SIXTH FRAMEWORK PROGRAMME

FarmSeedOpportunities

Conservation, breeding and production

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Introduction

Alongside the dominant conventional production, other forms of agriculture strongly connected to the "terroir" (a French word that refers simultaneously to the soil, climate and cultural values of an area, similar to the English notion of 'place') have been preserved and are now re-emerging in Europe. The development of niche markets as well organic and low input farming systems is also related to the diversification of demands of consumers, in particular for good tasting, traditional, organic and/or local produce. Moreover, these agricultural systems need a wide range of varieties - from landraces to old varieties, farmers' varieties and population varieties – able to be adapted to diverse agronomical practices, with the aim of increasing the resilience of the agro ecosystems, and facing climate change. Recently, in Europe the limitations of commercial varieties – bred for conventional, high input agriculture - to the needs of organic farming has stimulated several Participatory Plant Breeding initiatives for organic farming, creating new forms of varieties, plant breeding and seed production organization.

But the large diversity of experiences and initiatives is not fully integrated in European laws and policies. Current seed laws and policies have been conceived in order to modernize agricultural systems. This framework is based on the assumptions that seed systems follow a natural development pathway from farmers' production through government involvement towards a perfectly competitive private seed market, e.g. from the informal to the formal one. Farm Seed Opportunities (FSO), a research project in the FP6 European Research Framework (2007-2009), was targeted to support the implementation of seed regulations on conservation varieties (directive 98/95/EC and new directives 2008/62/EC and 2009/145/CE) and to propose complementary seed regulation scenarios taking into account the diversity of the European seed systems.

The FSO project is a collaborative effort of farmers and scientists from France, Italy, the Netherlands, Spain, Switzerland and the United Kingdom.

This publication highlights the main FSO conclusions and presents FSO policy recommendations.

1. The diversity of breeding initiatives of landraces and local varieties: inventory and case studies
2. Report on the definitions of varieties in Europe, of local adaptation, and of varieties threatened by genetic erosion
3. Report on stakeholder expectations of placing biodiversity of agricultural crops on the market
4. Matches and mismatches of the 2008/62/EC Directive text, practice, and positions
5. The analysis of the bottlenecks and challenges identified for the on farm maintenance and breeding in European agricultural conditions
6. Methodologies for participatory research in on farm maintenance and breeding
7. The experimental data on seed qualities of farm varieties
8. Seed quality and marketing recommendations
9. Analysis of relevant cases studies on the Role of Innovative Market Promoting Sustainable Use of Agrobiodiversity
10. Policy recommendations

The concepts of conservation varieties

The term "Conservation varieties" was first introduced in the EU Directive 98/95/CE, which included the policy objective of "conservation" in the core of seed legislation. As stated in 17th preamble of the Directive, opening the official seed catalogue to conservation varieties – and thus marketing them as seed – was considered a means of reducing genetic erosion. In this regard the directive 98/95 implicitly acknowledges that seed regulations since the 1960s have contributed to the genetic erosion of agricultural diversity and must be amended.

Since 1998, however, the road to acknowledge conservation varieties has been long and tortuous and the directive still lacks full application by Member States. In the ten years spent in hatching the new directives – giving the guidelines to Member States for the implementation of the 98/95 – no less than 14 text revisions were discussed before it was passed by the Permanent Seed Committee, which shows the difficulty that parties with such divergent interests have in reaching an agreement. On the one hand, some saw a danger that it would undermine the main commercial system of introducing new varieties into the market; while others sought to open marketing possibilities to seed of varieties that were until then "illegal" but of interest to other models of agriculture such as organic farming or bio-dynamics.

Finally in 2008, the Directive 2008/62/CE was approved on agricultural species and in November 2009 the Directive 2009/145/CE on vegetables saw the light. A comprehensive text on plant propagation species and fodder plant mixtures is still being negotiated at the Permanent Seed Committee in Brussels.

Key features of a conservation variety within these two directives are the concepts of "landraces", "local adaptation" and "genetic erosion". Through literature study, interviews and meetings with key experts we have discussed the meaning of these three features in different European languages and contexts.

The notion of "landraces"

The diversity of the approaches encountered in the Member States could be evaluate through the diversity of the translations of the word "landrace" in the national version of the directive.

Stakeholders' consultations also revealed that concepts dealing with landraces are frequently mentioned in everyday life in EU countries. Most of them use terms that refer to either the regional or historical patrimony, either ecological or socio-economical values.

Local Adaptation

History of cultivated species shows that local adaptation is relative in time. Going back in the history, one could find out that within a certain region, each historical period has had its own distinct set of varieties, which could be considered as local varieties. The Roscoff cauliflower type from Brittany (France) can for instance, illustrate this. Since the end of the 19th century, farmers have created hundreds of population varieties by selecting within broccoli varieties that came from England and which previously originated from Italy. With the "modernization" of agriculture the Roscoff cauliflower populations were replaced by F1 hybrids. Recently, French organic farmers have renewed the Roscoff breeding and developed new local types of cauliflower by selecting within genebank accessions for the needs of low- input, organic agriculture. This shows that linking a conservation variety to a certain region of origin, such as required in the new directive, is highly questionable or at least that this concept can be useful for some type of conservation varieties – mainly which are called local varieties – but not for all. In general, an evolutionary approach is needed regarding the history of varieties and agriculture, in order to promote within seed legislation further evolution and creation of diversity.

Genetic erosion

Inherent to adaptive potential is the amount of genetic diversity present within a landrace. Genetic erosion, a decrease of genetic diversity within and among varieties, also diminishes the adaptive potential of a variety or crop. If the conservation varieties are to be described on the basis of Distinctiveness, Uniformity and Stability, and if the Uniformity requirement is applied too strictly, this will result in that many landraces will remain illegal and cause a decrease of genetic diversity and hence increasing genetic erosion and decreasing local adaptation potential.
Concerning the definition of genetic erosion, it should be noted that it is very difficult to define the level of diversity loss in plant genetic resources, because it is not easy to express in numerical terms. First and foremost a census or a list of the local varieties still grown by farmers would be needed in order to estimate the risk of inter-varietal erosion. Secondly, the variability of each local variety would have to be known - these are often fairly heterogeneous populations – to estimate the risk of intra-varietal erosion. Obviously, the absence of a preparatory cognitive survey makes it very difficult to indicate the risk of genetic erosion of a specific resource. Furthermore, even assuming that it is possible to qualify the risk of erosion there is still a marked contradiction. When the seed of a conservation variety is sold in conformity with all the rules, can it still be considered at risk of genetic erosion?

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

Stakeholders' expectations

The FSO project analysed the expectations and problems of different stakeholders with marketing biodiversity. Production chains that were included in this survey covered a wide range of diversity, i.e. pasta and bread makers in Italy and Spain, producers of cauliflower and broccoli in France, tomato growers in the Netherlands and Spain, maintainers of old fruit and vegetables varieties in Switzerland, Spain and Italy. In total, 27 enterprises and organisations in five countries participated in the interviews. Most initiatives working with landraces (we prefer to use this term due to the fact that the term conservation variety is not yet known or used) are rather small and rely on highly motivated, but heavily underpaid staff. Several organisations are still in a start-up phase and depend partly on funding of private or, most often, public donors.

The motivation to work with conservation varieties can be agronomical, economical and ethical. Especially for farmers it is a means to diversify their production, to adapt crops to a specific environment and to establish more sustainable farming and equitable trade relationships. Most initiatives are also concerned with the loss of biodiversity and raising public awareness on this issue. Nevertheless, while stakeholders are optimistic about marketing opportunities, they are also worried about the lack of public commitment with agrobiodiversity. They see sensitising of the consumers to change their consumption habits as a first priority. In general, economic aspects are not estimated to be as important as the quality aspects of the crops. Stable and recurring product quality as well as flexibility of the growers to follow the demand were estimated to be the most important factors for success.

Markets as a tool for promoting on farm management of PGR

Marketing of produce based on agrobiodiversity, such as local bean varieties or marmalades of old fruit varieties, has great potential and product launching is relatively easy and with minor economic risks. Moreover, one of the activities pointed out by the Global Plan of Action for the sustainable use of PGR is "Developing new markets for local varieties and diversity rich products", as underlined in section 14.

However, the profitability of the products is relatively low due to small-scale economies. Most initiatives try to place the products in

the premium price segment and combine it with premium cultivation labels, such as organic production. Such diversity-based products are often highly seasonal. This makes continuous marketing difficult. Crops and variety choice is principally based on taste and exclusivity. Furthermore, product image, producer reputation, and an attractive history are important for successful marketing. The relative importance of the regional origin of a variety or its quality components depends on the cultural backgrounds of the country. For example, in Italy there is still a strong association between a variety and its region of origin, especially for vegetables. In southern Europe, this connection between product and region is stronger than in the North and part of the tradition. The divide between North and South Europe agriculture can easily be verified analysing the nationality of Geographical Indications (GIs). Italy, Spain, Portugal, France and Greece have the great majority of GIs listed in class 1.6 – on fresh and processed fruits, vegetables and cereals – showing how in these countries there is still a strong connection between food, culture and the so called "terroir". We consider this class of GIs relevant for analysing their relations with agrobiodiversity.

Actions required to support an appropriate market

Subsidies are inevitable for diversity based products, especially in the start-up phase of marketing projects. Seed and variety protection laws, and consumer protection legislation are seen as the main obstacles for the development of this niche market. Access to public gene banks should be enhanced and the gene bank conservators should be more active in providing characterisation and agronomic evaluation of their plant genetic material.

On the other side, if the aim is to promote the sustainable use of agrobiodiversity more research should be done on the impact of GIs and branding. Work on analysing their impact on rural development, their economic benefit, the impact on small farmers or as a key for local innovation through collective action should be complemented by the compatibility of GIs with agrobiodiversity objectives and their coherence with seed laws.

Another aspect that needs consideration is the definition of code of practice for the characterization of a specific product. To date, little importance is given to local varieties and the maintenance of their diversity.

Finally, it is important to promote and maintain the informal seed system behind each agrobiodiversity rich product, e.g. creating a legal space for the commercialization of their seeds as conservation varieties.

Matches and mismatches of the EU directive with end-

The FSO project analyzed whether the Directive 62/2008 may indeed contribute to the conservation and continued use on-farm of a wider array of crop varieties, or whether the current articles may curtail current practice.

One of the intentions of any of the EU and national seed regulations is to guarantee seed quality. Good seed is important for every farmer. Purchased seed has to match the expectations of the buyer even though most quality factors cannot be identified by simply looking at the seed. The varietal identity has to be guaranteed and the varietal uniformity should be within the expectation range.

Commission Directive 2008/62/EC comprises 24 articles concerning issues like defining conservation varieties, procedures for acceptance, rules for seed production, packaging and labelling, among others. The implications of each of the articles for the current practices of end-users and the stimulation of biodiversity were particularly analyzed during the FSO program. However, this directive is only on agricultural landraces and varieties and there is the new directive 145/2009 on vegetables, of the 26th November 2009, one month before the end of the project, which will be mentioned in the recommendations part of the project.

Main concerns identified are on:

Region of Origin

Seed maintenance, production (except for vegetables) and marketing should be conducted in the identified region of origin of a conservation variety. However, throughout history, cultivated plants have always travelled, like potatoes and tomatoes, from Latin America, carrots and onions from Asia and cabbages from Western Europe. Moreover, many old varieties, which may be thought to be local varieties originate from elsewhere. Hence, from a historical and ecological point of view there is no reason to restrict a plant genetic resource to a certain region. On the other hand, the name of a variety could be strictly correlated to a particular area; hence, it may be useful for some local communities to have means to protect their patrimony from the global market (e.g using tools like Geographical Indications).

Registration costs

Seed producers of landraces and old varieties are mostly small enterprises that usually maintain and sell a wide range of crops and hundreds of varieties. Dutch authorities estimate that costs of registration and seed certification would amount more than 1000 Euros

per variety. Obviously, this will make it impossible for small enterprises to register all the varieties they maintain. Therefore registration costs will reduce biodiversity on the seed market and the variety choice.

Restriction of seed quantities

Multiplication of each conservation variety is limited to 0.3-0.5% (depending on crop) of the total seed market of the crop concerned or the amount needed to sow 100 hectares, whichever the greater quantity. These amounts may limit the commercial viability of multiplying and marketing conservation varieties, while there is no conceptual reason for restricting the acreage. It appears that restrictions seem to be put in order to limit the market of conservation varieties and to prevent unfair competitiveness among seed industries by the use of the less restricted catalogue of these varieties.

Registration requirements: Distinctiveness, Uniformity and Stability

For description purposes varieties should be Distinct, Uniform and Stable. Especially the uniformity requirement was considered a bottleneck. FSO therefore analyzed current methods and standards for uniformity and conclude that a minimal description of the salient features of the conservation variety may sufficient. In case a registrar may want to apply detailed descriptions for the registration of conservation varieties, then the same methods may be used as for conventional varieties with the exception that methods developed for cross fertilizing crops may need to be applied for the description of genetically diverse self fertilizing crops. Alteratively, a minimal description can be applied, describing the distinguishing features based on users' experiences. Strict uniformity standards should not be applied since the key objective of registering conservation varieties is to promote the sustainable use of diversity and that identifiability is a primary aim and not uniformity. Two issues need careful consideration: the inherent lack of stability of landraces may require a wide interpretation of the identity (description) of the landraces being considered as conservation variety, including an option to re-register a variety when it changes over time (e.g. as a result of climate change). Furthermore, the fact that current seed certification standards for uniformity are much stricter than the registration standards has to be dealt with in the implementing rules at the national level.

Finally an analysis of the positions of countries (country representatives in the negotiations in Brussels) that led to the formulation of the directive revealed that the countries with a strong (conventional) seed industry have had a predominant position in the debate and not those that harbour the largest number (or acreage) of potential conservation varieties.

Breeding initiatives

One of the objectives of the FSO is to develop on farm breeding methodologies for the conservation and development of landraces, amateur and conservation varieties. The starting point for the development of these methodologies is the already existing experiences of farmers, small-scale seed producers and researchers. To be able to draw on the expertise of these practitioners, we have selected five breeding initiatives for in depth case studies.

Prior to the selection of the five cases we carried out an inventory of all known initiatives within the European Economic Area. These include private persons, institutes and companies that use landraces, amateur or conservation varieties as a starting point to create improved varieties that are adapted to local cropping systems by either:

- Allowing such a variety to evolve with the local cropping system through natural selection in combination with intentional human (mass) selection;
- Using landraces as crossing parents in a breeding programme to develop new varieties.

Motivation for maintaining and breeding landraces

For many initiatives one of the important reasons for growing and improving landraces is the superior food quality and taste, which has been lost in the modern varieties. Such initiatives use the quality of the varieties to develop marketing strategies to increase the profitability of their crops.

The cases show that especially under less favourable growing conditions landraces can compete with and even outperform modern varieties. In Sweden, for example, farmers who had stopped growing winter wheat because modern varieties did not survive the Nordic winter are now growing landraces that do survive the winter. So, landraces offer new opportunities to farmers in marginal areas as these allow them to cope with environmental stress and to compensate lower yields with a higher product price for quality.

Breeding landraces

Despite the superior quality of landraces, the majority of the initiatives also see a need to improve the landraces or use these as a base population to generate new varieties. This is

What is breeding?

The activity of plant breeding aims at provoking genetic changes in a crop in order to enhance crop performance for yield and/or other desirable traits. These genetic changes can be achieved by deliberate selection of certain plant types, but in addition by using selection pressure from the growing environment. Usually plant types that are better adapted to the environment produce more seeds than plants that are not adapted and hence after several growing seasons the composition of the population will be shifted towards the more adapted plant types. In this study we consider both deliberate selection as intentionally growing a diverse population in a certain environment, with the aim to adapt the population to the environment, as breeding.

because the landraces, which were taken out of production for many decades, did not have the opportunity to co-evolve with the current agricultural system and changes in climate.
The farmers involved in the initiatives with the self-pollinating cereal crops, mainly multiply the varieties at their own locations, sometimes in combination with mass selection. They experience that the varieties change due to selection pressure of the environment. In the cross pollinating vegetable crops more strict maintenance breeding is required to keep a variety in good shape.
From the studied cases it becomes clear that most farmers do not resort to crossing varieties to create new diversity. The cross pollinating varieties continuously produce new plant types and this gives good opportunities to select new varieties from landraces and open pollinated varieties. In the self pollinating crops, such as wheat and tomato, the possibility to find new types is much smaller. In the case of tomato 'Kultursaat' breeders therefore do make crosses. In the wheat case of Allkorn the breeder involved still finds sufficient diversity within the landraces to select new varieties.
Summarising we have learned that many initiatives involved in maintaining old landraces:

- Experience a need to improve the landraces;
- Allow improvement in self pollinating cereal crops by mass selection and natural evolution due to environmental selection pressure;
- Need organisational, financial and knowledge assistance in maintaining and improving cross pollinating vegetable crops without making new manual crossings.

Future challenges

From the cases we learned that the majority of old varieties are not available on the seed market anymore. If in the past these were saved by genebanks, these could be made available to farmers again. To obtain such seeds farmers should be organised in e.g. an association or seek an alliance with an institute, because genebanks do not directly give out seeds to individual farmers, but only to so called bona fide users. Even then, due to restricted financial resources, genebanks only make available limited numbers of seeds. It usually takes one or two cropping seasons to obtain sufficient quantities to sow a field of reasonable size.
Once farmers have obtained landraces, the current seed legislation in the EU limits the possibility of up scaling the initiatives to a larger group of farmers, because the legislation prohibits the farmers to exchange or sell seeds of these landraces to other colleagues.

Bottlenecks and challenges for maintenance and breeding

In the FSO project, on-farm field experiments were conducted with "non-conventional varieties" (landraces, old varieties and new farmers varieties) during the 3 consecutive years of the project (2007-2009) with the objectives of assessing the evolution / adaptation over time and space of these varieties when they were moved from one environment to another. These experiments were carried out in the Netherlands, in Italy and in France.

A large experiment of 25 trials with 4 species (wheat, maize, bean and spinach) started in 2007 (or autumn 2006 for bread wheat) and esd conducted for three years in three countries according to the experimental design below. In 2009, an additional common trial was conducted in one site (Le Rheu experimental station) under organic management. This allowed the comparison of all versions of the varieties that have been grown on farm for two generations with the initial samples (or other reference samples).

Specific features of each species experiment

Each species underlines a specific aspect of plant breeding / on farm conservation. For maize and spinach, mass selection was applied by the farmers, which allowed to characterise the effect of the farmers' selection and practices. For beans, various breeding strategies have been developed by the farmers illustrating the diversity in the way farmers interact with the varieties. For wheat, very little or no selection was applied by the farmers which led to mostly assess the effect of natural selection/adaptation within each environment.

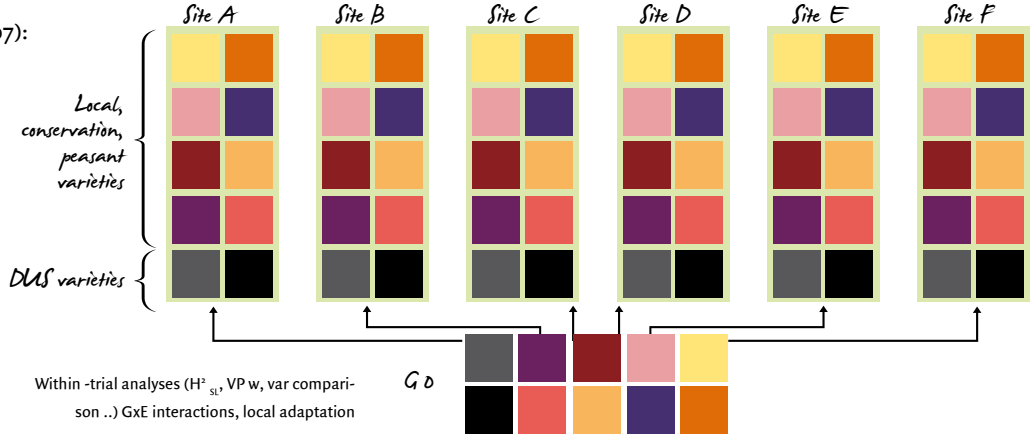
Conclusions from the first year experiment

In 2007, quantitative measures were recorded mainly on the wheat experiment where 10 varieties including 8 farmers' varieties from French, Dutch and Italian farmers and 2 modern varieties have been grown on farm. Qualitative observations, environmental conditions and farmers' practices were recorded for the other species.

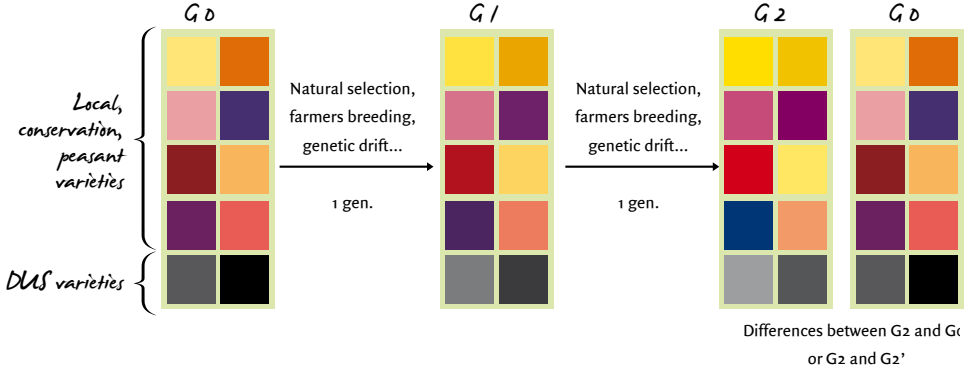
Although modern varieties must pass strict criteria for homogeneity before being released, it appeared that under on-farm organic and low-input conditions, characterized by heterogeneous environments, modern wheat varieties may be just as variable phe-

g, outcomes of field trials

First season general design (2007):



General process over the three years:



notypically as some landraces for certain seed production traits while landraces often had unexpectedly low within-variety variability. In bean, variation for flowers, pods, seeds, was found within the landraces which did not correspond to "original" description but was interesting for the farmers.

In wheat, strong Genotype by Environment interactions (GxE) were detected, but modern varieties did not appear significantly different than some landraces except for plant height and distance between the last

leaf and the spike. We found phenotypic evidence of the selection history of the landraces but little indication of local adaptation. This emphasized the importance of farmer experimentation with many different varieties as they may find landraces or farmers' varieties from other regions that are of interest on their farms. For certain species such as bean, farmers found interesting to apply mass selection or selection of phenotypic "variants" within traditional landraces.

Main conclusions

The FSO original and extensive experiment based on four crop and vegetable species allowed an accurate characterization of varietal evolution over time in response to drastic environmental changes and contrasted farmers practices on-farm. Overall, after only 2-3 years of on-farm multiplication, evolution over time appeared significant for many traits assessed both on-farm and on the research station. The significance and range of evolution depended on the variety, the farmers' practices, farm environmental conditions, and the trait. Although less pronounced, this trend was also found for modern varieties. Still, all varieties stayed distinct based on multivariate assessment.

Identification of bottlenecks and challenges related to seed legislation

Distinctiveness

Distinction among varieties using phenotypic observations (in the field or on harvested grains/material) was always possible: on-farm trials and the common experiment at Le Rheu always had a significant main effect of the variety in ANOVA for each measured character. This was true even in the presence of strong GxE interactions which modified phenotypes from one farm to another and even when varieties appeared heterogeneous. The landraces were more diverse than the varieties registered in the official catalogue. A multivariate analysis based on the common wheat experiment at le Rheu showed that while the versions of each variety diverged, they always group in separate varietal clusters.

Homogeneity

The UPOV protocols define homogeneity as a percentage of "off-type" plants. This seems difficult to apply in the case of landraces, populations or new farmers' varieties. In the FSO trials, measures on individual plants for each variety and in each trial were used to assess the level of homogeneity within each variety. For a few criteria (e.g. plant height for wheat), the varieties registered were much more

homogeneous than the landraces. However, for the majority of phenotypic traits measured, under on-farm conditions the level of intra-varietal heterogeneity was comparable among landraces and modern varieties. Thus the standard of homogeneity as defined in UPOV and in the registration and certification process is not relevant and does not make sense when varieties are observed and described on-farm under organic or low-input conditions. True "off-type" plants that occasionally appeared in a variety (e.g. in beans) were not always identified as problematic by farmers, and in fact could be plants of great interest for certain farmers.

Stability

Stability in space. A single initial variety, cultivated in contrasting environments (the Netherlands – France - Italy) could (i) perform differently depending on the environment (GxE interactions), (ii) evolve in a different manner in each environment depending on environmental and cultural conditions in the course of only two years of differentiation. Landraces were neither more or less "stable" than modern varieties over the 6 farms in terms of GxE cross-over interactions.

Stability in time. In the common experiment at le Rheu 2009 as well as in the on-farm trials, we found that for most of the characteristics measured, phenotypic expression had changed (2nd generation versions vs. initial / reference varieties). The evolution varied depending on the variety, the trait and the location where it was cultivated. Thus, two-three years of cultivation in contrasting conditions appeared to induce variations in phenotypic expression, including for the modern varieties. Despite these changes in quantitative traits, however, each variety remained distinct and recognizable. Some farmers explained that it takes 4-5 years for a landrace to adapt to the conditions on their farm. After this period, the population's performance stabilizes for agronomic traits, even while it stays heterogeneous at the individual plant level. The length of this project did not allow for the evaluation of this facet of phenotypic stability in farmers' fields, but this "stability" (buffering capacity) due to diversity remains a major reason for using landraces. Utilization of the UPOV criteria of homogeneity and stability therefore appears to us to be inappropriate for describing conservation varieties or any other variety cultivated on farm; only the distinctiveness criteria appears to be useful and is not called into question by either the non-homogeneity or the non-stability of these varieties.

Limited Geographical Zone

Some landraces gave very good results, sometimes even superior results, for certain productivity traits outside their zone of "origin" or "natural adaptation". Therefore, limiting cultivation of these varieties to a narrowly defined geographic zone would limit farmers' choice of and access to potentially interesting landraces and historic varieties. In addition, the reduction of permitted cultivation to a legally defined geographic zone for conservation varieties would favour the increased genetic erosion of these varieties both by limiting population numbers and sizes and by limiting the range of environmental conditions to which the variety is exposed (thus impeding their evolutionary potential).

Genetic Erosion

The results of a study conducted on the dynamic management of wheat populations (INRA) showed that a network of on-farm sites can maintain the overall genetic diversity as long as the sites and cultivation practices are diverse (metapopulation principles). Another study on the Rouge de Bordeaux variety conserved within the French farmer network (RSP) showed the complementary nature of on farm dynamic management and conservation in the genebanks. While samples conserved in the genebank only captured and maintained a small part (often a single genotype) of the diversity initially present in a landrace, the evolution and adaptation that can develop after many cycles of on farm cultivation in contrasting conditions allow the diversification and the maintenance of the evolutionary potential of a variety.

Methodologies for participatory research in on farm main

Over the last 20 years there have been several noteworthy initiatives in participatory plant breeding (PPB) and participatory varietal selection (PVS) in cereals, legumes and vegetable crops, in both tropical and temperate regions of the world. But whilst all these PPB and PVS initiatives describe themselves as 'participatory', there is a need to carefully distinguish among the different kinds of participation involved in each case. For example, Table 1 shows seven different types of participation, ranging from passive to more active forms of participation. This typology is useful because it can help to better define and assess the 'quality' of participation in each PPB and PVS initiative— past, present and future. The typology shown in Table 1 can also help visualise and clarify the roles, rights and responsibilities of different actors (scientists, farmers...) involved in future programmes for on-farm conservation and management of agricultural biodiversity in Europe.

From the perspective of the European Union, an important implication of the typology in Table 1 is that the meaning of participation should be clearly spelt out in all EU-funded research and development for on-farm conservation and management of agricultural biodiversity.

In recent years there has been a rapid expansion of new participatory methods and approaches in the context of PPB/PVS and, more generally, in agricultural research and development. These have drawn on many long-established traditions that have put participation, action research and adult education at the forefront of attempts to emancipate disempowered people. To those involved in the wider body of development and conservation programmes, projects and initiatives, these approaches represent a significant departure from standard practice. Methods are being used not just for local people to inform outsiders, but also for people to analyse their own conditions. Last, effective use of these participatory methodologies often depends on the existence of platforms that bring relevant actors together to mobilise capacity for social learning, negotiation and collective action for research into the management of agricultural biodiversity. Platforms range from farmer networks to farmer field schools (FFS) and/or project partnership as in the case of FSO.

For both scientific and technological research, as well as the evaluations of PPB/PVS research products and impacts, a suite of methods for participatory inquiry can be combined in different sequences (Box 1).

Table 1. Typologies of participation

Typology	Components of each type
1. Passive participation	People participate by being told what is going to happen or has already happened. It involves the unilateral announcement by an administration or project management without listening to people's responses. The information being shared belongs only to external professionals.
2. Participation in information giving	People participate by answering questions posed by extractive researchers and project managers using questionnaire surveys or similar approaches. People do not have the opportunity to influence proceedings, as the findings of the research or project design are neither shared nor checked for accuracy.
3. Participation by consultation	People participate by being consulted, and external agents listen to views. These external agents define both problems and solutions, and may modify these in the light of people's responses. Such a consultative process does not concede any share in decision-making and professionals are under no obligation to take on board people's views.
4. Participation for material incentives	People participate by providing resources, for example labour, in return for food, cash or other material incentives. Much in-situ research and bioprospecting falls into this category, as rural people provide the fields but are not involved in the experimentation or the process of learning. This is commonly called participation, yet people have no stake in prolonging activities when the incentives end.
5. Functional participation	People participate by forming groups to meet predetermined objectives related to the project, which can involve the development or promotion of externally initiated social organisation. Such involvement does not tend to be at the early stages of project cycles or planning, but rather after major decisions have been made. These institutions tend to be dependent on external initiators and facilitators, but may become self-dependent.
6. Interactive participation	People participate in joint analysis, which leads to action plans and the formation of new local groups or the strengthening of existing ones. It tends to involve interdisciplinary methodologies that seek multiple perspectives and make use of systematic and structured learning processes. These groups take control over local decisions, and so people have a stake in maintaining structures or practices.
7. Self-mobilisation	People participate by taking initiatives independent of external institutions to change systems. Such self-initiated mobilisation and collective action may or may not challenge existing inequitable distributions of wealth and power.

Discussing farmer's practices

Farmer's experimentation in Parma

It is important to clean out machines thoroughly before moving on to the next variety

Other kinds of participatory methods may be more appropriate for involving farmers and citizens in the upstream definition of research priorities and the framing of broad policies for agricultural research and development. These methods for Deliberative and Inclusive Processes (DIPs) include citizens' juries, scenario workshops, public hearings and visioning exercises.

Box 1. Methods and systems of inquiry for participatory research for on farm conservation and breeding

These methods and systems of inquiry include agroecosystems analysis (AEA), beneficiary assessment, diagnosis and design (D & D), diagnostico rural rapido (DRR), farmer participatory research, groupe de recherche et d'appui pour l'auto-promotion paysanne (GRAAP), méthode accélérée de recherche participative (MARP), naturalistic inquiry, participatory analysis and learning methods (PALM), participatory action research (PAR), participatory research methodology (PRM), participatory rural appraisal (PRA), participatory rural appraisal and planning (PRAP), participatory technology development (PTD), participatory urban appraisal (PUA), planning for real, process documentation, rapid appraisal (RA), rapid assessment of agricultural knowledge systems (RAAKS), rapid assessment procedures (RAP), rapid assessment techniques (RAT), rapid catchment analysis (RCA), rapid ethnographic assessment (REA), rapid food security assessment (RFSA), rapid multi-perspective appraisal (RMA), rapid organisational assessment (ROA), rapid rural appraisal (RRA), samuhik brahman (joint trek), soft systems methodology (SSM), theatre for development, training for transformation, and visualisation in participatory programmes (VIPP).

Improving seed production and marketing

In parallel to the field trials on wheat, bean, spinach and maize, FSO carried out the analysis of seed and grain produced by the farmer involved, with the aims of (i) identifying technological and economic key constraints in seed production and (ii) developing methodologies for seed production. The FSO main conclusions are here presented and some practical guidelines and recommended procedures will be given for the production of quality seed.

Part of the analysed seed samples came from the WP2 trials, which aimed to assess the adaptation process of varieties when they are moved from one environment to another. These were not representative of the usual farmers' procedure for seed management. Yet, this protocol has allowed establishing the impact of this environmental change on crop performance as well as on seed quality.

Purity

The analytical purity of a seed lot expresses the amount of pure seeds as well as its admixtures such as weed seeds, seeds of other crops and inert material (sand, chaff etc.).

The FSO purity results for wheat are satisfactory, with most lots meeting the EU norm of 98%. For maize and beans the purity is almost always near to 100%. It was observed however that many farmers lack the possibility to clean their seed properly. Seed cleaning equipment and drying facilities are expensive, so farmers sometimes do this collectively. In case of farmers producing flour or bread from their harvested grain, they are aware that it is of great importance to clean the grain properly in order to protect consumers from poisonous weed seeds or contaminants such as ergot.

Germination

In maize, but also in wheat and spinach, the germination results were mostly above the minimum norm. Therefore seed quality met the minimum norm in most cases.

In beans, which are a notoriously difficult species to reproduce, FSO observed that producing well-germinating bean seeds is more difficult than for most other vegetable species. This is due to the nature of the seed, having high oil and protein content, their size, their vulnerability, their natural enemies,

etc. That is the reason why the EU threshold has been put at 75% in order not to have shortages of seed. In effect, many (amateur) farmers normally plant 3 or 4 seeds in one hole, to compensate for non-germinating seeds. Moreover, it has to be mention that many farmers involved in FSO are actually specialised in wheat growing, not in bean seed production; and that the initial seeds given to these farmers apparently contained diseases already, making it almost impossible to produce good seeds. Surprisingly, and maybe due to selection by the farmers, the crops in years 2 and 3 looked much healthier.

Seed health

The object of the seed health test is to determine the health status of a seed lot. This is done by estimating the presence of pathogens present on or in the seeds. These pathogens may or may not give raise to disease development in the field, depending on (i) the genetic background of the seed (tolerance or resistance); (ii) the environmental conditions during crop establishment and growth; (iii) the crop management used. Disease management is an important aspect of crop growing, particularly for low-input and organic agriculture since in most cases conventional crop protectants should not be used. Therefore it is pivotal to start with seed that is free of pathogens as much as possible. From FSO wheat trials it is clear that some farmers produced seed with high levels of contaminants, while the majority were able to produce lots with a low infection level. The results indicate that it is necessary to take extra measures, such as specific seed treatments like the use of natural plant products or hot water treatment to remove or neutralise the inoculum.

In the case of maize, the efficacy of the treatment with sodium hypochlorite is very effective - especially for *Fusarium moniliforme* - and necessary for most lots. The presence of *Fusarium* and Nigrospora is problematic because of the production of mycotoxins. A hypochlorite treatment on grain for food purposes is undesirable however. It is important that farmers are aware of this problem. Indeed, the farmers who are using the grain for producing flour and bread, which they sell directly to consumers, take particular care when handling the grain for that purpose.

In the case of bean, FSO tested also four samples from a professional organic seed producer, of which three were free from BCMNV (Bean Common Mosaic Necrosis Virus) and BCMV (Bean Common Mosaic Virus), and one contained BCMV, despite the fact that it was produced in a controlled multiplication in another project aimed at improving seed quality. This demonstrates the difficulties in seed bean production. During a thorough discussion on this problem in the final farmers' forum organised in Marseille in October 2009, farmers involved in FSO pointed out that they are well aware of this problem, therefore some of them are specialising in seed bean production. As a matter of fact, beans are recognised as a species that requires special skills and attention.

Practical guidelines

The sharing of knowledge between farmers and scientists in the FSO partnership was very fruitful and pointed out that farmers' seed networks could be very useful in improving seed quality and meeting also the EU standards.

A number of different approaches can be distinguished, each with a different aim and used at different stages of seed production. These include:

- Select the best seeds form the bulk before sowing, such as is often done with bean seeds. Only the healthy-looking seeds of the right type will then be sown. This reduces the incidence of diseases in the next crop;
- Select the best seeds after harvesting, but before threshing and storage. This is commonly done in maize, where the best-looking cobs are selected for seed. These can then be treated separately and given more care during storage;
- Select a good-looking portion of a field to be harvested separately for seed. This is done because one can expect these plants to produce healthier and more vigorous

seeds;

- Select individual plants from over the entire field. In this way one can, in addition to the better seed quality, also enhance the genetic composition of the variety;
- In crops where the characteristics are no longer visible at the time of harvest, one can mark individual plants as seed plant during the vegetative stage. These will then be left in the field to produce seeds. This is often the case in crops like many vegetables in which the plant and not the seed is the commercial product. In this way one can still select, for instance, for resistance to leaf diseases.

These are the methods that can be used by farmers when producing seed for themselves only or for very limited distribution to others. If however, more seed needs to be produced, the production should become more sophisticated and planned. Then the following methods of selection are available:

- Prepare a field especially for seed production, separate from the crop production field, and taking precautions for undesired cross-pollination. During the season, one will then remove plants of undesired type ('off-types') and diseased plants;
- Use special selection procedures to maintain or purify the variety, like for instance ear-to-row systems. In land races this has to be done with great care: one should only remove the plants that clearly do not belong to the variety, in order to maintain the varieties' identity and normal heterogeneity.

Timing of the harvest is crucial in obtaining high quality seed. It has been observed that many farmers produce cereal seed next to other activities (vegetable growing, cattle raising), which are getting priority for obvious reasons. But if this goes to the detriment of seed quality one is in the danger zone: next year's crop establishment may become problematic. Some guidelines:

- Harvest as soon as the seed has reached full maturity; when too long in the field, and especially under humid conditions, fungi will develop on the seed, which may result in bad storage behaviour and low seedling quality;
- Harvest when the crop has not yet lodged. Weed seed may be collected with the crop seed, sand and clay particles will become admixed, and the more humid condition will result in seed deterioration (see next);
- When in swath, leave it only for a few days maximum there, for if rain comes, the seed may start to germinate. Pre-harvest sprouting is one of the major factors of inferior seed quality;
- Harvest in one operation: so no quality differences occur in the lot (they will result in bags with good and bad seed, even if one tries to mix). If a combine is used, be very sure it is clean or was used for the same variety before;
- Preclean when possible: separate the seeds from the inflorescence material (except with maize, that can remain on the cob, but these need to be peeled from the husks for more efficient drying);
- Dry as soon as possible. If the material is too wet, artificial drying may be necessary and should start immediately after harvest. Each day lost will result in an ever-increasing decline in seed quality;
- Store the seed dry in airy conditions, free from the floor (in woven bags on pallets or shelves);
- To avoid varietal admixture, harvested products should be kept separate and not used on the same machinery without thorough cleaning;
- Combat rodents and insect as best as you can;
- Make sure you have intact floors without crevices and wipe or vacuum clean these regularly;
- Have a good look at your seed stock every week: it is your treasure.

Policy recommendations and experiences from the FSO In

The Farm Seed Opportunities has painted a broad picture of the seed situations in Europe. The first and foremost result is that Europe is still full of diversity, at cultural, environmental, climatic and farming level. Even if the formal seed system tends to impose its norms and modernization through regulations, it fails to answer to all the diversity of the European farming systems and farmers' need.

In particular FSO found that only two types of varieties should fall under the concept of conservation variety: traditional farmers' varieties/landraces and commercial varieties once registered in the catalogue, but for which the commercial interest declined. This, therefore, is not a category for lumping together all the varieties, whose seeds at the moment cannot be marketed, and for which it will be necessary to explore different legislative openings. FSO studies identified the following categories:

- The varieties produced by farmers' and/or participatory plant breeding (PPB) not in conformity with DUS requirements;
- The old varieties no longer registered in the Catalogue (there are factors that can make registering these varieties problematical: excessive registration costs, difficulty in proving the VCU, only limited marginal areas interested in growing them) and which do not have a precise geographical area of origin;
- Local varieties used as genetic resources in reintroduction programmes, to cultivation in different areas from their area of origin;
- Variety – Populations that have no historical link with a given territory and which cannot be registered in the official catalogue having no correspondence with the DUS criteria.

These varieties may be important for increasing genetic diversity in the field – specifically in organic and low-input agriculture -, playing a key role also in facing climate change. All of this could be considered part of the European informal seed system.

Informal seed systems as way of sustainable use of PGRFA

Finding the right balance between formal and informal seed systems within European context should be one of the objectives of the regional strategy for on farm conservation of PGRFA. Such a strategy will also concretely address the implementation of the article 6 on sustainable use of PGRFA of the International Treaty on Plant Genetic Resources for Food and Agriculture (www.planttreaty.org), signed by European Union and its members in 2004. This article is mandatory for Contracting Parties and

applies to all crops species, not only to these listed in annex I, as in the case of the Multilateral System.

Moreover, it will ease the debate on Farmers' rights (article 9) at regional and international level due to the fact that many actions included in article 6 are also in strict relation with article 9:

- The promotion of the use of local varieties and underutilised species can be considered a way of protecting of traditional knowledge (Article 9.2(a)).
- Increasing farmers' options through participatory plant breeding could be considered a non-monetary benefit sharing measure (Article 9.2 (b)). Therefore an integrated on farm strategy that includes informal seed systems and their varieties should consider the promotion of Participatory Plant Breeding (PPB) to help farmers to fulfil their needs, facilitating them in accessing the genetic resources and broadening the range of available species. All they are actions aiming to bring compensation in farmers' favour.
- Finally, promoting diversified agricultural systems through policies that support informal seeds system will enhance farmers' role on seeds exchange, reuse and sell in agreement with article 9.3.

In this framework the on farm strategy should allow the presence on the market of proximity (local market or direct sell) of the seeds of the varieties identified by FSO, and at the same time needs to avoid creating opportunities for the diffusion of poor quality varieties on commercial markets. To this goal the role of networks or associations could be a key element in order to set up a bridge between formal and informal seed systems. The latter is a specific system based on social norms: trust, reputation and reciprocity govern it. Therefore enhancing the role of social networks could improve the quality of informal seed system. In this regard, the directives on conservation varieties open a new interesting possibility, for the first time allowing organisations to have a role within seed legislation (article 34 of the directive 2009/145/CE and 21 of the directive 2008/62/CE).

Finally, we would like to stress the importance of such a strategy, also because "it is impossible to replace farmers' seed systems completely and it would be unwise to try. Farmers' seed systems provide an important component of food security, a vital haven for diversity and space for further evolution of PGR" (FAO, *Strengthening seed systems: a contribution to the preparation of the Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*, 2009).

Peru 90% of seeds are produced in the informal seed system and the agrobiodiversity is a way of managing risks in search of food security. Two inventories have been realised: one for native potatoes, with 28 minimum descriptors identified with farmers' participation (a specific law passed in 2008 on this issue); one for national corn, based on 11 descriptors for classification, containing also recommendations for the participatory characterization and the identification of farmer's name or community using a particular landraces.

Scotland Landraces are still grown for barley, small oat, oat, rye, and cabbage. An ex situ conservation system is in place aiming at: (i) guaranteeing a safety back-up for seed growers; (ii) monitoring of seed quality and feedback to seed growers; (iii) inventorying landraces (www.scottishlandraces.org). Regarding conservation varieties Scotland will make a light implementation of the directive, and they have concerns about: (i) the definition of area of origin; (ii) costs for growers. Finally alternative tools for conservation may be better suited.

Canada has in place a seed system similar to the European one (Canadian seed act). There is a modernization project that aims at reducing the number of years of the registration trials and the number of traits considered for the Value of Cultivation and Use. In this context there is no place at the moment for organic varieties. Regarding GMOs, the conventional seed system is unable to segregate from GMO seeds and contamination of seed sources is quite common. For this reason organic farmers are starting to reproduce their own seeds, within the framework of a technical project on farm saved seeds. Farmers are also developing a PPB project within the network of farmer breeders.

Norway A kind of informal seed system is still in place: landraces are used to some extent, old commercial varieties are frequently used, farmers exchange seeds among themselves and across borders, some farmers get seeds from the genebank, and farmers develop the varieties from season to season by selection. For this reason Norway decided not to become member of UPOV based on the 1991 Act.
In 2010, Norway has introduced new regulations, based on the EU Directive on Conservation Varieties, which allow (i) exchanging, giving away and selling of seeds among farmers and gardeners on a non-commercial basis; (ii) for the release of conservation varieties, following the EU-rules but interpreting them less strict as may be the case in other countries; (iii) farmers to establish authorised seed shops for conservation varieties with simple procedure and lower requirements than for other seed shops.

Hungary A programme of multiplication and diffusion of landraces was initiated around 1960 by the national seed bank, aiming at preserving collected landraces, old cultivars, and local varieties and compensating reduction of genetic variation resulting from multiplication under the same climatic conditions year by year. The number of requests significantly increased due to the growing interest of farmers and breeders. Their motivations were: (i) searching special traits (quality, tolerance, shape, color); (ii) history; (iii) organic farming; (iv) raising awareness on agrobiodiversity. Problems foreseen with the Conservation varieties directives: (i) where to get the seeds? (ii) who are the registered maintainers; (iii) the majority of the varieties are stored in genebanks that are not prepared to diffuse them for lack of capacity.

Brazil Informal seed systems are important and they account for 60% in the case of rice, 87% in beans, 17% in corn, 46% in soybean and 34% in wheat. These are growing due to: (i) lack of trust in formal varieties; (ii) low quality and high prices of commercial seeds. Seed law regulates formal seed system, but creates some legal space for farmers´ seed systems: (i) there is a legal definition of local, traditional or creole varieties: varieties developed, adapted or produced by family farmers, agrarian reform settlers or Indigenous peoples, with well established phenotypical traits, recognized by the respective communities as such and taking into consideration also sociocultural and environmental descriptors, (not only agronomic); (ii) waiver of official registration for local varieties: Registration in the National Cultivar Registry of local, traditional or creole varieties is not mandatory; (iii) waiver for family farmers: Family farmers, agrarian reform settlers and Indigenous peoples who multiply seeds or seedlings for distribution, exchange or trade with each other are not required to register in the National Seed and Seedling Registry. The Decree created the following restriction: "farmer organizations can only distribute (not sell) seeds, and only among members of these organizations". This interpretation is questioned by farmers' organizations.

Nepal The traditional seed systems contribute to 90% of seeds of food crops and are characterized by production, exchange, and sale of farm saved seeds of both local and improved crop varieties. Seed production and marketing is regulated by Seed Laws, but in practice remain largely unregulated. The Seed act in 2005 changed application formats in favour of PPB varieties to include: (i) farmers' perception data; (ii) organoleptic taste data; (iii) accept data from participatory assessment; (iv) national listing (registration) of landraces and local crop varieties, including farmers' varieties; (v) provisions for production and marketing of farmers' varieties – both notified and non-notified.

Syria The informal seed system in Syria covers 90% of the barley seed: exchange of non-officially released varieties is the norm. The PPB programme started in 1995 in a collaboration between the Syrian National General Commission for Scientific and Agricultural Research (GCSAR) and ICARDA. Today the project involves 24 villages across Syria. The farmers involved: (i) grow the PPB varieties in their fields; (ii) evaluate the varieties and decide what varieties to grow each year; (iii) are involved in setting priorities and methodologies; (iv) can multiply their preferred varieties and exchange or sell them. The impact of PPB has been very positive for: (i) increasing yields; (ii) targeting farmers from the most marginal; (iii) decreasing crop failure by enhancing biodiversity: (iv) empowering the farmers; (v) enhancing rural livelihoods; (vi) strengthening farmers' seed systems.

Even so, the Ministry of Agriculture and Agrarian Reform argues that: (i) PPB varieties are to be released through the standard system of conventional breeding: 4 years in PPB fields + 3 years without farmers' participation; (ii) according to the system, selling and exchanging not-officially released seed in Syria is illegal. But there is no national seed law that restricts the exchange of seed. A law was drafted in 2002 with FAO to regulate the exchange of plant genetic resources based on the International Treaty on Plant Genetic Resources for Food and Agriculture.

Italy Italian regional legislations are one of the few operational examples at European level for protecting agrobiodiversity. In many ways they can be considered a forerunner of regulations in line with the aims of the FAO Treaty. This experience highlights the importance of the local context in addressing the question of the sustainable use of PGRFA. In particular, combining rural development with agrobiodiversity appears to be an appropriate strategy for harmonizing local incentives and global objectives.

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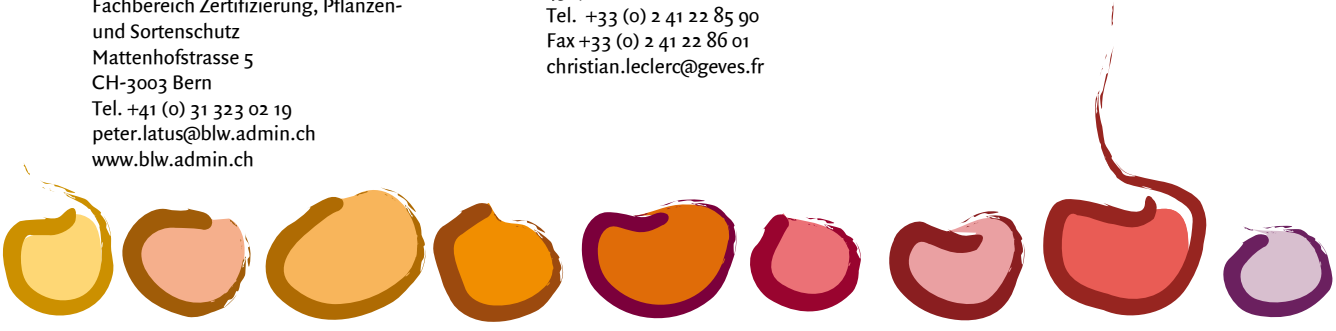


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