribusiness’ seem to have a dominating role. Emphasized and justified by ‘expert knowledge’, they seem to be the creators of knowledge and orientation in agriculture today and thereby define the pathway of the main agricultural practices. This exclusive expert knowledge seems to be reserved for a certain number of people by marginalizing common knowledge at the same time (Richardson 2005). Scientific wisdom seems to be the only and undisputed way to produce knowledge in the world that counts and that is reliable. Vandana Shiva, physicist, philosopher and renowned environmental thinker calls it ‘intellectual colonization’ when ‘western’ traditions of

7 To reuse the seed harvested from a precedent culture to sow it the next year. This practice is possible under certain conditions and for 21 species in Europe. It practice is forbidden under French legislation except for common wheat if royalties (usage-based payment to the breeder) are paid. Farm seed in France represents variable parts, depending on the species. From 2002 to 2005, 30% of canola and 46% of winter wheat was farm seed for example (UPOV, 2011).

knowledge spread over the world being regarded as a 'universal tradition' instead of a globalized local tradition that developed in a specific cultural context founded on power as a value. She also points out that the recognition of scientific (coming from the western cultural context) as superior over local traditional knowledge is based on power and not on the actual content of the knowledge: "The scientific label assigns a kind of sacredness or social immunity to the western system. By elevating itself above society and other knowledge systems and by simultaneously excluding other knowledge systems from the domain of reliable and systematic knowledge, the dominant system creates its exclusive monopoly" (Shiva 1993: p.11). This position of being scientific is not contested today, even though alternative epistemological currants challenge former assumptions. Shiva (1993) explains that local beliefs are socially constructed whereas theoretical scientific concepts are often reduced to directly verifiable observable claims without democratic social implication. This topic will now be discussed, showing that farmers have delegated the production of knowledge and find themselves in penury.

2.5. The relation between subject choice and available means in science

In the article 'From Academic Imperialism to the Civil Commons' the link between knowledge and sustainable development is established (Sumner 2008). The author differentiates 2 ways of action: one is 'academic imperialism' having its origin in the interpretation of sustainable development as a business model, which is "capital accumulation on a world scale through academic means" (Sumner 2008: p.77). The second way of action is the promotion of public goods, accessible to all community members, based on cooperation and on equity on all levels, from local to global. Philosopher John McMurtry developed the concept of civil commons which is involved in the latter: "any co-operative human construct that enables the access of all members of a community to life goods" (McMurtry 2001: p.820). In view of education and knowledge, this would be related to non-proprietary research that benefits everyone, and doesn't produce profitable goods. Sumner (2008) sees this type of research marginalized by commodity-driven research, such as GMO development, resulting in products of private ownership, industry-funded academic chairs, building private not public wealth. McMurtry states the national strategy of the Canadian AgriFood Research Council which explains that increasing competition for research funding demands research priority setting on fields that valorize the investments. This implies that sponsoring bodies fund research on topics that accompany their preferences: the private sector, as one of these intermediates between the scientist and the research topic, keeps scientists informed about current market developments and needs of the industry. They are involved in the identification of topics and decision-making processes via private-public partnerships (McMurtry 2000). When increased costs trigger a decrease of governmental research in public

interest, it is quite a logic development to see an accumulation of industrial opportunities and products responding to industrial needs (Clark 2000).

3. Where are we today?

3.1. Loss of peasant know-how: confidence & means

The de-valorization or "de-legitimization" of common field knowledge by 'superior' academic wisdom, as Richardson (2005) calls it, seems to be considered as the first step in the disappearance of local knowledge. But shouldn't they be complementary? During interviews with farmers in Brittany, France, it became quite clear that what was formerly habitual and common knowledge within the farmer communities is less and less existent in today's generation. Resulting from the development of genetic progress and legislation, farmers were 'expropriated' from a centralized seed sector. Their varieties and with them, the treasure of the adapted know-how, wisdom, their cultivation, use and their cultivator's identity were principally swiped off the table (Bérard & Marchenay 2004). This practical know-how in plant reproduction had been indispensably inherent to generations in the agricultural profession. Due to a specialization and reorientation of the agricultural profession during years of modernization, it was neglected in favor of new, different indispensable knowledge. A modern lifestyle makes no more use of know-how formerly part of the "collective memory" (Tolley 2001: p.3) and necessary for autonomy in nutrition, healing or even essential for survival. So to be independent today can be considered as difficult regarding the delegation of 'knowledge production' to others and a lack of confidence. Intimidated by technology and academic science, there is low consciousness that a re-acquisition of these instruments (practical know-how, adapted farm seed, etc.) is possible and necessary due to the evolution of conditions (social, politic, environmental, etc.). A farmer, searching for autonomy, especially in plant selection therefore seems to be a person with strong awareness and will to re-appropriate know-how and instruments for self-governance.

After seeing the formalization of the seed sector and the rising importance scientific knowledge, the influence of economic factors will now be illustrated shows. The application of industrialization to agriculture triggers the neglecting of traditional know-how and farmers jump on the bandwagon. The next paragraphs will show tendencies in the seed sector, as everyone tries to keep up to high productiveness, disparities increase.

3.2. Status quo: a profit driven seed industry?

In Europe and North America a seed industry that was not totally separated from the industry of other agricultural goods like fertilizers, phytosanitary products and seed treatments, machinery and some composed animal nutrition (Gura & Meienberger 2013; Howard 2009). Today, the mayor profitable part of seed supply is 'externalized' and run by private companies within organized commercial open-end supply chains, whereas 'internal' closed-circuit seed supply still coexists with this model and faces specific constraints. (Turner 2010).

The claim of property rights and technologic innovations in plant breeding that act as barriers for (useful) reproduction are considered by alternative currants to be used as proper 'strategies' by a few multinational companies taking into possession the genetic commons. Individual critical authors may call it 'The Greed Revolution' when 'mega foundations [and the] agribusiness muscle in on public goods' (ETC Group 2012). Sumner (2008) fears the "industry encroachment into institutions of higher education" might "block" development in alternative sectors such as "organic agriculture, which does not allow the use of GMOs […] from becoming established" (Sumner 2008: p.84). Lallau joins in by questioning the "diffusion" and "financing" of GMO seed "without public debate and democracy" (Lallau 2012: p.9). In difference to the 1930s, today many farmers' primary fear is that products of scientific laboratory creations could escape our control. While 'natural methods' (transferring pollen to stigma), were used to create hybrids in the 1930s, transgenic crops are obtained with laboratory manipulations[8] (Duvick 2001). To what extend can scientific progress be questioned? Duvick (2001: p.73) suggests that only today's 'advanced biological knowledge' permits to be critical about environmental, ethic issues and to scrutinize food quality: would that have been possible beforehand? As Nicolas Supiot (2013), farmer-researcher in Brittany points out, it is not critics of science itself, but the manipulation of nature and non-systemic approach. Some farmers see it as more convenient to adapt farming methods and varieties to ecosystems and benefit from their 'multi-functionality', rather than adapting environments to varieties created in a reductionist approach (Uniterre 2013). How these patterns of thinking in plant breeding established over the last years have effected biodiversity and therewith farmers' choice will be explained next.

3.3. What happened to Biodiversity?

The search for homogeneity in breeding for mono-genotypic varieties has indeed permitted a significant increase in yields and mechanization but also "the ransom of genetic progress" considers Gallais (2004: p.2). Genetic diversity is a desirable feature, considering the protection against environmental stresses like weather extremes, diseases or insect pests. Genetic diversity has reduced on farms because hybrids and pure lines are genetically more uniform than open-pollinated varieties (Duvick 2001). Furthermore because of the 'division of labor'[9], which implies specialization in the place of crop diversification on farms. The dynamic of negative environmental impacts triggered by a transformation of agriculture, for which improved varieties are a symbol, is little contested today. The Food and Agriculture Organization of the United Nations (FAO) confirms that "The main cause of the genetic erosion of crops - as reported by almost all countries - is the replacement of local varieties by

8 "Gene transfer across very wide taxonomic distances does occur in nature but not through gene guns or tissue culture, and the products are not multiplied and distributed so widely and rapidly as transgenic farm crops" (Duvick 2001: p.73).

9 Is amongst the standardization of products and special purpose equipment a major principle of the application of Fordism, a mode of mass production and –consume established after World War First.

improved or exotic varieties and species." "Often, the number of varieties is reduced when commercial varieties are introduced into traditional farming systems" (FAO 2004: p.5). Instrumentalized by the delegation of seed saving and selecting activities, slowly adopting the genetic development, farmers bought the pig in the poke. The new farming mode is not only 'standardized' but 'standardizing' (Demeulenaere & Goulet 2012). It rationally considers biodiversity as 'genetic resources' (Bonneuil & Demeulenaere 2007). Scientific progress as premise for the 'green revolution[10]', had on its' coat-tails a rapid expansion of chemical fertilizer necessary for crop protection and success. Heavy insecticide and fungicide use facilitated crop management on one side but sterilized the natural biotic environment on the other. To sum up, farmers are deprived from political and economic independency and free choice through the abandon of multiple local varieties and landraces as "some 75 percent of plant genetic diversity has been lost" since the 1900s (FAO 2004: p.3). According to Kastler (2006), by the end of the 20th Century, crop biodiversity had 'left the farmer's fields', mostly due to legislative aspects, to be stored in freezers and in collections. It was seen as a third separate activity, disconnected from the other two: food production and institutionalized plant breeding.

One can comprehend the claim of the millennia-long right to re-sow the seeds from one's harvest. Same goes for the sentiment of unfairness when seeds, the 'stolen' civil common, are utilized without recognition and privatized without any return (Shiva 1993). The recognition and awareness on official and international level of the Erosion of biodiversity has boosted the support of farmers' rights. The 'International Treaty on Plant Genetic Resources for Food and Agriculture' of the FAO (Article 9) acknowledges the 'enormous contribution' of 'local and indigenous communities' to 'conservation and development' of plant genetic resources - essential to agriculture. It calls governments to account for its protection and promotion. Concerning the use of plant genetic resources, important points are the protection of traditional knowledge and the rights "to equitably participate in sharing benefits [and] in making decisions, at the national level" (FAO 2013a). An inter-governmental working group of the United Nations declaration on the rights of peasants and other people working in rural areas was established to deliberate on a juristic means (UN Declaration) for the specific rights of peasants: access to land, seeds, or information for example (La Via Campesina 2012; UN 2012). What does it mean to fight for farmers rights in the domain of seeds? What opinions for the future? The search for autonomy becomes an adventurous journey that will be extrapolated in the second part of this document, keeping in mind a key question: what kinds of seeds are wanted for what kind of agriculture?

10 A term primarily applied in the context of developing counties, signifying a politic of modernization for agriculture with the object of achieving food security. It is linked to the use of expensive chemical inputs and seed.

Part II: Farmer-researchers

4. Necessity enforces creativity: farmer-researchers

The creation of knowledge is an important success factor for farmers that fall out of the standard agricultural framework. Especially to organic and extensive small-scale agriculture, often situated on extreme geographic locations and situations, the classic model is not adapted. Is not only not adapted, but there is simply no reliable alternative model (Richardson 2005). If one wanted to start up a farm in conventional agriculture in contrast, one would have data, orientation and a clear concept to follow. For a long time now, research and knowledge production has been done following a productivist logic of intensification and standardization, resulting in mainstream production models. These are orientated on easily assessable factors like input (e.g. fertilizer, phytosanitary products, fuel), crop management practices, crop development (e.g. growth rates, plant development stages) and productive output (e.g. products, manure). One would be much more efficient than another one that's starting up on an alternative concept, breaking with the well-established classic vision. The pre-made, ready to apply recipe aiming for optimization considering rational production factors is not suitable for everyone (Desclaux et al. 2009). It is not adapted to certain types of agriculture because the fundamental values and objectives are not the same. Many farms might resemble each other, but underlying there is an enormous diversity of contexts. Just like personalities and locations are very different, each and every one is situated in a special, individual agro-ecologic and socio-economic environment. Not only soil, climate, crops and distribution channels differ, but markets, expectations and personal preferences are susceptible and depend on local societal structures and cultural values (Krämer 2013); therefore they have to be taken into consideration too.

This diversity of situations as constraint to a one-fits-all solution demands that one responds to it with diversity itself, may it be in products, species or varieties. So in order to achieve his/her personal goals the farmer is led to be creative and experimenting, define his/her functioning and mode of operation because he/she cannot rely on ready-made guidelines for his/her situation. So in the very basic sense of the term, a farmer-researcher is a farmer who is practicing research in the framework of his farming activities. But what is he/she searching for? There are many personal things to search for. He/she might be curious to understand processes and phenomena that he/she works with in everyday life. Certainly he/she's on research for optimization of the farm system, which could mean to increase the quality of the products, their social or ethical value, to lead the farm to perfection by optimizing efficiency towards a satisfactory production level, limited workload and financial independency. It is clear that diverse worldviews imply diverse aims and priorities (Darnhofer et al. 2012). The words 'efficiency' and 'profit' can mean different things to two people, regarding their personal criteria. So isn't every farmer, in his/her individual situation, a farmer-researcher? An important point in this reflection is awareness: A farmer-researcher is aware of the

individual socio-political situation he/she finds him/herself in, and pursuits change towards more sustainable ways of production and living.

But why exactly? What are the farmer's personal motivations to do so? It is his/her individual situation – and because there is nobody that does it for him/her, as Dominique Bourdon illustrates: "I don't expect anything from other people." (Bourdon 2013). To be able to take matters into one's own hands and be independent from a system with which one cannot identify is a great motivation and personal affirmation. It can be out of political commitment, a wish to promote organic or low input small scale agriculture and change the way things are done today. Step by step, he/she is going further in reaching for a fairer, more sustainable, more natural way of dealing with food production, in a healthy, conscious society. In the end this is the reason why he/she intentionally calls himself/herself a Peasant (in French 'paysan' literally is the one who comes from the 'pays' which means country). For many it is not sufficient to lethargically carry out tasks as they have been popularized, but to search for alignment and revaluation with one's personal context, criteria and expectations. It is a thrill and an enjoyment that pays back when seeing the results and rewarding clients appreciate the quality of products.

At this point it is important to state also what is not meant by the term 'farmer-researcher'. There is no wish for identification with classic academic researchers, whose position is not the same. These are, as Bernard Hubert (2002) explains in his article, subject to expectations and framed by certain limits. In the first place, they do research because that is what makes them earn a living while being situated in a social environment with norms and customs. It is important to consider that a research program always aims at satisfying different partners (Hubert suggests 3 categories: financers, beneficiaries, on-field operators) that each don't intend the same results and impacts, even amongst their own category (Hubert 2002: p.52). Besides, institutional pressure and recognition in the academic world is often linked to the pursuit of proving things and finding predefined novelties. The quality of classic scientific work is most often measured by the approval of the constituent and sponsor or numbers of publications in certain magazines. So the classical fields of research quickly become limited, depending on the judge and criteria used to identify them as "problematic in the real world" (Darnhofer et al. 2012: p.18). Finlayson et al. (2005) also point out the influences of political and ideological forces at work when prioritizing and adjudging adequate research methods or topics. Academic research is often cost intensive, making studied subjects evolve from lucrative contexts and possibly in favor of influential groups (Levidow 1998; Vanloqueren & Baret 2009; Diedrich et al. 2011). The general intention though – to serve many – isn't in opposition with the concept of a farmer-researcher. The point is that his/her object of research is chosen by him/herself and evolves from dynamic practical issues. In order to make headway real needs have to be addressed - these are best known by the individual person in need. Ethic and social criteria determine a clear position in a local context and demand realistic, practical results without any need to proof something, which creates a frank and

open research atmosphere. Often a broader viewpoint is found that appreciates intuition, spirituality and personal inspirations for which scientific rationalism doesn't offer space. A conception of the 'living' as respectable element of nature gives a different base for interpretation when working with nature. This way of thinking though is quickly disqualified by people that live and work in a different vision. The methods used for research can either happen to be well recorded in a precisely defined protocol, or simple field experiments conducted without repetitions and 'double blindfold' consumer studies, it is not what matters the most. The difference here again lies in the interpretation of results and the aspects of the results that are thought of as important.

In order to acquire know-how, an important means is social learning and exchange. Farmers will join their colleagues and interested citizens to experiment together, which already evokes the important knowledge co-construction process in this approach of individual learning. How do exterior actors see the issue of farmer-researchers in smallholder farming and is it as sustainable as it seems?

4.1. A Peasant agriculture refocuses on local connections and independence

Many authors and public institutions agree that smallholder farming is a sustainable solution for today's situation (FAO 2013b). Without wanting to erase the highly developed, industrial kind of agriculture that exists today, there are many farmers that want to propose and live alternatives. What their colleagues might consider as 'going backwards', has proved to make sense to them. One has to consider that the wish to turn towards small structures and local valorization and less technology is a whole mindset or world-view. Because of its complete distinction from the general mindset and underlying paradigms it can easily provoke a "Shock of Model" (Lallau 2012: p.6). Smallholder farming with integrated crop and livestock farming is certainly less competitive, but can be a lot more productive and profitable than large scale industrial farms if measured on the whole farming system, not per product (Hoffmann 2011; De Schutter & Vanloqueren 2011). A high productivity per surface unit and the lower induction of inequalities is one of its strength and meets great possibilities of improvement. This consideration does not work when seen through the eyes of an industrial measure that privileges high production per unit of labor time though (Lallau 2012). The arable land on the globe is not extendable (without major environmental impacts such as massive deforestation) and unequal access to land is a major societal problem. The rural exodus of the past and ongoing years is proof of mechanization replacing agricultural labor. Unemployment and global migration streams are abundant issues of our times. Considering a de-mechanization and re-diversification which implies increased manual work, one can increase labor holding capacity on a farm. Peasant agriculture seeks to create jobs on the land. Reduced technological input could result in lower artificialization of agrarian ecosystems by more sustainable cultivation practices. A consideration distanced from agro-industrial values, such

as profit maximization by increasing production capacities, could allow lower pollution. Structures of smallholder farming that exist today are proof of a higher caretaking and respect for the soil in a long term perspective of fertility conservation for future generations - or because of economic and cultural dependency on a very piece of land (Lallau 2012). Farmers' anchorage and identification in localized cultural environments results in higher diversification and valorization of the final products. Considering these advantages, measuring productivity per surface unit isn't such a bad idea. But it is of upmost importance to acknowledge that this implies a whole new consideration of efficiency: its definition could be pushed further into social, ethic and environmental concerns instead of limiting it to productivity.

A whole choice of lifestyle and voluntary rupture with the actual system lies behind the intended announcing of the term 'peasant'. Way more than questioning currant cultivation practices, it is about identification with values of rural communities before agricultural modernization, about social interactions, a close relation to 'the living' and about an identity as a group. A sharp distinction is made from the instrumental role of farmers in 'economic systems' where the farm is conceived as a business or operation[11] part of a supply chain and symbol for 'modern' post-war agriculture (Demeulenaere & Bonneuil 2010). "Here, this is not a farm where we search for techno-economic results, we search more the whole, fulfillment, to do lots of things, meet people" (Mercier 2013). Farmer-researchers are modern 'peasants' that want to regain individual strength, be independent from a dominant model, take decisions that they want not must, re-take things into their hands. This leans on the model of traditional family farms seeking for autarky and social stability of their community (smallholder farming). Especially former urban dwellers and non-natives that didn't grow up in an agricultural context reconsider their way of life and become farmer-researchers. They often cultivate on small, marginal surfaces. This is a reason why some start in new agricultural structures together. Some farmers share their land to offer others the opportunity to settle in collective structures (e.g. baking, vegetable growing and milk transformation activities on one farm). "To be peasant baker is rather a consequence than an objective […] I have decided to choose a way of live that is coherent with my values, to try to have, what movements like the one around Pierre Rabhi call 'happy sobriety[12]'"(Supiot 2013). This is what Nicolas Supiot, who grew up in the city, said in an interview at his farm in Brittany. This lifestyle was his choice, because "an industrial economy cuts off man from its relation to humanity and the 'milieu': nature" (Supiot 2013).

The French 'Confederation Paysanne', movement and union for peasant agriculture and agricultural worker's defense, supports six important themes in order to re-find sense in farmers' work which should be to feed and not to produce. Those themes are local

11 In French: 'exploitation agricole' is usually understood as the 'farming enterprise', but the term exploitation also stands for 'exploitation' (like the English word) meaning abusive utilization.

12 Voluntary decrease of consumption of material goods for a greater pursuit and appreciation of essential life values.

development, equal repartition, quality, working with nature, autonomy on farms and transmission to following generations (Confédération Paysanne 2012). In 1998, the FADEAR[13] established the charter of peasant agriculture ('Charte de l'Agriculture Paysanne') which represents 10 principles including the repartition of production volumes in order to permit more people to be farmers, live of farming, and be part of local development which promotes shared prosperity. Solidarity with peasants from other regions as well as privileging long-term reasoning and aiming for independent functioning of farms is accentuated. Furthermore, the respect of nature is emphasized, implying the valorization of abundant resources while economizing rare ones as well as the maintenance of animal and cultivated biodiversity. Additionally the research of quality and transparency of production, and processing in direct contact with consumers and the civil society (FADEAR 2012).
In the previous paragraphs the reasons and motivations for farmers to become farmer-researchers were shown. Some economic aspects in relation to such innovative ways of farming will now be disclosed.

5. Social aspects compensate for financial limitations

"I searched to overcome systems with which I disagreed [...] and also from an economic point of view because there is a time when you realize that what makes the system work is money - I'd say even more than my ballot paper. Even though I had little money, my choice was to choose a life where I had less recourse to money in order to regain my sovereignty: it goes through a process at the time called food self-sufficiency [...]" (Supiot 2013). Of course, farmers live in the same world as everyone else and are certainly dependent on structures like financial security and "generally you want an income!" (Bourdon 2013). There is often voluntary work involved, due to a lack of workforce which is to attribute to a lack of money. The increasing farm sizes might suggest that smallholder farming is not paid very well, but it is about finding a balance and a way to do the job one loves. "It would be easier if it were 2 or 3 people, able to replace each other but specialized and working together" (Bourdon 2013). There is a "lack of financial and human means in associations and among the peasants" says Florent Mercier (2013) who is committed to working with peasant seed and reasons that those who are innovative are always people who are overwhelmed with work and have plenty of things in their mind, just like associations working around innovative subjects. There are always shortages of means but the social structures, the close links are what compensate for it. The networks that hold tight compensate for the weaknesses. Even if at some moments an association goes through a difficult phase, there is always the network. What F. Mercier (2013) said is well illustrated by a number: the interviewed farmers spend about 10 to 25 % of their working time in social relations, which is principally 'exchange of information' of all sort. But who are these social partners? And how does such a farm function? The next lines will briefly illuminate the interviewed farmers' activities and social relations.

13 Associative federation for the development of agricultural and rural employment.

5.1. Innovation is needed for a coherent farming system. 3 examples

This research for alternatives is constructively carried out in all day life. Peasants, alternative farmers, are silent but powerful militants, taking direct peaceful action on a local scale. It is a peaceful movement that begins with the transformation at the center – in every person itself. It seems as if there is a dynamic process that these farmers go through, starting by a transformation of their own farm, searching for coherency, for the application of their worldview in a farming system. Peasant baker Dominique Bourdon explains that what he wants is "to produce food for clients, organize direct selling, to exchange with people, explain, create a better world", whereas the production is not of first importance, "it could have been something else, other than bread". To promote a way of working 'out of the dominant model for a better future' is what unites these farmers in love with nature, which also have diverse personal objects as the next paragraph will show.

Dominique Bourdon, having worked in a completely different domain before, bought some land. Then he started to restructure and diversify by planting trees and hedges on his land. First in small animal production, the demand of customers was at the origin of the development of household activities into professional ones: milling, galette[14] and diverse bread making. He chose his cereal varieties in relation to his soil, climatic conditions, adaptability to baking and cultivates his soil with plow horses. The contact with horses and the reduction of energy consumption are main motivations for his way of working. The reject of recourse to money from the bank reflect well the search for independence from the dominant system, which has money as a symbol. "I want to imagine another way of farming; even if it's difficult I want to try. I would like to find solutions to develop another way of life, to have another development of farming. It's not easy but I like that". His interest to closed production circles by on-farm transformation and direct selling to customers also comes from curiosity to see and understand the consequences of each step. "When you're only a baker, you suppose [things], but now I've seen: when you do this you have an impact on that". Searching for constant challenge and reflections, loving to solve problems, he wouldn't mind delegating his baking activity to someone and concentrating on the development of another. "The farm exists now and it works, it could continue like this: try to get more customers, sell more bread, have an income, and a good life. But I like experimentation, I know how to make bread now, I would like to learn something else, manage a project, […] continue in Organic Farming, […]". His spirit of innovation is fueled by the will to promote a sustainable way of life which he shares with his social network. The exchange of help and machinery with neighbors, oral contracts with farmers and consumers, self-service in the farm shop without sales person and participation in community funded projects show the reality of trust-based relationships as part of his vision for the future. Through personal networking activities, with

14 Traditional thin large pancakes from Brittany made from buckwheat flour.

customers, suppliers, farmers or neighbors that also work with plough horses and in regional groups of organic growers association like 'Nature & Progrès[15]', professional discussions and philosophic reflections are means for the exchange of information (Bourdon 2013).

Florent Mercier, passionate about wheat cultivation, is in the second generation of a mixed production system with a fixed, well defined concept of products and good relations to consumers established. Well aware that soil quality is the great weakness of the 72 ha farm, his parents have chosen to concentrate on transformation (milk, cheese, flour) and make it the central part of the farm, valorized by direct marketing. The farm is "beyond the dominant genetic model – starting with the cows selected for pasture farming", found in alternative Swiss farmer groups. He found his wheat populations thanks to devoted research of adaptive and adapted varieties on local, regional and international level. Without any necessary investments in the last 10 years, he has deepened the links with other farmers, researchers, bakers and taken the time to travel, visit other farms, participate in trainings, and get involved in local and regional associations that promote organic, sustainable agriculture. Furthermore, varietal essays, participative plant breeding and implication into seed saving associations mark the life and work on the farm, where many people come by to discover and learn. Interns, other farmers, researchers, consumers are important partners for exchanges. For F. Mercier the transmission of know-how is a great aim and motivation. He gives on farm visits for newly arrived citizens of the surrounding villages, farmers' formations and teaching in agricultural colleges (Mercier 2013).

Nicolas Supiot, peasant baker cultivates and seed-saves diverse wheat populations in association with other plants, mills them and turns them into sourdough[16] bread which he sells in short circuits. Passionate about bread making and curious to understand its mechanisms, he developed a sour-dough adapted to the wheat varieties used, which themselves are chosen through his personal idea of a bread, his own working methods, material, agronomic conditions and the possibility for direct sale. While the industrial bread is usually made from common wheat (*Triticum aestivum*) and characterized by large air pockets obtained through yeast, N. Supiot has chosen to privilege the use of sourdough. This makes bread more digestible and longer storable. Corresponding to his persuasion of the need to promote healthy food and suiting his way of artisanal baking (less gluten needed), he chooses traditional varieties. His connection to the local territory can be seen in his spiritual approach to nature and cultivation of local cereal varieties, traditional local crops (buckwheat), the keeping of a local pasture-adapted cow breed and the consideration of native species in experiments and agronomic issues. The transmission of knowledge to other bakers and Wwoofers[17] as well as many people coming by is an important aspect of his work. While the baking activity permits economic stability, agronomic field experiments and varietal selection seem to nourish his

15 A Participatory Guarantee System with own private organic standard and certification.

16 Is a pre-fermentation of flour by lactic and other bacteria used to make bread rise and more digest.

17 WWOOF stands for willing workers on organic farms. Voluntary work is exchanged for food, accommodation and formation.

search for comprehension of historical and modern human-plant relations. Co-financing of the farm with same-minded people permits the progressive collective establishment of the 'école du vivant' (school of the living), a place for knowledge transmission, encounters, innovative science, praxis and reflexivity around nature (Supiot 2013). This is an example for the promotion of public science and shows that farmer-researchers have a different, more complex approach to nature and to all living beings. This is why they find different solutions than classic researchers as you will see.

In his systemic vision, N. Supiot sees exterior influences causing 'potential damage' as agents that have a specific function, which is to stimulate the exchange of information. This concept can be applied to anything, a plant, a person or an abstract system. N. Supiot explains his holistic approach of co-evolution by 'pathogens' in the interview: a plant aggressed by a 'pathogen' will excrete a tannin for example, that will make it taste bitter and avoids it being eaten or will even damage other attacking insects. The 'aggressor', through his action, will make the plant enter in alliance with other plants, insects, etc. which will make it able to arrive at a more complex and superior evolutionary level. The plant's excretion is not a result of the aggression, but of its adaption to the 'milieu' that leads it to a state of constructive interaction with other living elements - it is about forming alliances. The 'aggressor' is a simple agent of evolution (it would be nonsense to eliminate it) whereas the immune system is the agent of relation with the 'milieu' (not a defense mechanism). Humans should therefore not eliminate the agents of evolution he argues, but support the plant to adjust to new circumstances through increased interaction with its 'milieu' (Supiot 2013).

If wanted, such mechanisms underlying plant adaption and development from his vision could also be applied to farms. When exterior constraints restrict the present way of functioning of the farm, farmers enter into interactions with consumers, other farmers and institutions in order to find solutions to innovate and develop an adapted way of functioning. Just like with plants, steady exterior influences cause adaptive development of the farm, which is in a dynamic process of innovation linked to its social and physical environment. For holistic plant breeding approaches, dynamic adaptation is a key point.

After demonstrating farmer-researchers' motivations and that their conception of natural systems can differ from conventional ones, a closer look will be taken at the seed sector. The next lines will illuminate how artisan seed breeders are obliged to establish structures of collective organization for their pursuit of innovation and finding adapted plants.

6. What varieties for this kind of agriculture?

Agriculture based on independency, which seems to be the condition for real sustainability, needs adapted seeds that are legally recognized. "Peasant seeds don't fit into today's legislative frame, in which varieties are conceived as distinct, uniform and stable. Peasants need varieties that can adapt to local conditions, and for that the varieties must be able to evolve over time in a dynamic process, which is incompatible with DUS criterions" is what Elise Blanchet, study engineer in the research team of cultivated biodiversity and participative

research explains to curious students visiting the Office. Seed, the golden key to independence, has experienced a revival and a re-acquisition by farmers. In the start, farm saved seed, still common practice today, found attentive ears because of imposed legislative restrictions. Farmers from diverse backgrounds fought for the right to re-sow their seeds (CNDSF 2013). A survey about opinions on the obligations to use certified seeds, in 2002, grabbed the attention of farmers interested in autonomy and established first connections between different farmers. About 300 of them reunited in 2003 and founded the 'Réseau Semences Paysannes', national network for the defense of peasant seed that joins up 70 organizations today. Within this network, born from a collective situation of necessity to share experience and facing a maladjusted legislation, there are different associations that work around the topic of peasant seed and cultivated diversity. This includes the essential right to re-sow, exchange, sell, give and select seed.

The on-farm (dynamic) conservation of ancient or traditional varieties and the research of varieties for individual needs in combination with curious farmers and researchers have led to various experimentations and emergence of peasant seed. These are for the major part populations, selected by farmers for individual needs and shared with others as part of the civil commons. Their diversity is primordial for their capacity of adaption to individual contexts and pedoclimatic conditions. Communication and the exchange of seeds are necessary in this network of diverse actors, promoting the cooperative sharing of know-how concerning the cultivation and selection of peasant seed as well as ways of collective organization (Thomas et al. 2012). The strong social identity in this group bases on cooperative ways of working together and the comprehension of diversity as a major strength, both in agriculture and social movements (Demeulenaere & Goulet 2012). Through activities such as meetings, conferences, practical formations, farm visits, participatory experiments, travels etc. the network promotes information and learning for its member associations and their individual participants but it also raises awareness amongst public actors and political decision makers. A group emerged from the RSP, that focuses on wheat and agreed on the need to exchange seed, share knowledge and practical know-how in cooperation with researchers.

It was in the year 2000 that traditional varieties from the region of Redon (Brittany) were released from seed bank freezers of the INRA. These had been collected by a researcher in the 1970s looking for lodging resistance genes. Neatly classified by phenotypic criteria and the village of origin, they represent a map of the cultural heritage of this region. After their testing, selection, multiplication and the rediscovery of other traditional varieties (from conservatories, still cultivated by passionate individuals or farmers that had resisted the major part of modernization), different cultivars (local and exotic) now compose the base of populations and specialized ecotypes[18] created in farmers' fields or in congruent conditions.

18 Adapted to special conditions, through selection by nature or humans.

Parallel, in other parts of the country, people were interested in the cultivation, started resembling and collecting traditional varieties (Bonneuil & Demeulenaere 2007; Chable 2013; Mercier 2013). It was in this cooperation with researchers, that diversity was re-created and exchanges fueled the re-apprehension of traditional wheat selection methods. Different projects under exterior financing enabled the group to conduct experiments and evaluate characteristics[19] of different population varieties in today's agricultural context. This selection and multiplication respects the agronomic conditions and ethical values of peasant, organic or biodynamic farming, contrary to artificial conditions in breeding for uniformity (see Figure 1) (Bouharmont 1995; Kastler 2006).

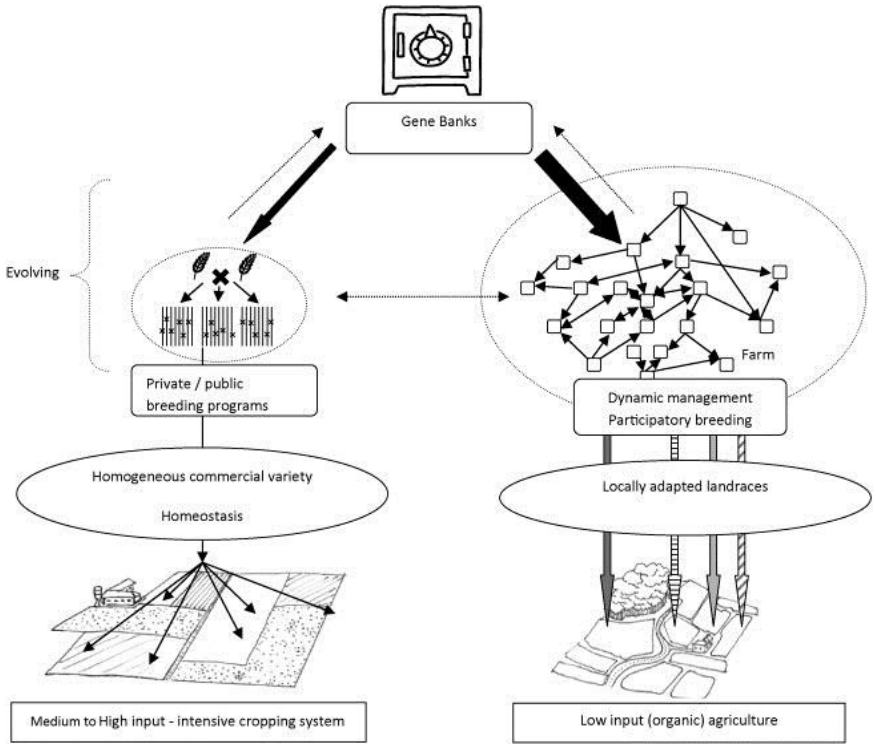

Figure 1 (Enjalbert et al. 2011): Schematic representation of the management of plant genetic resources in public/ private breeding programs and PPB/dynamic management.

There seems to be a wide range of movements that act for the promotion and conservation of biodiversity. Finding out what distinguishes them, the opinion of some farmer-researchers is shown.

6.1. Dynamic management for valorization versus preservation

Natural agriculture, as describes an Italian farmer at a wheat breeding conference at the 'Let's Liberate Diversity' Forum in Basel, is about the relation between man and nature and cannot be reduced to organic cultivation methods. It is about the link between the culture and cultural history. So while further research of forgotten local cultivars continues, it is at the same time a

[19] Through participatory research projects of the SAD-Paysage unit of INRA in the framework of is the PhD thesis of Camille Vindras for example: on the evaluation taste quality of wheat and broccoli from participative selection.

symbol for the different streams one can identify in the alternative seed movement. While preservation breeders, passionate gardeners and nostalgic amateurs want to see the 'cultural heritage' conserved as it is, many professionals give priority to the cultivation and improvement of these seeds under 'modern' conditions. They emphasize the importance of 'dynamic co-evolution' with agriculture and fear that legislation and purely economic orientated seed companies could make 'biodiversity end up in seed bank freezers or museums'. This distinction of groups of interest is reflected in the cultivated varieties, whose definitions are subject to various interpretations and can lead to confusion. This is why the RSP doesn't use the term 'ancient varieties'. Seen from a point of view of communication, the definition and translation of certain terms "is a real problem" (see annex 4) (Blanchet 2013). "Although landraces are commonly considered as endemic to a particular region, they have always been moved over short or even long distances and thus brought into competition with autochthonous landraces if present. They may disappear, or they may replace these autochthonous landraces or more likely, they may together form a new landrace. For each site and for each year their composition becomes adapted to the conditions of that site and that year" (Zeven 1998: p.129). This resumes well the interest farmers can have in 'dynamic co-evolution' of their varieties, which is not the intended effect that cultivation of amateur and conservation varieties have.

Clearly, there is a diversity of actors in the domain of seed. In the European project 'Farm Seed Opportunities' (FSO), part of the sixth Framework Program for Research and Technological Development of the European Union, field trials were inspired by farmers' questions. It illuminates thus the necessity of a wide range of varieties adapted to the emerging niche-markets of sustainable agriculture (Bocci et al. 2012). The project is a pleading for the dynamic management of biodiversity through peasant and participative plant breeding (PPB), for which the actual legislation doesn't make room. Thanks to the coexistence of all mechanisms of evolution (selection, mutation, genetic drift and migration) in populations, peasant farming practices which use population varieties are the key to local adaption of seeds and maintain genetic diversity at the same time (Goldringer 2007). PPB prjects such as Paysblé for wheat or MaisPop for corn in Brittany show that all the populations cultivated by farmers can evolve like a meta-population in the farmers' network. Population varieties have lower yields, but more stable, rustic, offer low sensibility to climatic hazards, diseases and competition from weeds (Bouharmont 1995). "We need to re-create diversity" says Veronique Chable, in view of the homogenization of varieties during the process of genetic modernization (Chable 2013). According to results from the FSO project, there is also need to readapt populations to current agricultural systems and changes in climate, as they had been taken out of production for decades and didn't have the opportunity to 'co-evolve' (Bocci et al. 2012).

To establish this link between culture and territory, it looks like varieties have to be cultivated and adapt themselves. This capacity of adaption seems higher the more diverse a variety is. So

now, what are the exact varietal needs of farmers? And why? Of course, every farmer searches something specific, but some examples will illustrate how farmers search for adapted varieties and try to understand the mechanisms of this research. Are they autonomous or networking? Where do they find the know-how needed?

6.2. Selection criteria and collective approaches

In practice, varieties used in peasant agriculture all have something in common which is selection for yield stability. Wheat is the species that sticks out and seems to be of particular interest. "We grow wheat in a very simple way: we sow and we harvest. This demands for wheat that dominates the weeds - and we need straw for the cows" says F. Mercier, explaining the choice of traditional high wheat varieties. He goes on saying "we are proud and happy when we have beautiful cows and beautiful wheat […] not with high yields" (Mercier 2013). Many would agree to this choice of quality over quantity in relation to direct marketing and find truth in these words that illustrate the relation to plants, not seen as objects but as beings and source of inspiration (Lieutaghi 1991 in Bonneuil & Demeulenaere 2007). "The most extraordinary discoveries are made either where we've done a mistake or by chance: The most beautiful wheat, the most beautiful plants." "[We should] take the risk to make a gesture either stirred by a traditional belief or by intuition (scientific or poetic) and observe the result" encourages N. Supiot (2013). Many others also left the comfortable status of a 'user' of official varieties, started assembling and selecting varieties that appeal to them and compose their very own mix or synthetic variety[20] (Berthellot 2007). They research locally adapted seeds that perform well in their very own specific conditions of soil and climate, their technical, management and cultivation practices, under the circumstances of their own demands and those of their specific market and distribution channel. They try to be independent from seed companies by developing personal varieties, selected for specific traits (taste intensity, disease resistances, etc.) or just because they like the phenotype (e.g. color, leaf shape). Everyone has a personal idea of 'quality'. Years of observation and attentiveness create sincere companionship between plants and peasant seed breeders.

While plants, tall as humans, appeal to farming systems with animals, farming on poor soils might preferably suit deep rooted plants, able to make use of resources in profound soil layers. They choose traits like small fruit size because it is preferred by their aged customers at the local market on Sundays, early seeding and maturity because temperatures drop quickly in autumn in their location, technical aspects of the fruit in combination with the machine used to harvest. Peasant bakers have special requirements regarding the grain, like behavior during baking or kneading, nutritional balance, taste and appearance; traits that had partly been sacrificed for productivity and standardization during last decades. Standardized industrial

20 An artificial population of a certain number of components (lines, phenotypes, etc.) chosen for their intrinsic value or their value in combination, resulting from a multiplication of progenies of natural crossings (INRA 1999).

baking processes demand for strong viscoelastic[21] properties because of shorter, more intense kneading. This has led to an accumulation of certain proteins via selection, that recent nutritional studies have found be little digest, allergenic and cause of the increasingly common gluten intolerance (Bonneuil & Demeulenaere 2007). In view of the evolution of baking techniques parallel to industrialization, some contemporary experts qualify traditional wheat varieties as 'not able to be turned into bread' (Chable 2013; Supiot 2013). In France, henceforth about a thousand peasant bakers turn them into bread, by using adapted artisanal methods. Patrick de Kochko from the RSP reminds that the transformation to bread allows you to do farming on small structures, on marginal land, which is often the only accessible land, abandoned by industrial agriculture. Olivier Clisson, a peasant baker in Brittany explains that his bread is "sold for 4,50 Euros a kilo, which is less than a traditional baguette from the bakery. It's possible because I don't use chemical input, no intermediates and mill the gain myself" (Gauvry & Schwab 2013).

Needs and applications of cereal products are diverse amongst farmers and demand for a diversity of options. The commercialization can also influence the choice of variety and origin of seed. Different than in long distribution channels, in short distribution channels not long shelf life is researched, but rusticity and authenticity. This can be seen with vegetable growers in direct marketing where taste and appearance play a major role. Many consumers implied in court circuit food supply are attracted by 'ancient' vegetable varieties and their taste 'like they used to taste in the old days'. A few vegetable growers in the 'Aude' department have started to multiply and specialize in growing these varieties, after the CIVAM did consumer tasting tests and sensory analyses to support collective marketing efforts of farm products (Kastler 2006). The CIVAM are local centers of initiatives for the valorization of agriculture and rural areas. They offer help and support to farmers, consumers and collectives in the development of projects that aim for the promotion of sustainable agriculture, of short circuits, rural activities or nutritional, environmental and agricultural education.

The methods used in collective breeding and knowledge sharing all involve touchable reality. Farmers have the knowledge, the know-how and are observing daily what happens in the fields. For researchers it is indispensable to understand the farmers' way of reasoning, to see the 'ground', and do practical work together, like baking or the selection of individual plants in vivo. Meetings and discussions are therefore kept outside, the closest possible to practice, in the fields, touching, smelling and feeling the objects of discussion - peasant seeds. F. Mercier (2013) particularly likes these "seeds that make you travel, take you to associations, networks, make you talk and exchange". On his diverse travels, he meets other farmers, researchers, sees the field and experiments that inspire and motivate. These encounters nourish his individual reflections and innovations. Formations organized by farmers for

21 "Viscoelasticity is the ability of a material to stretch and easily change shape – like a thick and viscous liquid – without breaking or tearing, and to partly bounce back to its original shape, like an elastic or rubber band" (Figoni 2010: p.137) Gluten, a protein in the wheat grain has this ability.

farmers through diverse associations and organisms support comprehension and social learning.

Specialized books and the Internet also seem to be likely important resources for innovation, which starts in the head of farmer-researchers and is applied before, after, or at the same time as co-validation with their social partners. Regional associative seed networks such as Triptolème or Koal kozh organize meetings and 'open field' days to allow interested civilians and consumers to discover and learn about the work done by farmers. They can participate in seed saving (e.g. 'godparentship' for a variety) as a voluntary service to society. Triptolème's pedagogic cultivation packages containing seeds of the wheat ancestors allow to retrace wheat evolution in a pedagogic frame. The notion of 'cultivated and varietal diversity' seems to find increasing interest thanks to the implication of the public through associations, the recent political debate about modification of seed laws, initiatives of regional cultural heritage and of botanical gardens exhibiting ancient varieties for example. Other meetings, like the excursion day on September 6th 2013 for example, zooming in on cultivation techniques the local buckwheat supply chain in Brittany, permitted professionals and researchers to encounter each other. The visit of mills, transformers, field trials and the presentation of the participatory research project 'Sarrasin de pays[22]' allowed farmers to learn about market operators and opportunities for innovation (IBB 2013).

This second part, has presented the circumstances that can drive farmers to be researchers. They scrutinize the dominant model of farming for its productivity at the expenses of nature and society. To find ways to realize alternative farming systems, they communicate; they rejoin others that search for the same things and get together with researchers in PPB. Other social groups, like customers also contribute to exchanges of knowledge. Networks establish and collectively try to learn and acquisitioned skills. But still, in the case of seed breeders for example, there are economic constraints and legislation limits their good intentions. These constraints and some solutions will be the object of the discussion in part three of this document.

Part III: Discussion

7. Modernization becomes reflexive

Parallel to the predominance of the conventional approach, alternative movements have developed from the beginning. The main unifying element of the group of implied organic farmers for example is to share a conception of the world and ethical practices. A common language for the vision of a just relationship with the living makes exchanges fluent and easy (Richardson 2005). Production and collaboration with nature instead of its domination is what organic and peasant agriculture aim for. The IAASTD's Global Report illuminates that the

22 A participative research project for Buckwheat in France, piloted by INRA and the regional federation of organic farmers of Brittany (FRAB).

need for research on organic agriculture is very high compared to conventional farming because this kind of agriculture is based on the comprehension of the biological interconnection and functioning of all the factors influencing a farm. It is a lot more based on knowledge and reflexive management while less relying on exterior inputs (IAASTD 2009). Sustainable approaches try to minimize exterior inputs by circular economies at farm level, to diversify and reunite different branches of production, notably animals and crops (Dufumier & Lallau 2010). Olivier De Schutter, United Nations special reporter on the right to food recognizes the necessity to adopt agroecologic[23] production models for environmental, social and economic sustainability (De Schutter & Vanloqueren 2011).

Increasing official recognition of these possible solutions though have not yet let to a profound change in agriculture. But why not? This change appears to be slowly brought forward. Individuals, initiatives of small groups like farmer associations and citizen collectives slowly arouse consciousness amongst society. According to Bonneuil & Thomas (2012), there is a profound transformation happening in the relation of society towards scientific 'progresses. He attributes this mainly to the outrage and planet-wide mobilization against GMO crops, which seems incomparably strong to similar historic events in genetic manipulation (mutagenesis by radioactive or chemical agents, artificial sterilization, fusion of protoplast cells) never triggering such enormous controversial discussions before 1990 (Bonneuil & Thomas 2012). The rise of societal awareness on health, social or environmental issues can easily be traced in the increased demand for food products from fair trade, organic agriculture, local origins or animal welfare guarantees (Betz 2012; Richardson 2005). Governments, either giving in to demands of societal actors or taking responsible action, impose environmental regulations on industry and reflect this dynamic. In many professions, increased re-integration of ethic, human values and concern for the well-being and equality of others can be felt, trying to make up for the "loss of community" and "trust" experienced; a consequence of interdiction of moral judgment in the ruling model of techno-scientific mindset (Bawden 1997: p.1). Richard Bawden finds this mindset, at the origin of reductionism and individualism, caused these "slowly degrading environments (socio-economic, politico-cultural and bio-physical)", described on the previous pages (Bawden 1997: p.2). He warns that society might be "falling victim" to its own successes and cites the sociologist Ulrich Beck when he writes: "Modernization […] is becoming reflexive; it is becoming its own theme" (Bawden 1997: p.3).

Already a few voices have been heard of farmer-researchers and other societal actors question the outlines of early modernity and reach for this society of reflexive modernity. Finding out about such possible changes, a focus will now be laid on the economic feasibility of alternative modes of production. Furthermore, it will be discovered how individuals or groups

23 Agroecology is "the application of ecology to the study, design and management of sustainable agriculture. It seeks to mimic natural, ecological processes, and it emphasizes the importance of improving the entire agriculture system, not just the plant." (De Schutter & Vanloqueren 2011: p.36)

acquire the knowledge needed and distinguish between practical and abstract forms of knowledge. All this already implies the question of ‘what are the obstacles for individual farmer-researchers to advance, and what could be the answers?’

7.1. On-farm transformations and direct commercialization

Voluntary acts of re-localizing exchanges (monetary or not) aim for economic independence and social sustainability on a local level. They are part of the ‘alternative’ movement and increase in number. On farms, this aim is often related to diversification of products or deeper valorization. The transformation of farm products does indeed add economic value and follows the concept of a shorter supply chain. The wish for a holistic production ‘from grain to bread’ is a strong motivation and obliges to become a ‘farmer-researcher’, because it can be hard to find a way to sufficiently valorize the products coming from the own soil, produced under personal criteria and the specific environmental conditions to make a living. So if surfaces or means are kept small (deliberately or forced) it returns to the formerly discussed ‘productivity per surface unit’ and measures like ‘the number of people living on the number of hectares’.

There are many unconventional concepts in application such as peasant bakers, peasant fishermen, artisan brewers, pasta makers, crêpe makers, cheese makers or other transformation of primary farm products as oil or meat (Gauvry & Schwab 2013; Demeulenaere et al. 2008). For each of these artisanal jobs, valorizing the farms’ products, one has to experiment to find adapted recipes, ingredients, flavors that offer possibilities to be sold, far from long distribution circles (e.g. restaurants, school cafeterias, events, individual customers) (Gauvry & Schwab 2013). The combination of different professions is possible and involves finding and or creating adapted varieties, material and most importantly associated know-how for the individual context. To be a peasant baker, self-sufficient in seed saving, cultivation, flour, milling and baking for example demands specific know-how from each of the professions involved. The connection between all of these steps is an instrument for deep understanding and allows the adjustment of single parts for better systemic performance. To make a bread rise high with sourdough for example demands good management during transformation but also high quality base products of successful cultivation. An enormous satisfaction lies in the companionship of the grain towards a final product: a certain self-governance results from the decision making and responsibility. Seed production and selection for personal criteria, following plant development under the annual conditions and judging the right moments are the basis and condition for a best possible adaption of the transformation process and final product. It appears though, as if it was difficult to assure this production chain all alone. The importance of human relations for economic reasons but also for innovation will be shown in the next paragraphs.

7.2. Economic Feasibility

The family does often contribute to farm work with unpaid time, which has to be considered as help for the farmer. His/her activity of experimentation (construction of material, finding new recipes, selection of plants, etc.) can be carried out at the same time as his/her every-day work, it can even be paid (participation in breeding programs) or as a challenging occupation on top of a job which is already quite demanding and time consuming. The reality of its economic feasibility can be quite harsh, but is recompensed by reconciliation with nature and social, human values as many farmers confirmed. The obstacle to innovation is most often high costs. New installations of non-natives, citizens re-orientating towards voluntary simplicity starting up farms can be found more often in horticultural structures, whereas people coming from an agricultural background are often animal breeders found Richardson (2005). This is influenced by the high cost required for these activities (equipment, buildings, quotas, etc.). Especially in the start, lower production costs outweigh expensive, ever more powerful equipment in the farmers' choices. The long term perspective seems quite important when focusing on goals, that is why increasing effectiveness is preferably done through learning practical skills and reflective management (Richardson 2005).

Money is an obstacle because the transformation often necessitates further material investment, such as a mill, an oven, facilities and a room for baking. But also technical innovations, such as the switch from plowing to no-till farming, imply a costly change of material. "I usually buy old second hand material to be able to continue" says D. Bourdon (2013) who auto-constructs his material. It is a cheaper and more creative solution that results in exact tailoring for the purpose and underlines the craftsmanship linked to innovative smallholder farming. He had to reduce his work with plough horses due to economic reasons. This activity demands a lot of logistics and time. With dispatched fields, far from the farm and no neighbors working with the same techniques it becomes too expensive (cultivation with draft animals takes longer, they would have to stay overnight at the field, additional food, water and material would have to be brought) (Bourdon 2013). This problem brings up the next question, of farm machinery cooperatives (CUMA in French). These are associations of farmers that buy and share agricultural material. A co-financing allows each farmer to spend less money, have access to specialized material and save time, because the common investment represents the possibility to buy material of bigger sizes. The benefit of a membership in these groups is sometimes limited by the specialization of material. If a limited number of the purchased machinery is useful for the farmer, and sizes don't match those of his/her farming system or tractor, it might not be worth the annual financial contribution.

A very common limit of the establishment of adapted farm machinery cooperatives is the simple absence of other farmers, especially when it comes to small structures or alternative activities (no-till, draft-animals, etc.). The geographical distance due to a small number of same-minded, similar-working people is a phenomenon that seems to be is intrinsic to alternative groups, but can differ with regions. In other farming systems, for example those

that involve on-farm transformations, shared facility cooperatives seem to be better working because of flexibility and transportable products. Shared bread-ovens, food-processing ateliers, or mills are good examples. For seed production, the monetary investment can vary: for cereals it is lower due to the abundance of cereal growers and the usual separation of the crop from weeds after harvest. There are also external companies that offer on-field seed cleaning with machinery installed on trucks. With vegetables, seed production can be carried out manually for small quantities and often implies do-it-yourself machinery. The seed associations, like Triptolème for cereals and Kaol kozh for vegetables in Brittany, bought and aim to buy more collective material to harvest and clean seed. It was one of the main objectives of the founding members. In addition to a certain investment of additional time for various activities on the same farm, a good deal of organization is demanded. A de-specialization and deep valorization of farm products also demand for increased labor force and it is not easy to be good at everything. Especially in the start of new activities, it can take a lot of time and there is not yet any money to pay a co-worker. Therefore, the farmer-researcher should be backed up by supportive consumers.

7.3. The role of consumers

As resulted from the interviews, the contact to consumers is of utmost importance for small farms. They are source of information, motivation and influence production choices. This matches the environment friendly intentions of closing energy circuits, localizing food supply and shortening supply chains. These intentions are economically viable and a good way of value creation. Indeed, diversification of products accompanied by flexibility, creativity and adoptability can permit a successful valorization of agricultural products today (Krämer 2013; Chiffoleau & Prevost 2012). Diversity even becomes an economic necessity for some smallholder farmers. Direct selling actually implies the consumers' interest in a sustainable way of consumption. Consumers don't only have to appreciate the voluntary choice of labor intensive production, by paying an adequate price, but they also have to be present. For distribution channels such as 'Community Supported Agriculture' (CSA; AMAP in French) or other solidarity partnerships, a close-by community has to be willing and self-organized. The concept of CSA is based on a partnership of solidarity and trust between a group of consumers and one or more farmers. The consumer group supports the farmer financially by a payment in advance for the whole season, while a contract permits the farmer to plan his/her production and be sure to have a buyer. His/her own production is equally distributed to the consumers every week, supplying seasonal, local and diversified food. This model of a short distribution channel also aims at the establishment of a certain awareness and responsibility of consumers that can participate in farm activities and the weekly distribution work (Olivier & Coquart 2010).

D. Bourdon (2013) warns that is "often a few people that make it work, if they stop tomorrow it is difficult". He is very attentive to consumer wishes and offers every month a different

surprise option, the ‘bread of the month’. Other modes of direct distribution like farm shops, cooperative farm product selling points with other farmers or the local market that permit direct contact with consumers also have their pros and cons. Time consumption, geographic distances, the diversity of products to offer and infrastructure of the farm are important things to consider for the farmer-researcher. But also the appreciation and or consciousness about cultural heritage and knowledge about regional specialties have a role to play. This is promoted by agricultural marketing concepts such as the various countryside Bed-and-Breakfasts (‘Accueil à la ferme’) offering homemade dinner (table d’hôte) or controlled geographical indications (e.g. PDO, PGI, AOC). It was shown that users vale food products higher of which they know the origin and are therefore willing to pay a higher price (Vanittersum et al. 1999). In France, the appreciation of regional products is perceptible due to cultural factors. Furthermore, local food markets are still quite common in France and for some they are part of social traditions. People go not only for buying, but for the atmosphere, to chat with others, meet the producers, because it’s a pleasure.

After these issues concerning the economic feasibility of a farmer that is outside normal farming systems have been discussed, it is necessary to find out how it is done. How does the farmer acquire the information needed for his/her activity and experiments? All alone or in contact with others? Does this knowledge exist or does it have to be created? What are his/her sources and what part do social networks play?

7.4. Access to know how for innovation

As Richardson (2005), (Guéneau & Leblanc 2010), the IAASTD (2009), many other authors and oral sources have pointed out, there is a lack of practical information for sustainable methods linked to innovative small structures, organic agriculture. Consequently, there is urgent need for farmers that want to practice this sustainable agriculture, to build new structures and types of knowledge; knowledge that is not dominated by a constant pursuit of productivity, but rather oriented towards a practical use, direct application, individual satisfaction and ethic criteria. This commitment of following personal values is imperatively accompanied by the development and enforcement of social links as well as their implication in the construction of these alternative structures. The network of people and relations help considerably to construct the knowledge needed for activities that are ‘outside the dominant model’. It can take some years to find an economically valuable and personally satisfying concept that works under the local circumstances and it seems as if there is a process (the research process) underlying the realization of such projects. Starting with establishment and orientation, followed by anchorage in the local territory and after maturity, a further spread of the innovation. During all the process social links are essential. Once an economically stable and personally satisfying structure is established, the search of coherency spreads even out further, into social networks, trying to make this transformation towards sustainability spread, let civil society be a part of it, help and inspire others.

There are different types of learners and some farmers are more auto-didactic that others. They need innovations to starts in their own head, be self-experimented and finished before communicating results to others. Their motivation and nourishment though comes from social relations, books or the internet. Richardson (2005) points out the limited access to specialized information – if even existent – from resources such as books, the internet or official organizations. The use of a different language (may it be a foreign language, or other comprehension barriers), administrative complications, simple physical access and different habits can pose problems. Some farmers don't have the habit to look in books or consult these kinds of sources. They would rather call a friend and go see other farmers to co-construct concepts, discuss and understand.

Any communication is means for the exchange of information and can be useful for different purposes. Usually the exchanges of knowledge via human communication are of mutual benefit to both partners. Many kinds of groups or networks help the farmer's acquisition of knowledge. Amongst these groups, networks of likeminded farmers and consumer groups seem to be most meaningful, influential and build up real friendships. Direct exchange with consumers is very rich. They are often interested in the work of the farmer, want information on cultivation and modes of production while giving important feedback and appreciation. The interviewed farmers seem to draw enormous motivation and encouragement from likeminded consumers, through political discussions, collectively organized events and sometimes even working together in the fields. For technical assistance, farmers' partners are diverse. Material providers can be of importance, especially in the start of activities. The provision of practical information is usually a service that accompanies the purchased material. Nevertheless material and input providers can stay important cooperative contact persons over years and profit from the farmer's experiences and feedback.

Farm machinery cooperatives are technical partners for farmer-researchers and can advance innovative reflections. They are often of less importance though as a large part of the members have more conventional visions on the agricultural system and practices (Mercier 2013; Bourdon 2013). Other farmers, such as neighbors, farmers in participatory guarantee systems or regional groups and associations seem to be of greatest importance in technical questions. Profound help and co-construction of practical know-how happens foremost during topic related meetings organized by associations and networks. A gathering of peasant bakers on a special topic is an example. First of all it is a means to make new encounters and links in one's personal network. But at the same time, advice is given from those that already have a certain experience (choice of material, recipes, methodologies) or knowledge (Demeulenaere et al. 2008). They foster the emergence of new members and accompany them to finding autonomy. The same happens on a higher scale, when regional farmers associations are allied on national level, as it is the case for the RSP, which unites many associations working with peasant seed. The network exists for the exchange of knowledge and experiences, permitting everyone to profit and develop in their respective domains. But like in farmers associations,

the amount and content of internal formations, meetings and schooling are heavily dependent on the implication and effort of its members. While farmers themselves often have a lot of work, especially when they are committed and involved in associations, a great part of the responsibility is accorded to moderators (animators). They allow the networks to function well and advance in administrative and organizational work, but also need formation and remuneration. Particularly when the networks get bigger, relationship management and networking activities are time-consuming and financing becomes a real problem.
Social networks do play a major role for the discussion of practical issues, but also for emotional support for the farmer-researcher which finds out that he is not alone. A social identity evolves. Mutual assistance and the sharing of experiences, which are actually cognitive processes of learning and knowledge transmission, will be regarded in more detail.

7.5. Practical Sills and abstract forms of knowledge

These days, the agricultural world is marked by a change of the possible modes of education and schooling available to young people. As described in the case of shepherds in the French region Provence by Cedric Tolley (2001), the 'on the spot' learning still exists. Educational background seems to play an increasingly important role in this period marked by the rural exodus and an increasing number of people from urban backgrounds entering the rural world. Even though they learn applicable techniques in school, it is up to the students to interiorize the acts and get the habit of doing them profoundly automatic. In practice, it seems as if the rupture between school activities and actual work on farms is quite strong, because different kinds of knowledge are asked for in these two environments. For the shepherds in Provence, the action and cleverness of doing it well are of greater importance than cognitive knowledge (Tolley 2001).
Agricultural Knowledge, Science and Technology (AKST) is a term used in the 'global report' (IAAKSTD) to describe means and methods used in order to perform agricultural activities. It includes formal and informal knowledge. Anthropologist Mary Richardson (2005) resumes that knowledge, as the basis for practically application, is a mix of capacities of innovation adapted to a specific context. She reminds that for the development of local, the reanimation of 'ancient' or the application of scientific knowledge, the individual needs to pass through an 'embodied re-cognition' (Hassanein et Kloppenburg 1995). In order to incorporate any kind of new understanding or AKST, it must conditionally be brought into relation with the body, additional to the intellectual process of integrating heard or read information. In order to "re-cognize reality" the individual has to "establish a link to the living" (Richardson 2005: p.45), by making use of all its senses. Richard Bawden (1997: p.4) calls it the process of 'experimental learning' (involving the 'concrete world of experience') and the process of 'inspirational learning' (involving the 'spiritual world of insights'), which must interact for the emergence of 'meaning'. In other words: an internalized understanding of intellectual information passes through the body by practical contact with elements of the

environment. A distinction is to be made between 'formal' knowledge, a rather cognitive, intellectual mode on one side and skills (or know-how) on the other side. Skills are informal wisdom or modes of knowledge, which are naturally changing because they are of dynamic, practical, manual and intuitive nature (Tolley 2001; Merculieff 2002). Richardson (2005) also emphasizes the incorporated aspect of practical skills that are closely connected to an individual which was shaped by personal experiences. Refining a skill means improving techniques and the capacity of perception with all the senses, but intuition can also play a major role. They are incorporated through 'learning by doing'. Hence, they are highly localized and dependent on the local environment (e.g. agricultural tools). Transmission happens therefore necessarily during active execution. Skills are traditionally intrinsic in agricultural families and brought to young people when they're little. In Agriculture, the basic skills are learned 'on the spot', as a kind of secondary benefit of working – the reason why practical know-how is hardly transmissible outside of this practical context. 'Formal' knowledge in contrary is transmitted in places (schools, institutes) that were deliberately designed for this moment, the secondary benefit of these could be considered 'reflexivity' (Tolley 2001).

In all agricultural societies the knowledge is adapted to the local circumstances. Traditional knowledge is the interpretation of processes that have been observed throughout history and shared with following generations. Its informative value lies in repeated observations during a very long time (Richardson 2005). Indigenous knowledge or Traditional Ecological Knowledge (TEK), a term that one comes across often in literature, observes the relation of all living things and their environment (Berkes 1993). It "uses the information, advice and wisdom that have evolved over centuries of living as a part of the environment. TEK is a valuable source of environmental information that allows communities to realize their own expertise, apply their own knowledge and practices to help protect their way of life." (Sutherland 2003).

The production of knowledge amongst multiple actors results from the agreed identification of problems and the construction of solutions that enable them to make concerted choices. This is usually accompanied by a systematic learning process, demanding for collective action and is termed 'social learning'. In the learning process, the community develops a common understanding. Social learning entails cultural transformation and social change, which are even stronger the more the actors' interests differ (Darnhofer et al. 2012).

8. How can academic research help farmer-researchers?

The historic developments have led to a delegation of knowledge production in agriculture and therewith an abdication of farmers' autonomy. Farmer-researchers aim to recover this autonomy and independence from the specialized production system that has developed. Fault to being offside, they have to find a way to realize their 'innovations'. As alternative social movements mobilize and achieve to produce food in more sustainable ways, international recognition of those modes of production and their performers increases. What lies behind the

pattern of thought that developed, in which nature comes second? Is everyone conscious of this? And how, in regard to 'slowly degrading environments' can science contribute to a sustainable future? What does it take to support the work of farmer-researchers and can there be ways of working together? After discussing this, it will be explained using the example of farmer seed breeders and shown how to promote knowledge acquisition, both for farmer-researchers and researcher-farmers. Finally the difficulties and limits of alternative scientific approaches will be demonstrated and other possible answers for this issue shown.

8.1. The notion of 'environment'

Natural science is increasingly criticized not to integrate the complex (social) relations of the environment an object is studied in. This 'reductionist view' of resource utilization, always looking for productivity might have as result a counterproductive unsustainable use of natural resources which itself could have negative effects on people economically dependent on this local environment. In alternative visions, the resources are not seen as isolated from the ecosystem and the value of the ecosystem itself is more than economic (Shiva 1993). The anthropocentric world view is marked by overlooking the total integration of humanity with non-human nature. This kind of inherently anti-ecological thinking based on reason (only possessed by humans) separates the world into humans as conscious, knowing subjects (active) and knowable objects (passive) (Hintz 2003 ; Plumwood 2002; van Gelder 2013). Even further, the conviction to be in control of the environment is a false reasoning in occidental attitude, according to Richardson (2005). "Under this rationalist gaze, nature becomes not just objectified, wholly knowable, and technologically manageable, but literally replicable and replaceable as well" (Hintz 2003: p.1). Furthermore, humans seem to disclaim their dependency on nature and natural resources, which sometimes acts as the framework that justifies a lack of ethic consideration for non-human issues (Plumwood 2002). Gregory Bateson, having studied the fields of biology, anthropology and psychiatry terms 'ecology of the mind' a mental process which is the organization of the communication network that connects man to his environment of interest. The 'mind' emerges from an interaction and is not a 'thing' inside of the head of an individual - a brain all alone can't think, it is imbedded in a system that includes body and environment (Wittezaele 2006: p.11). This notion is part of Bateson goading scientists to abandon the habitual 'single vision' dominated by scientific rigor and integrate environmental dimensions (social, natural, dynamic) into their work (see annex 3). He considers this non-ecologic way of thinking in need to be reviewed and the only scope of action on a short term scale in order to escape the environmental crisis present today. Integrating environmental dimensions into research can start by opening research programs to other disciplines and modes of knowledge and actors.

8.2. Integration and participation as means of farmer empowerment

Institutional and epistemological recognition of some alternative forms of knowledge resulted from the arrival of the concept of sustainable development at international level (Barthélémy 2005). In the environmental domain and, the knowledge and practices of indigenous people and local communities, considered as 'traditional' has been realized to be playing a central role (Dufumier 2006) and therefore became the 22nd Principle (22) of the Rio declaration of the United Nations (UN 1992). Traditional ecological Knowledge or TEK "is a field that, in recent years, has expanded rapidly and is becoming ever more central to resource management activities aimed at achieving the long-term sustainability of our planet" (McGregor 2006: p.1). Going further than rediscovering and integrating TEK, is the actual integration of non-scientific actors (the users of natural resources) into scientific research (on these natural resources). As Darnhofer et al. (2012) resume, such participative approaches have brought into attention some formerly underestimated topics, such as the role of power relations or the influences of institutional frames and formal science. On one side, farmers' participation in international research helps to lowers the cost of research, and on the other side it helps to respond better to diverse needs of practitioners and increase the adoption of results by small farmers. It can be a means of 'empowerment' of rural people (Demeulenaere 2009). Because this term is connected to different approaches and dynamics of power acquisition (feminism, psychology, international development, public empowerment politics) it can be interpreted in different ways (Drydyk 2008). Born from radical social criticism most of the movements that make use of the word act in a social and intellectual context. The aim is to bring forward individuals and mobilize marginal groups in order to "acquire capacities to take action personally or collectively and enroll in a vision of social change" by transforming power relations (Bacqué & Biewener 2013: p.25). Csaszar (2004: p.144) presents distinguished conceptions of power, as in the power to make choices (power to), the power to act with others (power with), the internal power or self-esteem and power over others (power over). In the case of farmer-researchers, the means for empowerment are knowledge-sharing and -construction processes (power with). Collective action is characterized by cross-linked forms of organization, shared believes, internal solidarity and a common cause.

The links between diverse associative groups and political or research institutions are sometimes ambiguous due to other frames of thinking (Jouve 2006). But when conscious of these frames, co-operation can be to the benefit of all participants and make a process of 'social learning' possible. This implies knowing about the nature of our knowledge. In other words, the different epistemologic dimensions. Either one is convinced that reality is mind-independent (objectivism) or that the researcher has an active part in the conception of things (relativism). Then, one is aware of the constructed nature of facts and different modes of thought, standards of reasoning, points of view (Bawden 1997; Darnhofer et al. 2012). These two dimensions are represented by the horizontal line in Figure 2 from Bawden (1997).

According to Bawden (1997), extreme beliefs about 'the nature of nature' (ontological dimension) can be either holistic or reductionist. The first extreme considers natural systems as whole and in order to fully understand its functioning, one has to look at the entire system. It opposes to the second extreme, which considers natural systems as collection of many parts that can be understood individually. Different worldviews result from these dimensions. A conscience of the worldview of others makes us able to understand their reasoning, communicate more easily and enroll in processes of social learning (Hubert 2002). This is important when farmers are participating in research programs.

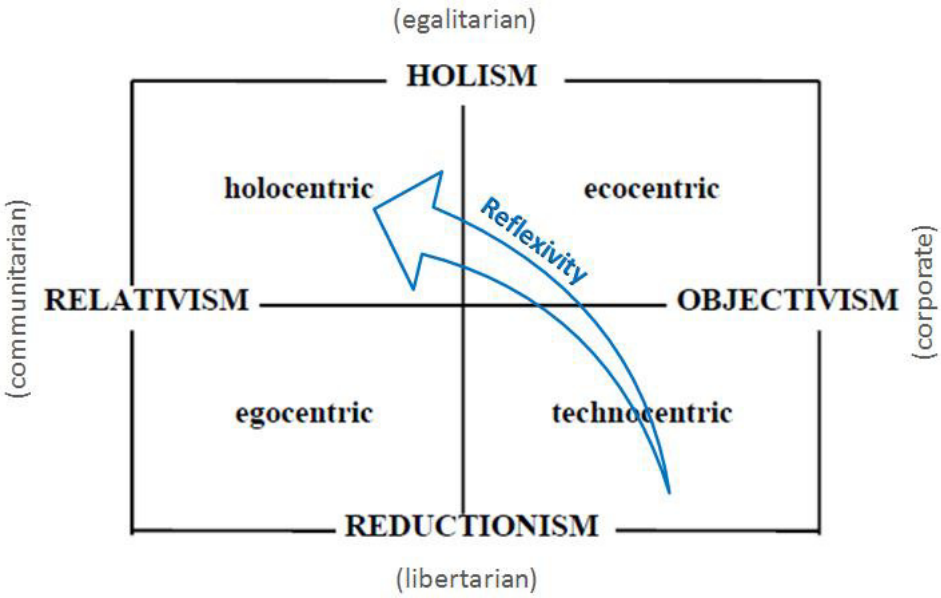

Figure 2 modified after Bawden (1997) and Hubert (2002): Worldviews as functions of differing ontological (vertical) and epistemic (horizontal) positions (in black) and philosophies that influence them (in gray).

In multidisciplinary research, disciplines work side by side in collaboration and the subject is set about from different perspectives. But just as nature science perspectives neglect social aspects, social science perspectives (that often integrate other forms of knowledge and exterior participants) often have a hard time integrating hard facts. However, the consequences of this (see above) make it necessary to overcome disciplinary divisions. An interdisciplinary approach in contrary, redefines the 'assumptions underlying the respective disciplines' in order to establish a common conceptual framework and terminology (Darnhofer et al. 2012: p.11, 14). An interdisciplinary approach builds a bridge between what is termed 'hard system thinking' (facts) and 'soft system thinking' (meaning, reasons, values). By allying these two systems, the limits they encounter when regarded solely can be overcome. When understanding their respective disciplinary limits, scientists can start to integrate either 'social aspects' or 'hard facts' coming from the other disciplines (Darnhofer et al. 2012). So to sum up, interdisciplinarity breaks with the dualism of nature and culture. Then again it is necessary to take interactions of natural, social and economic systems into count (Barthélémy 2005). 'Farming system research' (FSR) combines dynamic approaches, participation of societal actors and interdisciplinarity. In its systemic vision, it considers more

important how the parts interact than how each part performs. It requires its operators to be reflexive, flexible and conscious of their choices (Darnhofer et al. 2012; Chaibou et al. 2003).
Is this then the only, optimal solution? Science in service of farmers through a holistic, collective approach? Certainly there are more opinions and options. Though it focuses on holistic, collective approaches, FSR will always return to serve itself from the box of reductionist methodologies, studying things in detail, before returning to the systemic view. It is all about complementarity. Not one research is the best; it is about reflexivity (see Figure 2). It is about the comprehension that everyone lives in an era that is influenced by its history and the people that act in it. Some may call it a 'paradigm'. It is about being conscious that "this [,our knowledge today] in twenty years, it'll be questioned - even before - because it will be understood from a broader perspective […], other parameters will put it in perspective again" (Supiot 2013).
After getting an idea of the varying general understandings and conceptions, collective action can more easily enroll in social learning processes in order to promote farmers' innovation. Some approaches that take this holistic direction will now be disclosed.

8.3. Farming system research produces knowledge for purposes in step with actual practice

In the late 1970s, the academic community of Hawkesbury Agricultural College in Australia decided to change towards a holistic way of thinking and teaching based on real-life projects with active participation of their students and the rural community. The aim was and still is to help all participants to learn about systematic approaches of learning in order to create responsible action and development for the future (Bawden 1997). Committed to "helping in the facilitation of the development of learning communities", the Hawkesbury Agricultural College contributed to the increase of holistic viewpoints (that acknowledge the existence of other viewpoints). Holistic viewpoints seem to be rather marginal and are therefore referred to as alternative, while classic science is often characterized as reductionist, shaped by the context it developed in (see Part I) (Hubert 2002). An 'epistemic mutation' toward a re-centering of farmers in the middle of knowledge production is therefore a condition for ecologic innovation (Demeulenaere & Goulet 2012). The diversity of farmers implies a diversity of opinions. Here is one example: when asked how science could be in service of the common good, N. Supiot suggests a "phenomenological scientific approach, that is to say the observation of phenomena and to try to understand their mechanisms". "Very sincerely I think that man has nothing [new] to invent. Everything is there. Nature is a marvel". "When trying to reproduce these [observed phenomena] on the farm, don't jump to a conclusion. If it works once or not, doesn't mean that the perspective was completely wrong, maybe I haven't considered all the parameters. And next year there is maybe another parameter that calls it into question". This 'ecologic' kind of science would "stop to want to dominate nature", "stop

to isolate infinitesimal parts" and start to collaborate with nature, co-evolve and make use of its "dynamic intelligence" by imitating its mechanisms (Supiot 2013).

Mimic theory (or Mimicry) is such an approach that tries to understand the functioning of natural systems and imitate them in form and function (Malézieux 2012). It is closely connected to some farmer-researcher's approach. Natural ecosystems are "time proven survivors" (Ewel 1999: p.2): energy efficient, adapted to local constraints, productive, stable, resilient and sustainable. Even diverse systems can suffer patchy or selective attacks but have the ability to compensate for it. Longevity (Perennialism) and functional diversity can be considered as most important criteria for pest resistance, general resilience, productivity and nutrient retention. Lower but stable, biologically sustainable yields are an important advantage of mimicry systems (e.g. agro-forests or perennial prairies) (Ewel 1999). Perennial poly-cultures in agriculture seem feasible but an adaption of cultural methods and techniques has to come along which implies major changes in relation to today's dominant agricultural model (Jackson & Jackson 1999). A great diversity in sub disciplines of ecology has developed specific knowledge and research which is finally needed to be interpreted and integrated into agriculture. To give this idea of 'mimicking nature for a more sustainable agriculture' a boost, Jackson & Jackson (1999) call on young researchers and renowned ecologists as well as agriculturalists to be pioneers and make this topic more visible, start public discussions. Vanloqueren & Baret (2009) identify academic barriers to interdisciplinarity as obstacles to the development of such agroecologic pathways. These paths' incompatibility with existing agricultural systems requires structural changes (e.g. "breaking away from large-scale monocultures") which prevent that they become a priority (Vanloqueren & Baret 2009: p.980). But the same goes for the academic world, there are high 'switch-over' costs. These prevent entire changes of paradigms or trajectories and prioritize step-by-step progresses along the established technological course of movement. Scientists have been educated in a particular way to be specialists in some domains, not in others, with specific competences. The investments in such a system of education, in research centers and infrastructures have led to the establishment of networks, reputations, knowledge, and funding possibilities (Vanloqueren & Baret 2009: p.980).

9. Seed and PPB

After discussing general aspects of how science can help farmer-researchers and therewith contribute to sustainable modes of agriculture, a focus will be set on a special group of farmer-researchers: peasant seed breeders are not only constrained by practicing an unconventional mode of agriculture, but also by legislative aspects. In order for scientists and farmers to work together, they have to define their common goals of research or plant breeding. By pursuing knowledge acquisition in collective learning, they discover the process of social learning and form communities of reflective learning. Their members are influenced by their conceptions of the market and of society. Just as there is a wide range of farmers' and researchers' personalities, there is a wide range of participatory approaches.

Part II has shown the diversity of actors in the seed sector demands for a diversity of resources. For a comprehension of the choice of seed and its breeding methods by different actors, the work of Desclaux et al. (2009) is very helpful. Even if one often hears that varieties adapted to organic agriculture are needed which is generally true, one risks to overlook the multitude of actors in the sector of organic agriculture. Different objectives and mindsets are at the origin of different concepts and actions. Then again, these are influenced by social dynamics, political and territorial structures as well as economic and communication means. It has been observed that farmers' criteria for varietal choice are generally a result of 'domestic' (respect for a local and cultural heritage), 'civic' (healthy nutrition as service to nature and society) and or 'inspirational' (emotional or phenotypic evaluation) considerations (Bonneuil & Demeulenaere 2007: p.11).

A first division in the group of organic farmers should be made according to the 'way of considering the market' and in connection to that: objectives of selection. In a first look at the Model of Desclaux et al. (2009) (Figure 3), one can already situate farmer-researchers in the upper part, searching for independence and the re-conception of a system. After this, one could differentiate two currants that partly rejoin their paths, and are not always separable in practice. One of them is influenced by an individual mode of thinking; the other aches for collective governance. Desclaux et al. (2009) suggest peasant bakers as one possible example for the first group, the 'individualists'. Because their aim is the 'deconstruction of the market', they aim for valorization through local, short distribution channels together with committed consumers and other producers. This is reflected in selling through AMAP or other partnerships based on solidarity concepts. The management from seed to crop over transformation to the finished bread is symbolic for their autonomy. For the accomplishment of their aims they rely on heterogeneous, authentic flagship varieties. They can sometimes be official varieties from the catalog, but are mainly adaptive populations which were selected by themselves or by other smallholder farmers.

The second group, the 'collectivists', aims for the co-construction of complementary, new markets. It is dedicated to the respect of interactions between varieties, agro-ecologic and social environments. This becomes visible in the integration of different complementary actors in order to provide services for the commonweal: like environmental education, farm visits, formations and selected varieties. Their action is not restricted to a local environment and a close social network is their means for dynamic collective action. This group of mainly organic farmers often works in participative plant breeding (PPB between farmers or PPB between researchers and farmers) and has multiple criteria in plant selection for multifunctional purposes (Desclaux et al. 2009). They generate and exchange knowledge in the aim of spreading it and free use for everyone. The production of such knowledge commons (comparable to other commons, cultural and natural resources like water or languages) is a powerful way to act for social change outside the frame of institutional power (Sumner 2008).

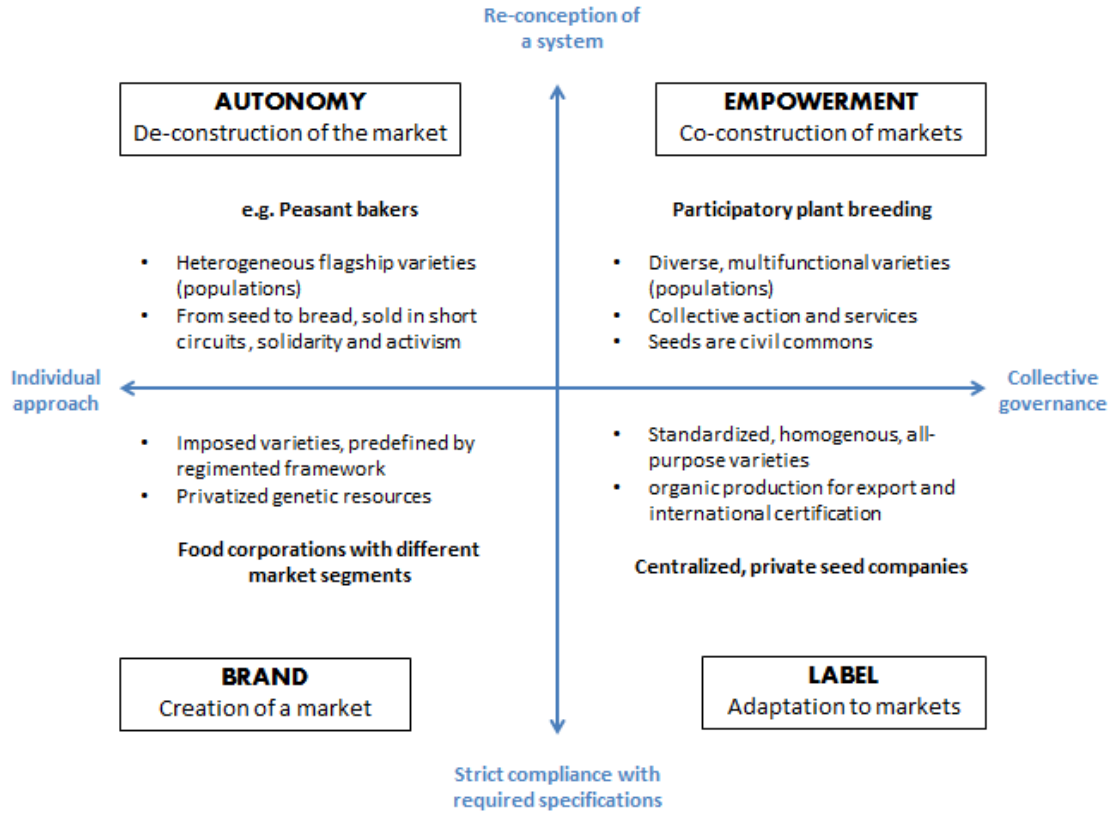

Figure 3 (Desclaux et al. 2009): Different currants in organic farming, their varietal needs and breeding methods

The inclusion of public organisms and scientists in the production of common goods through PPB, is an important step for the evolution towards sustainability and the maintaining of biodiversity. Many researchers share these ideological values and an increasing number of research centers integrate exterior actors and disciplines.

In participatory research approaches, the moral as well as the pragmatic need for establishing mutually beneficial relationships between farmer and non-farmer organizations has been recognized. L. Sperling, J. Witcombe and S. Ceccarelli are regarded as the pioneers of PPB, working on beans in East Africa, rice in Nepal, and barley in the Middle East respectively. Principally born to meet the needs of economically marginalized people in the South, there are more than a hundred of participatory selection programs in the world today (Bonneuil & Demeulenaere 2007). Hence there are about the same number of breeding schemes. The issues related to such PPB programs are primarily economic and social, based on an enlarged conception of biodiversity that allies biological and cultural diversity (Demeulenaere 2009). One could draw a scale that shows a gradient from more passive to active participation, from hierarchic to empowerment and from corporate to communitarian thinking. On this scale, the right side tends to be on-farm research, where farmers are told what is going to happen and knowledge is appropriated by the producers. When moving to the right, participation increases from information giving to consultation to material providing (fields) to functional participation (the farmer's accustomed cultivation method) to programs resulting in 'self-

mobilization'. In the last, farmers start independent seed breeding founded on the knowledge acquired in the common learning process (Bocci et al. 2012: p.17).

In those programs aims, subjects and methods of plant breeding are planned during a process of co-construction. Farmers are part of all decisions made and results are judged in co-evaluation. Farmers and researchers have common ideas and decide collectively on research topics. The intention is that all parties benefit from collective learning processes and reflections, accordingly exchanges are based on evident complementarities between local knowledge and scientific knowledge. Social groups acting around environmental issues are considered to be potential experts instead of just users (Barthélémy 2005). This last concept is the optimum for our peasant seed breeders but not intended by all Participative research programs. For example, the regional funding project PaysBlé (2009-2012), was directly inspired by farmers' questions. N. Supiot was directly involved in the conception and F. Mercier actively participated in all the activities dealing with the project. The call for tender from Brittany was also conceived as a means to get closer 'Science and Society'. This regional project was also included in the European project SOLIBAM[24] in which participatory research is one of the basic concepts.

Depending on the research topic and Institution or team, which is connected to financial and human means of the program, farmers' participation can be limited to voluntary reception of field experiments on his/her farm grounds (FSC & RSP 2011). Studies aiming to understand local adaption or the conservation of biodiversity don't necessitate active breeding. Furthermore one has to take into account the domains of knowledge of people implied in a program. Financial impasses and struggles, due to a lack of recognition appear to be a major break for further development of most participative programs and are sometime source of to an unbalance mutual benefit between the actors. If the aim is to do selection, there are many possible breeding schemes.

9.1. PPB, adaption and epigenetics

Figure 4 shows two possible examples of wheat breeding programs and the role that the farm or research station play in field trials (Bonneuil & Demeulenaere 2007). In the right (example for a PPB scheme) farmers welcome numerous genotypes on their fields and cultivate them just like they would cultivate their usual crops. The genotypes adapt to the on-farm cultivation methods, are crossed and selected according to the farmers criteria. While intra-population crossings and mass selections are done in farmers' fields, crossings are done on research stations (Bonneuil & Demeulenaere 2007). The delicate manual pollination is time intensive and it is helpful to have a sheltered area (Blanchet 2013). Depending on the type of

24 SOLIBAM: Strategies for Organic and Low Input Integrated Breeding and Management (2010-2014), a large collaborative project fully funded by the EU Seventh Framework Program; grant agreement number: FP7-KBBE-245058

experiments (breeding methods) and the plant species the part of cultivation on research station differs and is up to null.

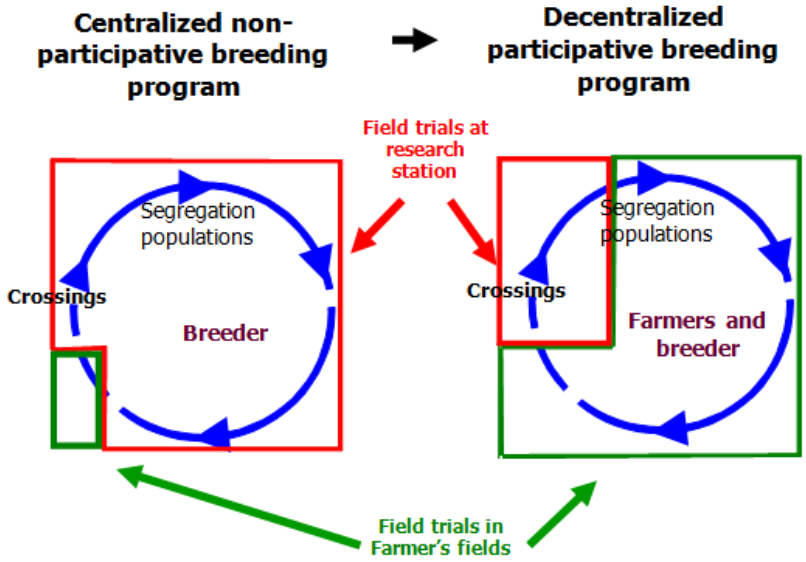

Figure 4 modified after Cecarelli (1989) and Bonneuil & Demeulenaere (2007): Schematic representation of examples for a centralized and a decentralized participative breeding program.

There is a real appreciation and legitimacy of 'popular' knowledge held by farmers, useful for researchers to study genotype x environment interaction. As Demeulenaere & Goulet (2012) point out, peasant seed breeders consider themselves to have an active role of accompanying the plants in their evolution. In combination with the plants' natural capacity of adaption it leads to the expression of its entire potential (Demeulenaere & Goulet 2012).

The conventional plant breeding approach would search to isolate a single resistance gene or character from a wild plant into a crop in laboratory manipulations. The PPB approach favors a systemic, evolutionary vision over the "fixist vision of the variety" (Demeulenaere 2009: p.193). It rather selects compatible genotypes for their adaption to the specific environment or their resilience. It uses diverse populations and natural selection as well basic human crossings in a vision that 'man cannot do any better than nature already does'. It is thus combining hard systems (analyzing farmers' selection criteria) and soft systems (asking why). The local adaption of varieties by "peasant selection in a particular territory for a special use and exchange under the local social rules" is a major topic (Bonneuil & Demeulenaere 2007: p.2). As epigenetic mechanisms are able to alter phenotypes rapidly and reversibly, they are considered to be of importance in local adaption potential of plants. Even though little is known so far about interactions of epigenetics and environmental factors (Chable et al. 2009). Epigenetics is a field of research in evolutionary biology that is of high actuality as it concerns research on plants, animals and humans (Schrey et al. 2012). In plants, epigenetic mechanisms seem to act like a trans-generation memory of environmental stresses (biotic and abiotic) encountered by former generations. Traits resulting of responses to these stresses can thus be transmitted to the progeny. These traits appear as changes of morphology and changes in gene expression without altering DNA sequences (Molinier et al. 2006). The study of

Dawson et al. (2012) or the project Farm Seed Opportunities (Bocci et al. 2012) for example showed that under natural selection and in a very short time, varieties can evolve significantly for certain traits. If this adaption results in an improvement of traits that are interesting for the farmer, he/she should (legally) be able to continue cultivating the seeds of those adapted plants, develop them through mixtures, crosses or mass selection (Dawson et al. 2012). The epigenetics mechanism was explored on winter wheat populations within the SOLIBAM project in the framework of a PhD study and other species (Khan et al. 2013).
So in PPB, collective searching for answers (social learning) aims to respond to farmers' preferences and acquire knowledge for varietal creation, supporting their autonomy for a sustainable agricultural model (Bonneuil & Demeulenaere 2007). It is clear that, to promote both farmers and the increase of BBP programs, their work has to be accorded a greater legal space than regulatory niches (Brac de la Perrière et al. 2011). But what else hinders more researchers to do so and what are the difficulties of such approaches?

9.2. Low acknowledgement of unconventional research entails instability

A major hindering for the establishment of durable PPB relations is trust. It needs time to get to know each other. The limited duration of research projects causes that actors are not permanent (FSC & RSP 2011). Especially from the farmers' side, skepticism can be felt towards scientists. In PPB, two epistemological communities are clung together by a common 'frontier object' that has a different signification and value for each actor. The object, 'the common ground', is evolving. It can change because the actors evolve during their interaction. One of these would be the protection of diversity for example, its enhancement is of interest for both parties, but for different reasons (Demeulenaere 2009). Especially the different practical and symbolic relationship to nature shows how difficult an accordance of the farmers' and the researchers' world can be. In sociology, this is analyzed as if each of them is situated in a proper mental and cultural universe (Barthélémy 2005, see Hubert 2002). The knowledge of the different participants concerning the common object, produced in their respective worldviews, is complementary. "If we admit that we can learn from popular knowledge to achieve a reasonable management of nature, it is necessary to understand how this knowledge is constructed and organized, how they account for the way that reality is perceived, conceived and lived in each society" (Friedberg, 1997: p.6). The difficulty to ally two worldviews in collective action lies in the open-mindedness and the capacity to put oneself in the position of the other, understand his/her aims and methods, and why they developed, from which social, cultural and economic context (Chaibou et al. 2003). There are many truths because there are many worldviews. The method is therefore success factor, the process of co-construction is the key rather than the product (FSC & RSP 2011). The unknown outcome of some projects, which are not established to proof something, might be a constraint to unaccustomed researchers.

“One of the major problems actually is the remuneration of the breeding work, and hence the whole functioning, and survival of the institute” explained Berthold Heyden, involved in PPB in the Graf Keyserlingk Institute for organic and biodynamic Plant Breeding in Germany (Moÿ 2010: p.23). But the same goes for peasant seed breeders’ work and those of the seed networks, as resulted from the interviews. F. Mercier (2013) suggests that optimally it would be financed either through the farms or directly by consumers. Then the peasant seed networks could even be independent from exterior subventions. The consumers’ interest in co-financing those activities by voluntarily paying a higher price could result for him/her in higher nutritional quality and is finally some sort of real ‘fair trade’, not only ‘buying a good conscience’(Moÿ 2010: p.23).

But then, the criminalization of farm saved seed and of varieties not represented in the official catalog (for commercial use) is a major break mechanism for the creation of value from peasant seed. Not all farmers are at ease to officially declare their production as they find themselves in a blurry legal situation. Furthermore the fixed idea of the variety as ‘distinct, uniform and stable’ is a handicap to farmer innovation, autonomy in seed breeding and hence to progress in sustainable agriculture. Auto-financing of associations and ideological collectives working in this domain seems to be a major defiance and future step to focus on. But in the meantime, it is important to raise awareness amongst decision makers in regional structures and in politics. While financial and human means seem to be lacking in research, in associations and on farms some farmers express their aversion to money coming from private funds. This is for ethical, social reasons and the dislike of increasing disparities partly due to increasing private wealth. While private foundations and corporations can ‘do whatever and buy their good conscience’, public money supports the idea that it’s the people that have to choose what they want for tomorrow and that they have to help to construct it (Bourdon 2013).

But isn’t civil society already doing this? How are politics supposed to be involved? It actually appears as if experiences, research projects and social movements in various territories are far ahead of the policies that affect them. Farmers that oppose to legislations by claiming their rights are active guardians of cultivated biodiversity (Nonne et al. 2011). The resulting innovations are in service of society and thus to science. Initiatives, such as the establishment of ‘maisons de la semence paysanne’ (peasants’ seed houses or more commonly named ‘community seed banks’) are examples in France and exist all over the world. These are regional cooperative seed banks (more than a physical place) implement dynamic co-management of crop diversity through on-farm conservation. Such structures of collective organization are principally there to meet others, exchange and share knowledge and seeds. They are active contra-examples for static diversity conservation in freezers. Further action can be perceived in the development of collective ownership and education. The ‘University of the living’ is a space for exchange, schooling and research in the domain of nature (Brac de la Perrière et al. 2011). Moreover, there are projects such as the ‘Citizen

Science Foundation' which promotes the democratization scientific and technical choices. It aims at increasing the capacities for public education and strengthening associative, citizen or worker movements (Fondation Sciences Citoyennes 2013). They organize formations, hybrid forums and public debates. These are public spaces in which controversies fuel a debate. They can be means of abandon of barriers between science, politics and society through the reconfiguration of each actor's role in a common learning process. Through the dialog, a shared basis (the common object) can be constructed. It forces the establishment of cooperation between "specialists and profanes", which Callon et al. (2001: p.1) characterize as "historically not existent". Their learning and exploration outcome depend the openness of the debate to controversy and other worldviews (Callon et al. 2001). Policy-makers could contribute to such Initiatives by supporting regionalization (food supply, research, farmer organizations, etc.), but also through the facilitation of access to land, labor, infrastructure and knowledge (Wibbelmann et al. 2013). The status of business incubators for example facilitates administrative and legislative issues for young start-up farms, allowing them to establish without unbearable economic pressure from the start. The general assistance of projects on regional level is desirable.

"Donors and international institutions, including CGIAR and FAO, should assist States in implementing the recommendations above. They should, in particular […] put farmers at the center of research through participatory research schemes such as participatory plant breeding" advises the UN General Assembly (UN 2009: p.21-22). But what about the acknowledgement of such research, crucial for a proper implication of such advice? An essential matter still remains: the researcher is respected and recognized for the value of the knowledge he produces (Demeulenaere 2009). Is it really such a vicious circle that high cost-research needs high-return results? According to Eric Petiot, the evaluation of non-classic research necessitates a "redefinition of the aims of research", "scientific knowledge should be founded on and guided by practice" (in Guéneau & Leblanc 2010, Hubert & Bonnemarie 2000). It seems thus, as if researcher farmers (researchers that actually cultivate and make their own experiences on their farm) were needed alongside farmer-researchers to combine the two professions in order to shrink the gap between two worlds (Chable 2013).

Conclusion

Understanding the increasing environmental and social challenges faced today, and recognizing the limits presented by the current agricultural system which had developed under an influence of technoeconomic modernization, there is little doubt that smallholder farming could make better use of local resources and improve productivity. The lack of scientific, practical and legal support given to smallholder farmers makes earning their living difficult. Lost without social relations, the farmers find support and exchange in social networks, increasingly involving civil society. Farmers have become researchers and generate

worthwhile innovations while policies aren't yet considered to be changed. As knowledge construction can be a social process that depends on the capacities of each contributor, some scientists rediscover the benefit of profane knowledge and promote farmers' autonomy. When forming learning communities, farmers and researchers can shape a sustainable future in step with practice. But it seems as if low acknowledgement due to disciplinary limits prohibits the emergence of such systemic research approaches. Hence it is important that all actors learn to acknowledge the existence of many worldviews (and thus many truths) and their potential contributions to address today's challenges. Diversity is the assumed precondition for adaptation, quality and resilience at all levels from field communities to food systems. There is definitively need for further research to identify constrains and levers for rapid change, which might lead to reconsidering the modernity of peasants (Lallau 2012) and understand the real value of agroecology.

Given that learning is key to sustainability and that there are no limits to continuous learning, are there only individual limitations?

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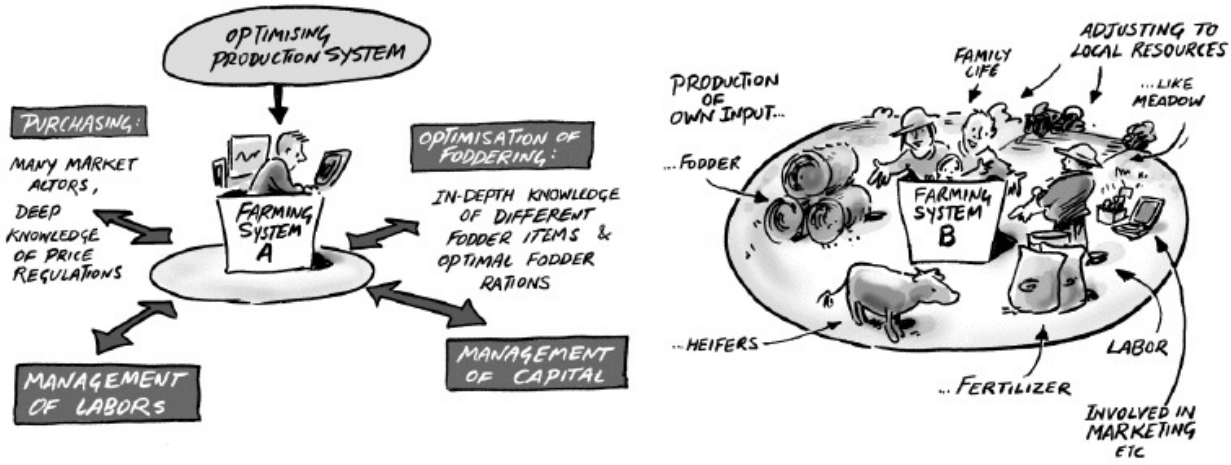
Annex

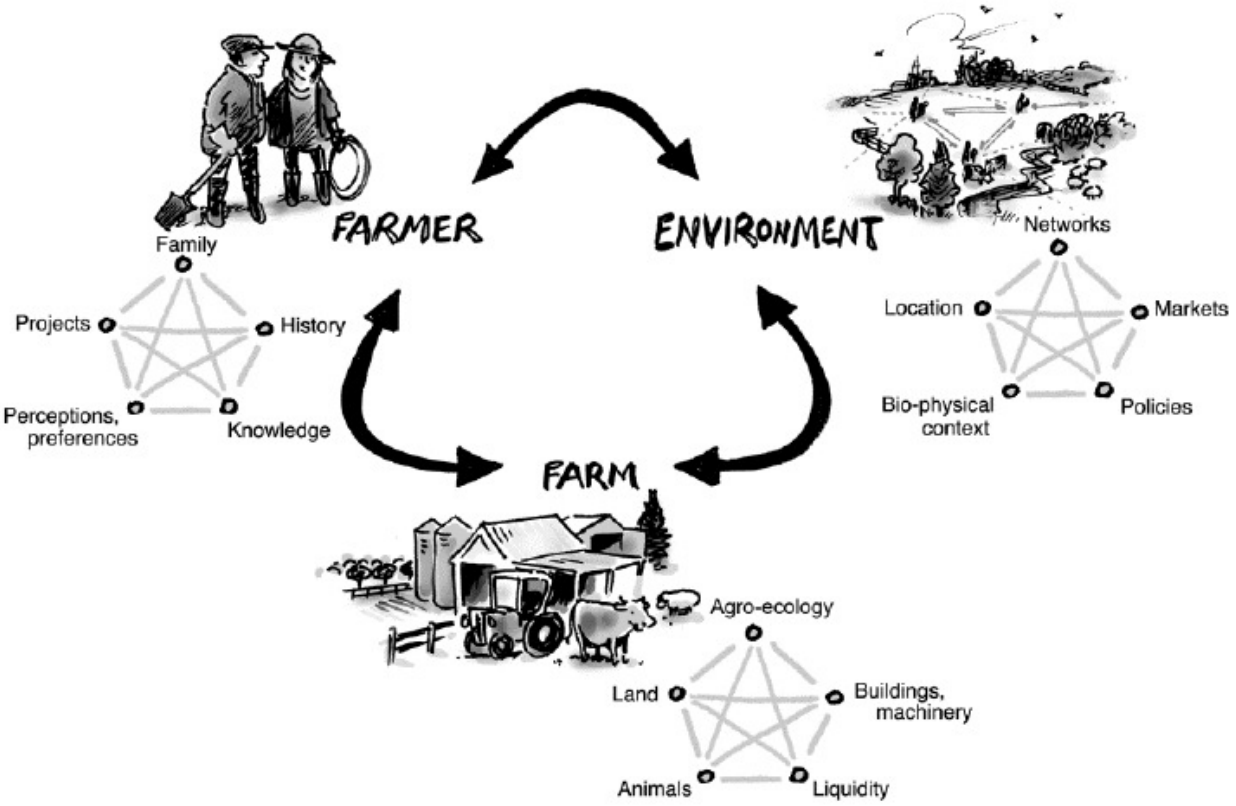
Annex 1: Questionnaire for interviews with farmers

- In the beginning, could you tell me about your story, how did you come here? Please tell me about your farm and what made you develop these activities you have today? Please mention the steps that seem important to you.
- How do you personally conceive your activity? What does being a farmer mean to you? What is your motivation?
- What do you search for and why? What were the last innovations/experiments that you did for example? What inspired you?
- Where and how do you look for information and why? Alone or with others? In books/the internet? Which methods do you use?
- What about social networks? How do you get in touch with others? What are the moments and places for exchange?
- In how far are you innovations and their research feasible on an economic/ social level? How much time do you spend for research/experimentations/social relations?
- What is your distribution channel and in how far are you in contact with consumers?
- What do you think is the role of agriculture today? Do you feel a change over the last years (society/ legislations/ amongst farmers etc.)?
- Are there things you don't achieve to do as you would like? What could help you to achieve them?
- What is your relation to science and to academic research?
- What relation to/ experiences from/ expectations of participative research or plant breeding?
- What would you wish that institutions/consumers/social networks/politics/ society in general to do in order to help you and support your activities? Are there special research topics you would like scientists to study?

Annex 2 (Darnhofer et al. 2012): In mathematical models the farmer is regarded as a technoeconomic optimizer. Considering environmental factors in Farming System Research can lead to a better understanding of farmer's choices, constraints and goals.



Annex 3 (Darnhofer et al. 2012): A systemic approach needs to take the environmental and social contexts into consideration. Interdisciplinarity and farmers' participation help to understand the farming system which is constructed by the farmer, but dependent on material resources and structures.



Annex 4 (Bocci et al. 2012): example for the possible confusions and difficulties arising from the translation of the term “landraces”.

Country	Translation of the word “Landraces”	Re-translation in English	Point of view
France	races primitives	primitive, original or basic	historical, social or biological
Germany	landsorten	landraces	
Italy	ecotipi	ecotypes	ecological
Spain	variedades	varieties	biological
Romania	soiurilor locale	local variety	geographical
Portugal	variedades autoctones	autochthonous varieties	geographical and social
Hungary	honos fajok	home variety	sociological

Ich versichere hiermit, dass ich die vorliegende Arbeit selbständig verfasst, ganz oder in Teilen noch nicht als Prüfungsleistung vorgelegt und keine anderen als die angegebenen Hilfsmittel benutzt habe. Sämtliche Stellen der Arbeit, die benutzten Quellen im Wortlaut oder dem Sinn nach entnommen sind, habe ich durch Quellenangaben kenntlich gemacht. Ich erkläre mein Einverständnis zur Überprüfung der von mir eingereichten Arbeit auf Plagiate durch eine Anti-Plagiatsoftware. Zu diesem Zweck stelle ich eine anonymisierte elektronische Form des Dokuments in gängigem Format zur Verfügung.

Witzenhausen, den 30.12.2013