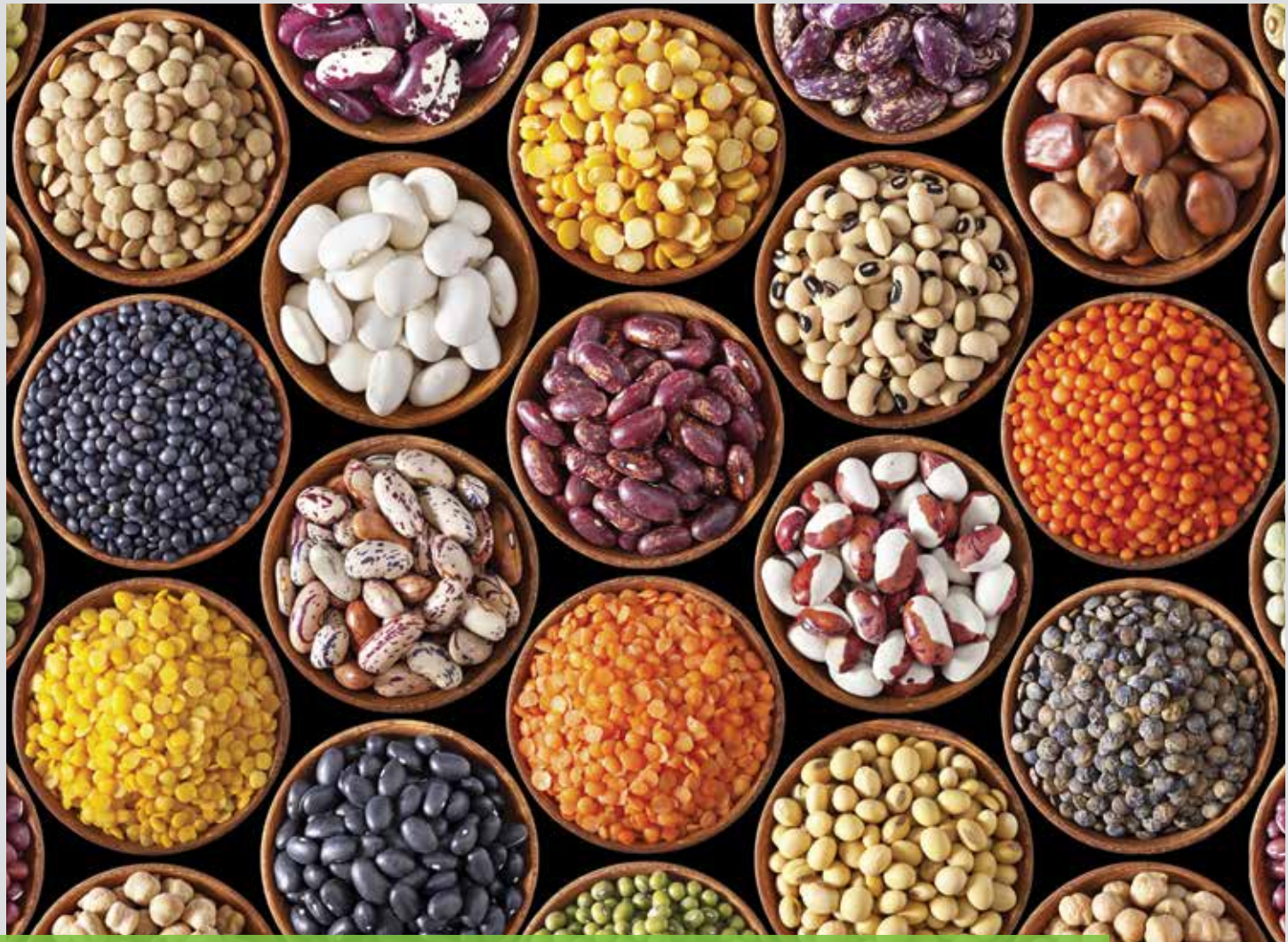

BIODIV'2050

No 4 - September 2014

MISSION ÉCONOMIE DE LA BIODIVERSITÉ

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EDITORIAL

Have the developments in agricultural production systems – particularly improved seed varieties – that have produced the benefits of which we are all aware in terms of our ability to feed the world, also eroded biodiversity in terms of the plants we grow and actually made agro-systems more vulnerable?

There is no consensus here either among scientists or professionals in the sector, particularly as regards the possibility and usefulness of farmers' seed selection (*in situ*). Nevertheless, given the importance of agriculture in terms of land use (53% in France), the vital importance of biodiversity in agro-systems, changing social demands being placed on agriculture and the resulting economic fall-out, we feel that this is a subject well worth tackling.

Edition No. 4 of BIODIV'2050 seeks to present a cross-disciplinary overview of the biodiversity of plants cultivated in France and to put the views of the various different stakeholders into perspective. We met and interviewed a selection of key stakeholders in the sector. Their views are presented in a series of inserts throughout this edition which continues to espouse Mission Economie de la Biodiversité's credo of researching and testing innovative solutions that strike a balance between economic development and the preservation of biodiversity – this time in the agricultural production arena.

The emergence of new agricultural models in response to societal pressure (agro-ecology, short food circuits, organic farming, etc.) coupled with the preservation of biodiversity, opens up new possibilities for creating value at local level as a number of successful experiments have shown. These new models are able to both leverage and contribute to biodiversity. They also have the potential to reconcile two approaches to conservation – namely *in situ* and *ex situ* – within participative arrangements involving farmers and the seed industry. For this very reason, we are determined to continue exploring this avenue and we would be delighted to exchange with the actors concerned with a view to setting up or developing concrete arrangements.

LAURENT PIERMONT
Director of
Mission Economie de la Biodiversité

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OPINION

DEVELOPMENTS AND CHALLENGES RELATED TO THE GENETIC DIVERSITY OF PLANTS GROWN IN FRANCE

PIERRE-HENRI GOUYON is a researcher at *ISYEB* (Institute of Systematics, Evolution & Biodiversity at the French Muséum national d'Histoire naturelle) and a lecturer at AgroParisTech, Ecole Normale Supérieure and Sciences Po. He focuses on evolutionary mechanisms – from genetics to ecology – and presents us with his perspective on the genetic diversity in cultivated plants.

What is genetic diversity in cultivated plants and how do you think it has evolved?

Biodiversity is a current observational fact. When we look at nature, we realise that all living beings are different and this is why Man initially sought to create categories known as species, based on the idea that they had all been created independently of each other in line with some sacred design. In the eighteenth century, the founder(1) of Systematics(2) explained that diversity existed only between species and that variations within a given species were mere whims of nature devoid of importance. It was Darwin that changed the perception of biodiversity 150 years ago. He demonstrated how species are not immutable but part of a process of divergence resulting from constant differentiation between forms based on internal variability and culminating in the emergence of new forms and the extinction of certain species over time. Gradually, differences between these populations will be so great that we will name them species in their turn, thus constituting a groundswell of diversity.

The process is the same for cultivated forms. Two factors drive genetic divergence between populations. Firstly, chance. Each generation is a sort of representative sample of the previous generation (descendants are never identical to their parents). This results in constant evolutionary pressure known as genetic drift which combines with various mutations to transform each population. Secondly, human or natural selection serves to differentiate populations in accordance with the conditions to which they are subjected. Genetic diversity therefore forms the basis of biodiversity. Starting out with just a few domesticated populations, plant selection and breeding by people of varying tastes under different ecological conditions has produced huge diversity in a whole series of characteristics (composition, robustness, resistance, etc.). The Darwinian process has been at work for over 10,000 years.

The early twentieth century marked a turning point as farming split into two separate professions: the farmer who grew the seeds and the seed company that reproduced plants to produce seeds. This distinction had two major drawbacks whose effects became apparent in the second-half of the twentieth century.

First off, it triggered a loss in the genetic base. The process described by Darwin was destroyed as we lost the diversity of the different agricultural fields and practices that constantly produced new forms. Furthermore, the genetic base used for breeding within a given species and within each variety was becoming smaller and smaller. The seed grower interested in producing enhanced seed lines was concerned with preserving diversity but adopted a static vision of conservation. The second problem was the standardisation of varieties and the introduction of controls. While this provided farmers buying seeds with guarantees, it also helped create a quasi-monopoly situation for a group of seed companies that naturally sought to maximise the return on their innovations.

This whole situation stymied the production of varieties imbued with biodiversity. Some of the motives were reasonable, such as excessive variability in plant height that made mechanised harvesting difficult, but others such as the ban on commercialising varieties possessing diverse disease-resistant genes were inexcusable. We now know that such diversity is the only guarantee of resistance over time. In brief, we have deployed mechanisms that prevent diversity processes from working while believing that this would not be a problem if we maintained a parallel biodiversity in our refrigerators.

According to the Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture published in 2010, "The genetic diversity of the plants that we grow and eat and their "wild relatives" could be lost forever, threatening future food security" What is your view?

This is an extreme point of view and I don't consider the term "lost forever" to be appropriate. I don't think diversity needs to be lost forever for the situation to be considered catastrophic, it just needs to diminish enough to expose us to enormous food security risks.

(1) Carl Von Linné
(2) The science of the classification of species

A decrease in genetic diversity in cultivated plants increases their vulnerability to parasites (insects, diseases, etc.) and makes them more fragile. Although we do not have absolute proof of a direct correlation, we are virtually sure that nature has deployed a costly sexual reproduction process (it takes two!) because diversity is absolutely necessary.

Also, genetic homogenisation means homogenisation of cultural practices and this fosters resistance among plants' enemies (e.g., certain weeds and insects have developed increased resistance to herbicides). We also need to appreciate that such homogenisation takes place not at local but global level with a corresponding increase in health hazards. In dealing with this increased vulnerability, we have relied too much on our innovative capabilities in these domains and, in my view they are more limited than we previously thought. Indeed, we are witnessing a massive increase in antibiotic-resistant germs that we are unable to counter.

Moreover, climate change will require greater resilience in plants and biotechnologies have yet to prove themselves in this area. This is why I believe that it is better to count on the diversity of plants themselves to combat these new challenges.

The consequences are enormous – huge epidemics could trigger worldwide famines. We need to alert people to this matter as we are responsible to future generations for preserving biodiversity.

There are currently two approaches to conserving genetic diversity in cultivated plants: *in situ* conservation and *ex situ* conservation. What do you think of these conservation methods?

Beginning in the second-half of the twentieth century, we began to be aware of the erosion of genetic diversity and two schools of thought quickly emerged on how to conserve it. The first favours *ex situ* conservation, i.e., setting up gene banks that conserve genetic resources in refrigerators. The other approach harks back to Darwinian evolutionary theory and favours *in situ* conservation or maintaining diversity in cultivated plants in a dynamic manner.

For me *ex situ* conservation poses three problems. First, seeds kept in a bank may lose their ability to germinate. The second problem concerns adaptation: seeds kept in a refrigerator may no longer be adapted to natural habitats when we get around to using them. The third problem relates to sustainability over time. All it takes is a power cut, a lack of funding or even a change in policy and the system may no longer function. From the outset the scientific community viewed *ex situ* conservation as a short-term solution that only makes sense alongside parallel *in situ* conservation strategies.

But *in situ* conservation also has its limits and first and foremost, you need to actually devise a model. The aim is to improve plants in agronomic terms and this means making advances in the areas of production and resistance while conserving biodiversity. This is difficult to understand for geneticists as genetic models describing changes in populations predict that selection can only reduce diversity. Selection eliminates and by extension standardises, but if we go back to Darwinian theory, it is actually selection that produced biodiversity – selection with varied methods in varied ecological conditions. So we need to come up with a new model. In my view we need to invest in research in this area rather than in biotechnologies but due to the attraction of molecular technologies and certain dominant models in seed and agricultural production, *ex situ* solutions and research into biotechnologies are being favoured.

Maintaining dynamic balance in biodiversity

"Biodiversity is dynamic by nature and cannot be maintained in a constant state, so claiming to conserve it by keeping it as it is just makes no sense. However, we can conserve biodiversity from a global perspective by maintaining a dynamic balance – biodiversity loss is offset by the fact that populations diverge, constantly creating new lines. We can compare this process to that of a bike or a satellite: keeping moving helps maintain equilibrium but it's not a static equilibrium. Satellites are an especially good illustration of the phenomenon as you only have to slow them down in order to change their trajectory and cause them to crash. The same goes for biodiversity: slowing down the dynamics of diversity causes it to collapse. So trying to conserve genetic diversity in a static manner will not prevent the erosion of biodiversity – this can only be done by deploying dynamic processes for producing biodiversity."

Pierre-Henri Gouyon


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Can *in situ* conservation be reconciled with the economic goal of maintaining the competitiveness of the French agricultural sector and the societal goal of greater food security and if so how can this be done?

It is difficult to get farmers – even those sewing farmers' seed – to understand that dynamic conservation is not just about trying to reproduce plants *in situ* so that they do not change but actually enabling such change in accordance with diverse pro-biodiversity environments and farming practices – and I actually have experience of trying to convince farmers of this! This idea is not part of current mindsets and I believe it is a major obstacle to understanding what dynamic conservation is all about, i.e., where the farmer is active and works hand in hand with researchers and seed producers. This participative research makes it possible to track and analyse diversity and come up with findings to improve production, enhance the resistance of varieties, preserve diversity and devise solutions to a whole series of sanitary, ecological and climate-related problems.

This is the challenge. In the short term, I don't believe that we can hope to shift the entire agricultural profession over to this type of model, but I do believe the subject needs to be tackled in order to develop operational models in this field. Similarly, I think seed companies need to invest in this area to work together with farmers. A new model needs to be set up and deployed on a large scale and this will require input from all stakeholders.

When that day comes, I am absolutely convinced that we will produce diversity while simultaneously producing enough food. The economic and social challenge of maintaining production as part of a food security strategy is no small matter. At the present time, we know that we produce enough to feed the planet. Hunger results from excessive inequality and not from insufficient production. Increasing total production by increasing inequalities would be counter-productive. The challenge of agricultural production in terms of feeding humanity by the year 2050 is to develop "smart agriculture"[3], i.e., an agriculture that has the ability to harness diversity and maximise output from a minimum area in an ecologically intensive manner, unlike now where we are focused on increasing productivity by the hour. If we are to feed nine and a half billion people in the future, the problem will not be labour but the number of available hectares. This will require investment, intelligence and a genuine global rethink. ■

(3) Marc Dufumier – « *Les moissons du futur* » [harvests of the future] (a documentary by Marie-Monique Robin).

PIERRE PAGESSE is President of *Groupement National Interprofessionnel des Semences et plants* (*GNIS* - the French interprofessional association for seeds and seedlings). *GNIS* seeks to promote and represent the seed sector by working with both professionals in the sector and the French public authorities. In the following interview, he shares his views about genetic diversity in cultivated plants and conservation challenges.

How do you tackle the frequently touted question of the erosion of genetic diversity in cultivated plants?

Over the past 50 years– in France at least – there has been no further erosion of genetic diversity in cultivated plants and private and public plant breeders are actually creating diversity year after year. For example, 600 new varieties of plants are planted in French fields and gardens every year. In reality, when we speak about the erosion of biodiversity in cultivated plants we tend to think not of biodiversity in plants themselves, but of what is on our plates and these are actually two different things.

➔ First off, biodiversity in our plates does not depend just on seeds but on how these seeds are selected and conserved and this reflects the economic model prevalent in our societies. Over time, a certain number of plants became preponderant because they met consumer demands and consolidated the place of farmers within a value chain and certain other species and varieties were forced out. So from this perspective, we may consider that there were losses.

➔ Second, this process should not be confused with the erosion of cultivated biodiversity caused by the growing impact of human activities on nature as perceived by the scientific community. For example, urbanisation involves the destruction of natural habitats and sometimes the loss of the wild biodiversity of the plants that lived there. This reduces the genetic resource pool available to plant breeders wishing to create new plants so it is very important to preserve certain particularly biodiversity-rich areas.

If we agree on this distinction, we can say that cultivated biodiversity is no longer being reduced not just in France but throughout Europe.

Varietal standardisation is often perceived as a risk in the face of new developments (climate change, access to resources, new types of pests, etc.). What is your view on this?

I really do not believe that there is any link between varietal standardisation and the risks associated with future developments. Standardisation of certain varieties simply means applying a beneficial feature identified in one plant (resistance to cold, drought, etc.) to the whole variety. So the problem is not homogeneousness within a given variety, but having a sufficient diversity of different varieties – even if these are homogeneous – with different characteristics for dealing with future needs.

Moreover, I do not see how nature can respond to the challenge of climate change. It reacts to environmental pressure in a slow and pragmatic manner. Part of plant breeders' work consists in accelerating plant adaptation to all types of stress. And they have not done too badly! For example, in France wheat yields up to 1950 averaged 800 kg to 1 tonne per hectare; at the end of the 1980s they had reached 7 tonnes per hectare thanks to improved selection processes and standardised varieties.

What are the respective roles of *in situ* and *ex situ* conservation and related elements? What possible improvements can you see in France?

Ex situ conservation involves keeping collections of old varieties no longer being used commercially – meaning that they are not being used anymore by farmers or amateur gardeners – but which may be of future interest either because scientific innovations have made it possible to rediscover particular features or because they cater to changing consumer tastes. For example, old varieties of vegetables that are currently reappearing in markets had been kept in *ex situ* conservation banks. In farming, seed breeders are reintroducing features from wild parents that had been kept in storage to certain modern wheat varieties.

At the present time, approximately 300 varieties of standardised wheat are grown in France but the collection put together by *INRA* (French National Institute of Agronomic Research) and French seed producers includes some 2,000 varieties. Similarly, out of the 900 varieties of tomato conserved *ex situ*, only about 10 make it onto our plates. So there is a big difference between what is conserved *ex situ* and what is actually grown and eaten. Also, we should point out that keeping these collections involves not just conserving but characterising varieties as well. Conservation is only of use if we know the characteristics of the plants actually conserved so as to respond to specific needs without needing to research the entire collection (which may contain tens of thousands of varieties). There are currently 27 collections of species in France and they are only maintained on a voluntary basis thanks to the work of private plant breeders and public research.

As regards *in situ* conservation, the concept initially referred to the conservation of ecosystems. This is the case with nature reserves where the habitat is protected to enable it to evolve – plants die and others are born. By definition, this is not plant conservation.

➥

As regards improvements, I think the French government needs to invest more in conserving genetic diversity in cultivated plants. Everyone agrees that diversity is important but very little investment is forthcoming. In France, we don't have collections for all of the plants we grow and while we don't need to keep every collection at a national level, certain historic species like oats or potatoes should be maintained. But you won't currently find any private seed breeder interested in organising a collection of oat seeds so it is only logical for a national body to be put in charge.

In any case, the basis for maintaining diversity is conservation of the resources that gave birth to this diversity.

In situ conservation and breeding by networks of farmers able to exchange seeds are put forward by some stakeholders as a way of achieving dynamic conservation that could also create value by catering to certain niche market demands. What is your view on this? Can seed industry professionals play a role in these breeding and conservation processes?

First of all, nobody really knows what dynamic conservation is as it's an emerging concept but we do know that 99.99% of biodiversity is cultivated and conserved by conventional seed producers. The networks of farmers calling for this method of conservation only represent 2,000 hectares out of 10 million hectares in France as a whole.

Secondly, these networks simply use open-pollinated or old standard varieties conserved by private and public seed breeders that they allow to develop from year to year. They are not going to revolutionise either French or global agriculture. Without wishing to challenge 15,000 years of history, modern selection is both more efficient and better able to provide food security than the traditional practices of our farming forefathers.

But our more innovative selection methods do not preclude traditional seed breeding from producing results. This is not a closed market. When these networks discover a worthwhile new variety, two things may happen: either they decide to "fix" it, in which case they do the work of a traditional seed breeder, or they let it develop from year to year, which is not seed selection.

Niche markets are definitely emerging but they mainly concern vegetable seeds and there is virtually no niche market for cereals. But just because it's a minority practice does not mean that it's not important and the sector has adapted, notably from a regulatory perspective. Seed breeders are not free to market the new varieties they have created but must include them in a catalogue that is subject to quality control. For food security reasons, the French government and the EU have placed constraints and controls on seed breeders and farmers that make it difficult to get authorisation for an unidentified object. We can't just make an exception where niche markets are concerned. A framework is needed and this is what the government has provided by allowing certain non-standard varieties to be marketed even though this is still perceived as insufficient.

In conclusion, to appreciate these issues I think that you have to make an important distinction: agriculture and food are the work of man and not of nature. All of the plants we eat have been created by man: wheat is a hybrid of two wild species, the sunflower an ornamental plant, corn a creeping plant, etc.

The fight for food is ongoing and the complete range of genetic resources needs to be deployed. ■

KEY CONCEPTS

"Species"

group of individuals with similar morphological, physiological and chromosomic characteristics capable of being interbred.

"Variety"

artificial population obtained for use in agriculture and distinct from other varieties.

"Plant genetic resources"

genetic material of plant origin containing hereditary functional units of actual or potential value.

"Seed"

part of plant used to form a complete new plant after sewing or being placed in the ground.

"Plant or seed breeder"

person or company that creates or selects new varieties.

"_In situ_ conservation"

conservation of ecosystems and natural habitats and maintenance and reconstitution of viable populations of species in their natural habitats and – in the case of cultivated vegetable species – in the habitat in which they developed their distinctive features.

"_Ex situ_ conservation"

conservation of plant genetic resources for food and agriculture outside of their natural habitat.

UNDERSTANDING

GENETIC DIVERSITY IN CULTIVATED PLANTS IN FRANCE: OVERVIEW, CHALLENGES AND OUTLOOK

The diversity of cultivated species is a vital resource for humanity and underpins peoples' ability to feed themselves. Developments in agricultural production systems and seeds raise fears over the erosion of genetic diversity in cultivated plants. Regardless of which stakeholders you talk to, this is still a contentious subject that requires a detailed overview to identify possibilities and levers for taking agriculture forward to deal with the challenges of the twenty-first century.

History and overview of plant breeding in France

Standardisation of plant breeding to meet the needs of modern agriculture

Plant breeding seeks to improve plants and create new varieties. It leverages existing diversity within a given species to cross individual plants, choose complementary performance and traits and select the best lineage. This drawn-out process – up to 15 years to obtain a new variety – was long carried out solely by farmers who developed their local varieties from season to season.

Beginning in the 1930s the French Government became involved and created a seed variety register (The Official Catalogue) in which the different varieties of the main cultivated species had to appear before they could be marketed (see the insert on Regulations). However, it was only after the Second World War and the creation of *INRA* (the French National Institute of Agronomic Research) that agricultural research became a key focus of public policy (Bonneuil et al., 2012). The aim was to make hunger a thing of the past in France and free up millions of people to work in industry. Plant breeding was central to this productive leap.

With the standardisation in demand for food and agricultural techniques, farmers began leaving the task of producing seeds to specialised companies. Local varieties were replaced by more efficient strains that catered to the needs of modern agriculture in terms of chemical fertilisers, irrigation, crop protection products, etc. As well as financing public research, the government also stepped in to structure the nascent seedbreeders association, *Groupement National Interprofessionnel des Semences et plants* (*GNIS* - the French interprofessional association for seeds and seedlings). Conditions for obtaining accreditation for inclusion in the Official Catalogue were tightened up (Goffaux et al., 2011) so that varieties became more uniform and stable and their genetic base narrower. Selection processes were subsequently accelerated by biotechnology-based techniques (genomics and transgenesis).

A seed regulatory framework was introduced in France and Europe based on a specific category of intellectual property rights: the new variety certificate (also known by its French initials – *COV*) guarantees free access to the entire pool of public and private genetic resources.

A gradual concentration in the global seed production sector

In the early twentieth century, in addition to the farmers who produced their own seeds, only a few small family-owned companies such as Vilmorin were present on this nascent market that began to boom after the Second World War. The government entrusted *INRA* with a key mission: improving plants with a view to boosting their productivity. This turned *INRA* into a plant/seed breeder and it relied on agricultural cooperatives for mass production and marketing of the seeds is selected. The 1960s witnessed a remarkable growth in the number of hybrid corn varieties developed by *INRA* and marketed by the big corn cooperatives of South West France which were transformed into major industrial groups and moved into seed breeding themselves. They signed contracts with American seed producers anxious to move into France which was the world's second largest corn market. *INRA* entered into knowledge transfer arrangements with the small number of French seed breeders that had not entered into partnerships with US firms, notably Limagrain. From the 1970s on, *INRA* moved out of seed breeding and into upstream research, especially in molecular biology.

At the present time, the European seed industry is made up of a lot of small- and medium- sized companies and a few big multinationals. Thanks to its public-private expertise, France is Europe's No.1 plant and seed producer and the world's leading seed exporter (excluding GMOs[1]). In 2013, the market was worth €3 billion or 20% of the trade surplus in agricultural production. The seeds are produced by 72 plant breeding companies (including a world leader – Limagrain), 240 seed producers and 17,800 farmer seed growers.

In 2012, the global seed market was worth USD 45 billion[2] and it has trebled in value since 2000 and the advent of GMOs[3]. The four largest seed companies control nearly 50% of the market and, with the exception of the Limagrain cooperative, all have emerged from the agro-chemicals sector (Monsanto, DuPont/Pioneer Hi-Bred, Syngenta).

(1) GMO: Genetically Modified Organism

(2) Based on estimates of the International Seed Federation.

(3) Growth of approximately 100% in traditional seeds and approximately 600% in GMOs. Source: Our-industry-syngenta 2014

Complex regulations

French seed regulation arose from the need to protect farmers from fraudulent commercial practices that developed within commercial distribution networks. A number of seed batches contained seeds that would not germinate, grains of another species or even sand.

The legal framework was built over the 20th century covering three main sets of rules.

➔ **Marketing rules:** seed must meet specific criteria regarding packaging, weight, labelling and in certain cases, germination, purity, etc.

➔ **Seed variety register (The Official Catalogue):** regulated varieties must be registered in the Official Catalogue prior to marketing. A variety is accepted only if it is distinct, stable and sufficiently uniform. The variety must also be of a satisfactory standard for cultivation and use for a number of species. The European Community's Common Catalogue of Varieties brings together all of the different varieties registered in Member State's catalogues.

➔ **Seed production and certification:** seeds of registered varieties must be produced in compliance with technical regulations. They also must be certified by the Official state seed controller and certifier (SOC) before they can be sold.

Most "regulated variety" seeds must satisfy each set of rules. Certain seeds known as "non-regulated varieties" (e.g., millet and basil) are only subject to marketing regulations.

When a variety is registered in the Catalogue, it can be marketed within the European Union. However, registration does not confer the person who registered the variety with an exclusive right to sell that variety. Only intellectual property rights (IPR) can confer exclusive rights for a set period of time. There are two types of IPR regimes: Plant Breeder's Rights (PBR), which give exclusive rights to a given variety, and the patent regime, which confers a different type of exclusivity.

➔ **The general PBR framework** was determined by international law and the Convention for the Protection of New Varieties of Plants (UPOV), adopted in 1961. Today, it provides breeders with exclusive rights over new varieties for 25 and 30 years. The new variety certificate (COV) can be obtained for any new, distinct, uniform and stable variety. The convention includes mandatory exemptions, such as for research and variety breeding: it allows breeders to use protected varieties as sources of initial variation to create new varieties of plants or for other experimental purposes without the consent of the initial rights holder ("plant breeder's exemption").

UPOV also provides for non-mandatory exemptions for farm-saved seed. States may – or may not - allow farmers to save part of their harvest to use it as seed on their own farm. If allowed, farmers must pay an equitable royalty to the breeder.

The 1991 UPOV convention was adopted into EU law in 1994. The EU plant-variety IPR regime makes the farm-saved seed exemption mandatory for 21 species. After having held onto its own specific regime for a long time, France finally adopted legislation on new plant varieties in 2011 (*Loi relative aux certificats d'obtention végétale*), bringing it in line with EU practice.

➔ **Patents:** in order to be patentable, an invention must be new, inventive, and capable of industrial application. Unlike the United States, Europe and France refuse to grant patents for plant varieties. However, the adoption in 1998 of the "EU Directive on the Legal Protection of biotechnological inventions", allowed for the patenting of natural biological products, including gene sequences, as long as they are isolated from [their] natural environment or produced by means of a technical process. EU patents – unlike their American counterparts – provide for the following exemptions in line with PBR exemptions: research, breeder's exemption and farmer's privilege. Patent protection – which was initially reserved for biotechnology-related inventions – has been extended to products arising from conventional seed selection processes.

The PBR regime remains the dominant model in France and Europe, although it is being challenged by the increasing popularity of patents.

Overview of the genetic diversity of plants cultivated in France

Developments in the genetic diversity in cultivated plants need to be analysed on a number of different levels:

➔ Cultivated species

Humanity currently depends on around a dozen plant species[4] out of the 10,000 – 50,000 edible plant species identified for 75% of its food requirements. Half of all food calories are generated by three cereals: wheat, rice and corn (Prosperi, 2008). In France, the situation varies depending on what crops are planted and we are witnessing a slight recovery of diversity with the reintroduction of old species like spelt and parsnips and the introduction of species such as the North-American blueberry or Chinese Cabbage.

(4) FAO (2006) *Interactions du genre, de la biodiversité agricole et des savoirs locaux au service de la sécurité alimentaire.* Training manual. Available at: ftp://ftp.fao.org/docrep/fao/009/y5956f/y5956f00.pdf.

➔ Varieties

The number of varieties listed in the French Official Catalogue increased by a factor of 13 between 1960 and 2004 to over 7,800 varieties (Cadot et al., 2006) reflecting the boom in plant breeding. However, this increase masks the disappearance of numerous local varieties that had never actually been included plus the fact that only a very small number from among these thousands of varieties actually dominate in the market.

➔ Within varieties

Throughout the nineteenth and early twentieth centuries there was enormous genetic diversity within local varieties with no controls over hybrid varieties. Although they belonged to the same visually identifiable type (e.g., spring cauliflower), all individuals were intrinsically different. This diversity was considerably diminished after 1950 following the production of pure new standard lines and the development of hybrids[5] that boosted agricultural productivity.

(5) See GEVES « *Différentes structures génétiques des variétés* » at http://www.geves.fr/index.php?option=com_content&view=article&id=46&Itemid=283&lang=fr

Erosion of genetic diversity in cultivated plants is an oft-repeated fear, especially by the Food and Agriculture Organization of the United Nations (FAO) in two reports on the State of the World's Plant Genetic Resources published in 1996[6] and 2010[7]. However, in reality it is very difficult to document. The picture in France is a mixed one: some species are referred to as "orphans"[8] while others are better protected. There is a big gap between theoretically accessible genetic diversity and that actually present in the fields. Beginning in the second-half of the twentieth century, the whole issue of the conservation of these resources was raised.

(6) 1996 report available at ftp://ftp.fao.org/docrep/fao/meeting/016/aj633f.pdf

(7) 2010 report available at http://www.fao.org/docrep/014/i1500f/i1500f.pdf

(8) Also known as "under-utilised species": non-commercial species that used to be popular but have now been abandoned by users due to a certain number of agronomic, genetic, economic, social and cultural factors.

VIEWPOINT

French Foundation for Biodiversity Research (*FRB*)

FRB was set up in 2008 as a cooperative scientific foundation tasked with supporting and showcasing research into biodiversity in liaison with stakeholders from the rest of society.

"There is currently very little research to confirm or rebut the erosion of genetic diversity in cultivated plants despite the attentions of a wide variety of actors.

In 2011, *FRB* published summary indicators for evaluating changes to genetic diversity in cultivated plants and applying these indicators to a model plant: soft wheat grown in France throughout the twentieth century. First we note the small number of evaluations of genetic diversity performed *in situ*, unlike the *ex situ* collections for which a lot of research is available. This research devises a chart for grouping together and tracking indicators that factors in different elements: number of varieties planted and how these are spread over a given territory together with their genetic diversity.

The study reveals strong homogenisation in the genetic diversity of soft wheat grown in France throughout the twentieth century, especially between 1912 and the late 1960s. This phenomenon is a reflection of three processes: homogenisation within varieties along with the transition to genetically pure lines; standardisation between varieties that tended to be increasingly genetically close over time; and a geographical homogenisation between *departments* in which the same varieties were increasingly being cultivated. This homogenisation raises questions about the vulnerability of the wheat being grown in the face of current and future environmental changes.

Given the dearth of available, relevant scientific research, it appears crucial to perform an inventory of expertise concerning the different levels of diversity being planted and how this changes over time. Moreover, we also need to give some thought to how networks of plant genetic resources are coordinated, the sustainability of management practices and the utilisation of this genetic diversity, as well as to the complementarity of different *in situ* and *ex situ* conservation methods and accessibility to this diversity."

Aurélie Delavaud,
Project Officer and Head of ECOSCOPE.

Maintaining the genetic diversity in cultivated plants: two co-existing visions

Maintaining the genetic diversity in cultivated plants is a tricky issue. There are two broad schools of thought: those who adhere to a static and those in favour of an evolutionary approach. The former consider that diversity in cultivated plants has increased thanks to variety breeding and that *ex situ* conservation in gene collections and banks will meet the future plant breeding needs. The latter believe that genetic diversity can only be perceived on a dynamic *in situ* basis under pressure from the environment. The two approaches are based on different conceptions of biodiversity and society (see inserts 3 and 4: FNSEA & Confédération Paysanne).

Maintaining diversity through ex situ conservation

From the 1970s, the risk of biodiversity loss in the field and the need for a gene pool to deal with new requirements (such as resistance to disease) bolstered local systems for conserving the variety of plants cultivated and crop wild relatives.

In 1998, the FAO's Commission on Genetic Resources for Food and Agriculture (CGRFA) identified *ex situ* conservation as "the conservation of components of biological diversity outside of their natural habitats"[9]. Approximately 1,750 gene banks and 2,500 public and private botanical gardens have been identified throughout the world. These collections include the genetic resources of numerous plants cultivated in France but originating from wild plants in other countries such as vines, tomatoes or corn.

Moreover, as the Aker programme has shown, effectively integrating recently developed bioinformatics and genomics tools may be used to streamline collections and boost the effectiveness of selection processes (cf. Initiatives). France currently has about 30 government-certified conservation networks organised by species (*réseau Céréales à paille* [straw cereal network], *association Pro-Maïs* [professional corn network], etc.) that pool both genetic resources and conservation costs between public and private actors. Samples of certain species need to be periodically renewed due to a loss of germination capacity and some collections are under threat due to a lack of coordination and resources (see insert on Geves), especially those containing species that suffer from a major lack of seed breeding such as coffee and coco (see Initiatives p.20).

(9) FAO's Commission on Genetic Resources for Food and Agriculture (1998): list of useful definitions for revising international commitments to plant genetic resources. Rome 8-12 June 1998. CGRFA-Ex5/98/Inf.2. Available at: http://www.planttreaty.org/sites/default/files/e5i2f.pdf

Maintaining genetic diversity through in situ conservation

Both researchers and farmers stress the need to work in a real environment, in experimental fields and on farms. Conserving and creating biodiversity are therefore part of a dynamic process taking place in a large number of plants in varied environments (see Opinion, interview with Pierre Henri Gouyon).

VIEWPOINT

Fédération Nationale des Syndicats d'Exploitants Agricoles (FNSEA)

FNSEA is France's largest professional farming organisation

"The diversity of seeds available on the market would appear to meet the current needs of farmers and the expectations of their customers, agri-business and supermarkets, which tend to want fairly standardised products. Plant and seed breeders' offerings appear adequate for the main crops planted. They are able to use their collections of plant genetic resources to meet future needs, create diversity and expand the breeding pool. Farmers are currently pinning their hopes on varieties adapted to environmental demands, i.e., using less inputs, that meet the technological demands of export markets (e.g., protein-rich wheat varieties). Certain minor species warrant further research and development, e.g., protein crops that are in decline in France, or millet which faces a number of technical problems. While the FNSEA has not identified any specific shortcomings in the plant genetic resource management system apart from in these lesser species, it shares society's concern over the erosion of genetic diversity in cultivated plants in France."

Christiane Lambert, Deputy Chairman.

VIEWPOINT

La Confédération Paysanne

France's third-largest farmers' organisation

"We have noted major needs among our farmer members for seeds and plants that are diversified and adapted to the new methods of production and marketing developing alongside conventional industrial circuits. They need to meet the new challenges of reduced chemical inputs and climate change as well as new consumer expectations concerning good, healthy nutritious food. In particular, we note that the current plant and seed offering suitable for use in organic farming is insufficient. A growing number of farmers are also looking to free themselves from the major industrial seed producers. The development of short food circuits and on-farm processing is giving rise to a need for new varieties, distinct from those that meet the standardisation criteria required for industrial processing and distribution circuits. In order to meet these new demands for diversity, autonomy and adaptability, our members are increasingly turning to farmers' seed.

From an institutional perspective, Confédération Paysanne defends farmers' rights to replant and freely exchange the seeds and plants produced on their farms. We are opposed to GMOs and to any form of patents on living organisms as well as to any actions that lead to a reduction in cultivated biodiversity (development of hybrids, etc.). We support the development of public research in partnership with farmers into plant selection that meets nutritional, environmental, social and economic criteria."

Guy Kastler, Head of Seed Commission.

Participative breeding programmes have been initiated with the aim of decentralising selection and getting different stakeholders – especially farmers – on board to create new local varieties with a very large degree of intrinsic genetic diversity. The Réseau Semences Paysannes (French farmers' seed network) set up in 2003 currently brings together 70 French and Belgian seed associations and producers.

In practice, these experiments encounter a specific regulatory problem: open-pollinated or evolving varieties (depending on the authors) produced by these programmes are neither stable nor homogeneous enough to meet the criteria laid down in current regulations so they cannot be included in the Official Catalogue, an essential pre-condition for being marketed or even exchanged.

Genetic diversity: a challenge for the future

The varieties produced by seed breeders have been developed first and foremost for their performances and how they meet the needs of "conventional" farming. But farming is changing and farmers may find themselves carrying out new functions: protecting or restoring the environment (water, soil, biodiversity, landscape, etc.), responding to current societal expectations in terms of health and food quality, etc.

They have to adapt to climate change, which is distorting the growing season and bringing in new pests, and they also need to act for climate change mitigation by storing carbon. Also, industry is crying out for energy or materials to replace oil (agro-fuels, agroplastics, etc.). The number of varieties should therefore become even more diverse in order to meet these new needs while not losing sight of the overarching, historical role of feeding growing populations whose food consumption is increasing in line with their living standards. This adaptation is structured around three key imperatives:

Ensuring food security through crop resilience

Crop resilience means the capacity of agricultural systems to adapt to or resist various threats, especially diseases, pests or climate hazards (Cirad, 2009). Lack of genetic diversity can be a source of vulnerability (Prosperi, 2008). For example, when a bacterial disease ravaged fields of American corn in 1970, it was only destroyed by cross-breeding with an African variety, thus averting a major food crisis (FAO, 1993). Diversifying the genetic diversity of plants is an effective protection strategy that reduces reliance on chemical inputs (Tooker et al., 2012).

Contributing to the ecological transition of agricultural systems

Twenty-first century agriculture has a formidable challenge to meet in the face of a rising population, namely producing more and better produce with less (water, energy, inputs and arable land) – a challenge given official status in France at the Grenelle environmental conference as well as in the Agriculture Ministry's agro-ecological project[10]. New types of agriculture and food production are emerging such as organic farming (85% growth between 2007 and 2012)[11]. A big effort is needed in plant breeding and selection to develop varieties adapted to these new practices that favour certain local characteristics: soil, climate, natural cycles, specific practices, etc.

Such approaches may justify reintroducing a certain amount of biodiversity and selecting new varieties and neglected species with eco-benefits. This is the case with legume crops (lentils, peas, clover, alfalfa, beans, etc.) that absorb nitrogen from the air thus reducing the need for nitrogen fertiliser.

(10) See French Ministry for Agriculture, Food and Forests (2012) *Projet agro-écologique pour la France. Agricultures, produisons autrement.* 18 December 2012.

(11) French Agency for Development and Promotion of Organic Farming (2013) *L'agriculture biologique : ses acteurs, ses produits, ses territoires.* Chiffres clés édition 2013.


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Responding to new societal expectations

A March 2013 survey of French consumers by Ethicity[12] shows that they seek healthier and locally grown products. Production and distribution methods are evolving to meet this demand. In France, nearly 107,000 growers stated that they sold through short food circuits[13] in 2010, versus 88,600 in 2005[14].

(12) Ethicity (2013) Les Français et la Consommation responsable 2013, Survey.

(13) On-farm sales, markets, local produce sold online, drive-to outlets, etc.

(14) Ministry for Food, Agriculture and Fisheries (2009) Renforcer le lien entre agriculteurs et consommateurs. Available at: http://agriculture.gouv.fr/IMG/pdf/100809-lettreCircuitsCourts.pdf

Some consumers are also turning towards the booming organic farming market and these are all great occasions for selling more diversified local species and varieties (see Initiatives Leclerc).

So, behind crop genetics, it is the very future of farming that is being played out. This farming is going to have to evolve and diversify its practices to deal with a wide range of imperatives and get different types of actors talking to each other in order to devise a sustainable and desirable future. ■

VIEWPOINT

Variety and Seed Study and Control Group (GEVES)

GEVES is a public interest research group that focuses on new plant varieties and seed quality.

"The agriculture of tomorrow will have to meet new needs and deal with new constraints such as limited supplies of fossil fuels and phosphorous, etc. Species and varieties that are either wild or seldom grown at present can have worthwhile characteristics: for example, certain species of lupin are able to dissolve phosphorous in host rock or fix it in the argillaceous soil matrix. Such characteristics may be reintroduced by cross-breeding using modern selection techniques in species and cultivated varieties.

In order to provide solutions for the agriculture of tomorrow, it is essential to ensure that wild and agricultural plant genetic resources – particularly for minor species and varieties – are effectively conserved *ex situ*. The cost of maintaining collections of plant genetic resources is significant and sometimes underestimated. Collections are frequently seen as a by-product of plant breeding research programmes and are therefore at risk of disappearing once the programme is wound up. The current modus operandi should be optimised and coordination of conservation networks appears necessary. Specific attention needs to be paid to maintaining "orphan" or minor species."

Christian Huyghe, President of GEVES.

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INVENTING RECONCILING APPROACHES TO ENRICHING THE GENETIC DIVERSITY OF CULTIVATED PLANTS ON A LOCAL SCALE

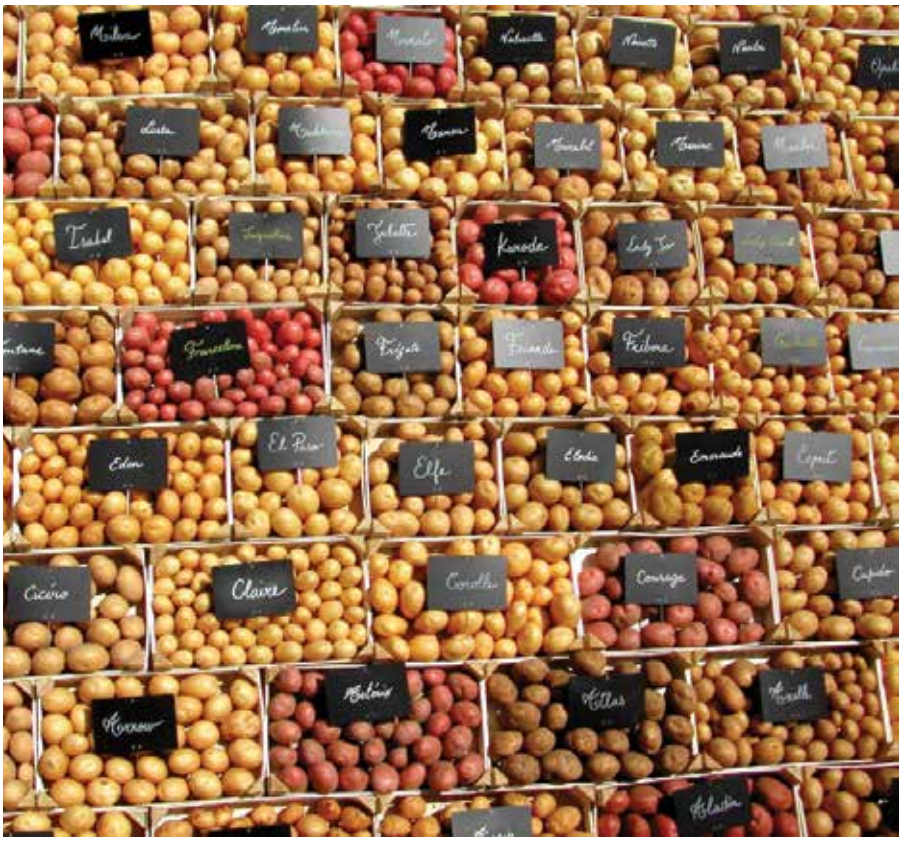
The risk of the erosion of genetic diversity in plants grown in France is perceived differently depending on who you talk to and what is at stake. Both approaches – *ex situ* and *in situ* – are complementary and each has its own limits. We will have to come up with new arrangements to bolster these two approaches and ensure a sustainable future for agriculture.

Consolidating and overcoming the limits of current management of collections and seed banks

The risk of loss of the genetic diversity stored in public and private collections and seed banks has been stressed by several people interviewed. For major crops, this risk appears very low due to active research for new varieties but it still needs to be scientifically documented. However, it appears very real and imminent for orphan species that could experience a resurgence of interest for use in the farming of tomorrow.

In France at present, there is a wide range of public and private collections of genetic resources of cultivated plants but there is no one database indicating which actor holds which plant genetic material. Only two *INRA* collections – wheat and corn – are included in the Multilateral System provided for under the ITPGRFA Treaty (see International p.17). Furthermore, the existing conservation networks for plant genetic resources need to be coordinated at the national level. In contrast, the United States has long had a policy of clear, straightforward access to the public domain for any researcher or farmer and this has been a big help to organic farmers seeking to develop varieties adapted to their needs.

Putting together an inventory of current conservation practices could be a useful starting point for drawing up an action plan with the aim of strengthening the organisation of public and private collections and identifying those that are particularly threatened or even redundant. Aside from identifying the genetic resources present in collections, this database would also make it possible to enhance information on the related technical and agronomic characteristics.



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One of the key priorities of the French Ministry of Agriculture's "*Semences et agriculture durable*" (sustainable seeds and agriculture) action plan[1] of May 2011 was clarifying approaches to conserving and disseminating plant genetic resources and defining the role and status of the various actors involved in conservation.

(1) French Ministry of Agriculture, food, fisheries, rural affairs and local and regional planning (2011) *Semences et agriculture durable.* Report 3 May 2011. Available at http://agriculture.gouv.fr/Semences-et-agriculture-durable

Freeing up innovation to respond to the variety of demand

The increasingly concentrated seed production sector has adapted to the current needs of agriculture but less so to the needs of emerging types of farming like conservation agriculture, organic farming, agro-ecology or low-input farming. These diverse forms comply with the demands of society and the desire of some in the farming profession. They seek to anticipate future constraints such as climate change and hydric or phosphorous stress.

One possible solution would be to free up as much innovation as possible in plant breeding by getting "users" (farmers, amateur gardeners, etc.) involved. This would round out and enrich "traditional" innovation stemming from the work of seed producers and could lead to new markets

POINT DE VUE

Comité Technique Permanent de la Sélection (CTPS)

The CTPS is tasked with overseeing the Official Catalogue together with the related technical regulations.

"The CTPS has adapted its assessment criteria in line with new environmental and societal demands. VAT trials (agronomic and technological values) designed to assess the progress represented by each variety were recently replaced by VATE trials (i.e., agronomic, technological and environmental values). New criteria focusing on disease and pest resistance or nitrogen utilisation efficiency have been introduced. Two new less genetically homogeneous garden vegetable lists have been added to the Official Catalogue for "conservation varieties" and «old amateur gardener varieties". Assessment criteria have also been adjusted to enable varieties intended for use in organic farming to be included in the Official Catalogue and two varieties of soft wheat were included in 2011."

Christian Leclerc, General Secretary.

for the resulting varieties. This method has produced very encouraging results in other areas. For example, bike and mountain enthusiasts helped develop mountain bikes, an idea that was initially refused by the industry until it became obvious that there was a serious demand for it (von Hippel, 2005). Users in general are showing an increasing tendency to innovate in order to design products corresponding to their own specific needs but not covered by the mass market - plant breeding could harness these methods.

Participative breeding programmes involving farmers throughout the process are being developed. As well as costing less, they help to boost the number of trials and "attain considerable statistical power that offsets the less controlled nature of farmer trials" (Bonneuil, Demeulenaere, 2007).

Nevertheless, supporting such innovations would require changes to the current regulatory framework. While evaluation criteria have been relaxed to allow varieties for use in organic farming to be included in the Official Catalogue (see CTPS insert), this greater flexibility for varieties created from traditional selection procedures do not meet the needs of evolving varieties. Faced with the difficulties of getting these niche market varieties into the Catalogue, seed users have banded together in a single legal entity to be able to exchange them: an association-type structure for AgroBio Périgord (see Initiatives), a holding company for Limagrain cooperative. The integration of the entire sector – from plant varieties (wheat varieties) through processing (sandwich bread) – allowed Limagrain to select and use specific varieties without having them formally included in the Catalogue (Gouache, 2002).

By increasing the number of stakeholders involved in the selection process, this innovation model has a number of advantages:

➔ it enables farmers developing alternative practices to participate in defining and responding to new breeding requirements;

➔ by responding to niche requirements, it potentially diversifies variety types which makes it possible to "revive" a greater part of the genetic diversity of the species concerned;

➔ by encouraging diverse types of agriculture, it prepares seed breeding and farmers for still to be identified future needs. This facilitates and speeds up the adaptation of dominant conventional agriculture.

However, we need to consider the ability of this model to deal with food production imperatives in France.

For such a policy to succeed, it is essential to promote exchanges between stakeholders in the seed production sector and the partisans of minority farming practices. A local approach supporting the emergence of a dynamic based around local actors would appear to be the best way to go. ■

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INTERNATIONAL

THE INTERNATIONAL COMMUNITY AND THE CHALLENGES OF GENETIC DIVERSITY: THE SPECIFIC CASE OF CULTIVATED PLANTS

The Nagoya protocol on access to genetic resources and benefit sharing

The notion of sharing the benefits of natural and genetic resources was raised as early as the first Earth Summit in 1972 and is enshrined in the Convention on Biological Diversity (CBD) adopted at the 1992 Rio Summit which established the "fair and equitable sharing of benefits arising from genetic resources"[1] as one of its three main goals.

Ten years after the Convention was adopted, only 20 countries had promulgated national legislation on the sharing of benefits. "Supplier" countries consider that they do not share in the benefits of using such resources and that they are victims of biopiracy while "user" countries criticise the uncertain and opaque regulatory framework existing in supplier countries.

Negotiations began in 2004 with a view to resolving this situation, culminating in the adoption of a protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits at the 10th Conference of the Parties held in Nagoya in 2010. This became known as "the Nagoya Protocol" (see Insert).

ITPGRFA: a specific international treaty covering genetic resources used in agriculture and food

Access to genetic resources is a crucial ingredient in plant improvement and a key focus for seed and plant breeders. Conscious of the implications of recognition by the CBD of the sovereign rights of states over their genetic resources and the principle of benefit sharing, in 2001 the international community adopted the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) under the auspices of the FAO[2].

The signatory countries undertake to provide free access to the genetic resources contained in their public collections for 64 listed crops via a common pool known as the "Multilateral System". Contracting Parties also agree to encourage natural and legal persons within their jurisdiction who hold plant genetic resources to include such plant genetic resources in the Multilateral System.

Access to the Multilateral System is restricted to the Contracting Parties and shall be provided "solely for food and agricultural purposes" and "the purposes of research, breeding or training".

(1) Text available at: http://www.cbd.int/convention/text/

(2) Number of parties to the Treaty: 131

Nagoya and Cartagena protocols: two supplementary agreements to the Convention on Biological Diversity

Key principles of the Nagoya protocol:

The CBD reaffirmed the sovereign rights of States over their natural resources, including their genetic resources. In practice, it is no longer possible to use the genetic wealth of a country without its consent and consideration or payment based on mutually agreed terms. To do this, each State must introduce clear, transparent and non-arbitrary procedures and require mandatory written contracts between supplier and user setting out arrangements for access and benefit sharing.

The Cartagena protocol:

The Cartagena Protocol aims to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity. It has been ratified by 164 countries.[1]

(1) The United States has not signed the CBD or related protocols (Nagoya and Cartagena), however it did sign the ITPGRFA Treaty in 2002.

Contracting Parties may not claim any intellectual property or other rights on these resources[3] and they undertake to share benefits based on their use.

The Treaty defends the rights of farmers to protect traditional knowledge, participate in decision-making at local level and share in benefits. As regards the sustainable use of resources, States are encouraged to deploy policies and farming systems that boost diversity and related breeding initiatives.

A benefit-sharing fund financed from a percentage of the sales of varieties created from parents included in the Multilateral System is invested in projects to support farmers in developing countries and to encourage them to preserve diversity in the crops they grow.

Parties wishing to provide or receive material must draft a Standard Material Transfer Agreement (SMTA). This mandatory model was adopted in 2006 and is now used worldwide.

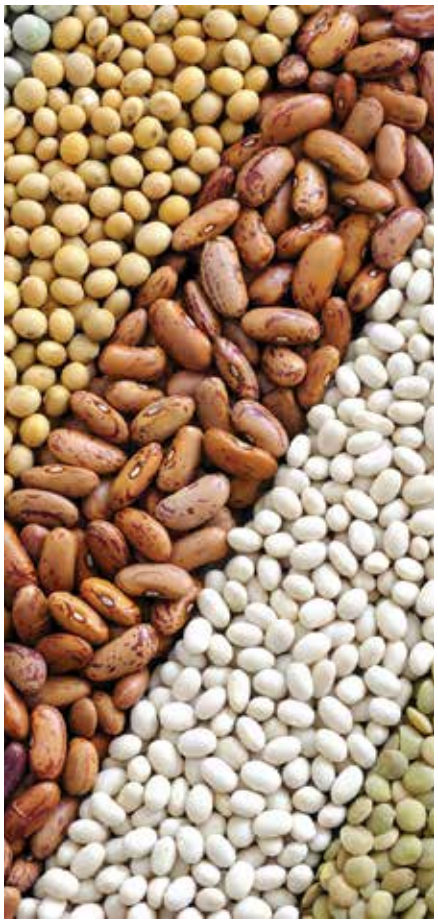
(3) i.e., the unmodified genetic resource

An additional funding mechanism not covered in the Treaty – the Global Crop Diversity Trust[4] – has been approved to raise funds from public and private actors worldwide. It will be used to develop and sustain gene banks, particularly the Svalbard Global Seed Vault (see Insert).

The ITPGRFA Treaty replaces the prior consent and bilateral contract arrangements stipulated in the Nagoya Protocol with simplified access to all of the resources covered. All species not included in Appendix 1 are covered under the Nagoya Protocol.

The Fifth Session of the Governing Body of the ITPGRFA held in the Sultanate of Oman in September 2013 was an opportunity to conduct a ten-year review. In the public sphere, collections are being pooled slowly while stakeholders in the private sector are reluctant to share information about their collections. ■

(4) For more information on the Global Crop Diversity Trust, go to http://www.croptrust.org/



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Svalbard Global Seed Vault

Deep inside a mountain in the Svalbard archipelago, halfway between mainland Norway and the North Pole, the Svalbard Global Seed Vault is designed to store duplicates ('back ups') of all seed samples from the world's crop collections in a fail-safe, state-of-the-art seed storage facility. It functions like a safety deposit box in a bank: the infrastructure is the property of the Norwegian Government, the seeds stored there remain the property of the depositing gene banks and collections. It currently houses 700,000 seed samples.

INITIATIVES

"AQUITAINE CULTIVATES BIODIVERSITY": PROGRAMME DEVELOPED BY AGROBIO PÉRIGORD

Back in 2001, a group of Aquitaine farmers began highlighting the need to support diversity in the crop varieties used in organic and sustainable farming. Believing the market offering to be insufficient and inadequate, they decided to claim back expertise in evolutive breeding and self-production on their farms. One of the essential steps involved setting up and running a seed bank. However, this was not possible under regulations forbidding the exchange of seed varieties not registered in the Official Catalogue, including exchanges between farmers (open-pollinated varieties are *de facto* examples). AgroBio Périgord came up with a solution based on a simple principle – seeds transferred within the same legal entity do not come under the regulation – and it set up an association-type structure of which each farmer is a member. Each farmer taking out a seed sample signs a research and production agreement. The experiment focused initially on corn and sunflowers but it was extended to garden vegetables in 2007. Today, more than 250 conventional and organic farmers are involved in experimenting with and growing open-pollinated crop varieties on their farms.

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For more information, go to www.agrobioperigord.fr/produire-bio/biodiversite-cultivee

THE AKER PROGRAMME: BUILDING A COLLECTION OF REFERENCE GENES FOR BEETROOT ON A WORLDWIDE SCALE

The AKER programme aims to improve the competitiveness of sugar beet by 2020 by doubling the annual increase in sugar yield per hectare. It is backed by 11 different public and private partners from the French sugar beet sector and is part of the French National Research Agency's Investments in the Future programme with a budget of €18.5 million. It aims to expand the genetic variability of sugar beet by providing a collection of genes from resources around the world which will then be used to produce new high potential varieties for use by the sugar beet industry. A reference collection of 15 varieties of sugar beet has been assembled from tests conducted on 10,000 varieties in order to represent a wide range of genetic variability, i.e., 60% to 80% of total variability within the species. This variability relates in particular to adaptation to diseases and growing conditions.

For more information, go to www.aker-betterave.fr

CREATING LOCAL PARTNERSHIPS BETWEEN PRODUCERS AND SUPERMARKETS: E.LECLERC'S "LOCAL ALLIANCES" LABEL

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This initiative was launched in 2010 to structure partnerships between the heads of E.Leclerc supermarkets and producers within their region under the label "*Les Alliances Locales*". It caters to the wishes of consumers to eat local produce and supports small producers by guaranteeing them regular, direct outlets for their produce. As well as boosting the visibility of an existing practice, the label is also a boon for the local economy. Each centre develops its own products, e.g., strawberries from Plougastel are only sold in Brittany while those from Périgord are only on sale in the South-West of France.

For more information, go to www.mouvement-leclerc.com/home/alliances-locales

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NESTLÉ SUPPORTS RESEARCH AND IMPROVEMENTS IN COFFEE AND COCOA: TOURS RESEARCH STATION

Faced with the significant lack of breeding and conservation initiatives for cocoa and coffee, Nestlé has taken the fight to the heart of the sector and created "Nestlé Cocoa Plan" and "Plan Nescafé®". Tours research station has set up breeding and improvement programmes for these two species. Selected plants are subsequently disseminated to cocoa supplier-producers. They are used to renew orchards (1.1 million cocoa plants distributed in 2012) and improve producer yields and income, thus securing coffee and cocoa supplies in terms of volume and quality. Producers may also receive training in best farming practices.

For more information, go to www.nestle.fr/rechercheetdeveloppement

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