Hunger issues: natural resources

Genetic resources: acceleration of privatisation of living organisms is a threat to food security and biodiversity

Agriculture, a human activity resting on the selection of living organisms

Of all human activities, agriculture is certainly the one that rests most on the use of living organisms, whether plants or animals. These organisms, along with land and labour, are at the basis of agriculture. Agriculture is directly dependent on the characteristics of the living organisms with which it operates: their productivity, their resistance to diseases or to climatic events, among others. These characteristics are strongly linked to the genetic nature of the living organisms involved, as well as to the techniques used for cultivation or animal husbandry.

This fact explains why, since the origin of agriculture around 10,000 years ago, humans have sought to domesticate and select organisms for use in agriculture. This selection has for long consisted of keeping the best grains to use them as seed, and to use as a bull the son of the best milk producing cow or as ram the son of the ewe that produces the best meat or wool.

Plant genetic resources

Traditionally, genetic improvement of plants has been implemented by the local selection of the best grains (mass selection) to be used as seeds for the following year. This has led to the selection of a great diversity of local varieties adapted to specific ecosystems[1].

[1] Doussinault, **Cent ans de sélection du blé en France et en Belgique**, in «Quel avenir pour l'amélioration des plantes? Ed. AUPELF-UREF, John Libbey Eurotext. Paris 1995

Stability of results obtained however depends on the characteristics of the plants cultivated: some plants reproduce mainly through self-pollination (wheat, cotton, soybean, tobacco and tomato) that leads to stable and uniform varieties. Others reproduce through cross-pollination (pollination by another individual of the same species) which leads to greater heterogeneity and genetic instability (sugar beet, alfalfa, maize, onion and sunflower). A third category can propagate through tubers, bulbs or cuttings (cassava, potato) that are even more stable as this process does not involve sexual reproduction.

It was in the middle of the XIXth century that plant selection began to be taken over by scientists who little by little selected pure line varieties[2] with respect to some preferred characteristics. Selection was performed on these characteristics by using new techniques such as genealogical selection. One of the precursors in this field was Louis de Vilmorin. This led to the invention of genetically stable pure line cultivars. Characteristics according to which selection is usually performed are:

- Yield
- Resistance to pests and diseases
- Tolerance to drought, heat, cold and pollutants
- Composition (nutritional content, toxins, ability to be stored, ...)
- Adaptability to variations of ecological conditions (climate, soil...)

With the development of the economy and of markets, these improvements ceased to be performed with the sole purpose of using the result obtained by those who had made them or by their community. Their purpose became the generation of profit through sale of the selected seed. Thus, seed production progressively became a commercial activity in the hands of specialised private or public companies. From originally being a common good, seeds progressively became private goods exchanged on markets. Access to commercially available improved seeds was therefore automatically restricted to those producers able to mobilise the financial resources needed to purchase them. Poorer producers were largely excluded from this process and from the benefits of «modern» selection. From a shared common human heritage, genetic resources became increasingly the private property of specialised seed producers who progressively became the private owners of genetic resources, not by creating them, but by combining them and revealing their properties in order to resell them for profit.

The re-discovery at the start of the XXth century of Mendel's work on the segregating nature of heredity (publication originally dated 1865) triggered a new and essential change in plant selection, namely the technique of hybridisation of pure line varieties that demonstrate strongly desired characteristics.

In 1914 the first Vilmorin varieties of wheat selected for their high productivity appeared. In 1928 it was the time for new varieties that combined characteristics of high productivity and capacity to resist to environmental constraints such as weather and diseases. These advances brought a doubling in the yields of wheat between 1900 and 1950, followed by another doubling between 1950 and 1975. In the case of maize, the first hybrid varieties appeared in the USA in 1935.

The advantages of hybridisation are that the desired characteristics of the pure line varieties are assembled in a very uniform way and that the combination of pure line

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[2] Individuals of the pure line varieties are genetically identical and each of them as identical genes for all its characteristics (homozygous state) because of a prolonged inbreeding (consanguinity).

varieties gives them more vigour (heterosis) and speed of growth that has an effect of productivity that is generally estimated at around 25%.

The main disadvantages of hybridisation are:

- The loss of the desired characteristics and of the uniformity of the plant population in case the harvest is used as seed (second generation). This implies that the producer must buy fresh seeds from the seed producer every year
- For hybrids to express fully their production potential, they must be cultivated in optimal conditions. This is why the cultivation of hybrid varieties generally goes hand in hand with the use of chemical fertiliser or even irrigation (Green Revolution)
- Hybrid seeds are much more expensive than other seeds.

With these characteristics, the introduction of hybrid seeds further accelerated the evolution towards privatisation of genetic resources. This notwithstanding, the promotion of more productive hybrid seeds has been at the centre of the efforts of governments during the last four or five decades. Governments have therefore favoured this trend.

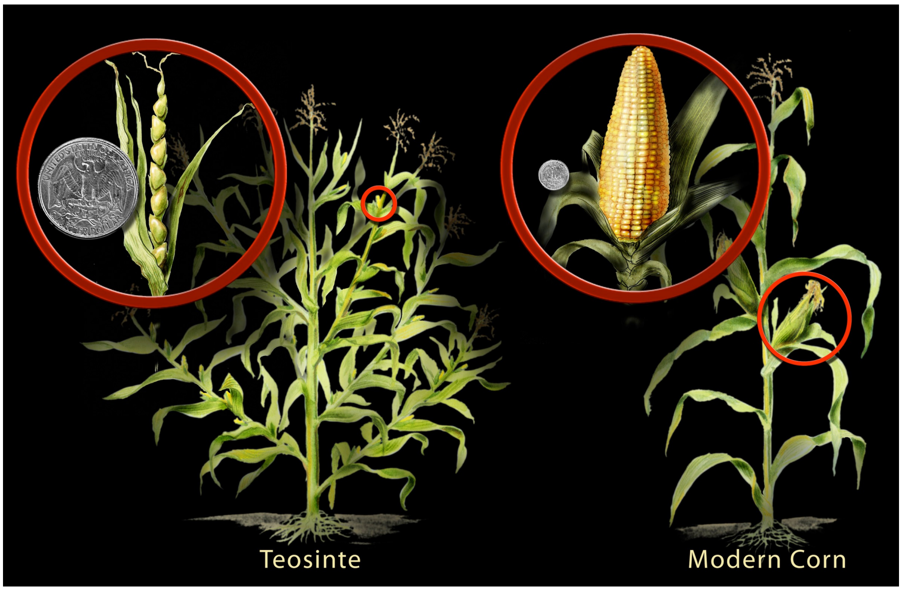
Privatisation of genetic resources found in seeds has been deepened because of new seeds legislation in many countries that has led to the prohibition of traditional ways of exchanging seeds.

In the case of France, the Catalogue officiel des variétés et des espèces (official catalogue of varieties and species) was created in 1932. One of the objectives of this catalogue is to ensure a strict correspondence between the variety of seeds and their name so as to avoid any fraud at the time of purchase on the market. This protects the buyer by guaranteeing the quality of the seed bought. At first, non-registered and registered seeds coexisted on markets, but after 1949, on the ground of fighting against fraud, the authorisation to market seeds was restricted to registered seeds. Registration however, depends on the satisfaction of a number of technical tests (differentiation, stability and homogeneity, agricultural and technological value of new varieties) and the payment of an initial down-payment and of annual fees. The use of non-registered seeds remains authorised, provided they do not leave the farm.

It is evident that this regulation is in favour of the development of seed markets to the detriment of traditional exchange of seeds among producers. In France, this has now become normal practice, but this principle is now also being increasingly imposed in non-industrialised countries where farmers still largely depend on exchanges among producers or on traditional markets and fairs.

All these changes have succeeded in transforming the plants with which agriculture operates, generating extraordinary increases in productivity. The cob of teosinte, the ancestor of maize, used to measure 2.5 cm 7000 years ago, while maize cobs now measure more than 40 cm in length. Maize yields used to be 120 kg/ha while today they can reach up to 10 tonnes/ha with yields being quadrupled over the last 50 years. The price to pay for this “progress” is a social regression which translates into the exclusion of a mass of small producers who cannot have access to this new technology and do not benefit from its advantages because of their limited financial capacity.

Teosinte and maize



Source: Department of Biology, Indiana University

The development of plant seeds has been one of the preferred domains of the private sector in agriculture. This could happen because seeds are a product that can relatively easily be made private and profitable:

- By patenting new varieties, so as to oblige any producer or user to pay a fee
- By making new varieties or at least their desired characteristics non-reproducible: this explains the success of hybrid seeds that lose their homogeneity and the characteristics of individuals at the second generation, obliging producers to buy new seeds every year.

Progress made in genetics and in genetic manipulation has allowed the creation and marketing of genetically modified organisms (GMOs). The DNA of these organisms has undergone some genetic manipulation to give them certain characteristics that are interesting from the agronomic or nutritional point of view, such as the capacity to fight against certain pests, resist herbicides or drought, improve the assimilation of certain elements (P, N) or the nutritive value of the product (organisms enriched in vitamins or medicines).

Against these announced advantages there are also risks: environmental risks because of the creation of "artificial" organisms the effect of which on the environment is unknown (e.g. there is a possibility of creating proliferating invasive species, a risk of mobilising genes that could be transmitted to weeds or other undesirable organisms, increased risk of pests developing resistance to the toxic substances produced by the GMO because of the continuous presence of these substances in the plant, need to make increased use of pesticide to treat resistant organisms - see the Greenpeace video, etc.) as well as dangers for public heath that these organisms could generate (some GMOs are designed to produce their own insecticide which is found in the consumer's plate with possible negative consequences on human health - the next generation of GMOs will even themselves have the characteristics of insecticides). Finally, GMOs are much more expensive than conventional seeds. For example, GMO cotton seeds cost €41.00 per bag in Burkina Faso beginning 2012, against €1.2 for conventional cotton seeds.

Marketing conditions for GMOs have been subject of discussion over recent months, particularly in the wake of the study by Prof. Séralini for the CRIIGEN (Comité de recherche et d'information indépendants sur le génie génétique which challenged the conditions and modalities of toxicological tests required before a new GMO can be marketed in the European Union. This debate has been temporarily closed by the decision of the European Union to set the minimal duration for this type of test to 90 days. Moreover, although the European Food Safety Authority (EFSA) has been developing new guidelines since January 2013, nothing has yet been decided apparently on the other aspects of the marketing procedures, regarding in particular the conditions that make compulsory the conduct of a toxicological test and its mode of financing.

Animal genetic resources

In the case of animals, genetic improvement has remained closer to the traditional approach of selection based on desirable characteristics, although some progress has been made recently in the field of genetic manipulation and cloning. However, practical applications are much more limited than in the case of plants.

More generally, animal genetic resources have so far been less attractive for the private sector than plant genetic resources. Of course, the private sector has, for some animals, invested in genetic improvement and in the provision of insemination services, including artificial insemination. The public sector however remains the dominant actor in genetic improvement in most non-industrial countries, despite some privatisation efforts undertaken here or there.

The main reason why there has been such limited privatisation is probably the difficulty, in the case of animals, to characterise a variety contrary to the case of plants. This difficulty is a constraint to the recognition of intellectual property rights in the case of lines of improved animals.

This notwithstanding, genetic and feeding improvements of animals have also led to considerable increases in productivity (see box).

Productivity and efficiency gains in pork production

In 50 years, pork production has seen:

- An increase of 64% of the size of the average litter (14 piglets/litter 50 years ago, 23 piglets/litter today)
- An increase in the efficiency of feeding: reduction by 28% of the feed required for one pig (410 kg of feed/pig 50 years ago, 273 kg of feed/pig today)
- An increase by 39% in the proportion of lean meat in a pig
- A reduction by 50% of dejections/pork.

(Source: Smith., 2013: **Developing the right genetic stock for a different future**, Oxford Farming Conference 2013)

The main issues of privatisation of genetic resources

It is possible to infer five major issues from what has just been stated: (i) appropriation of living organisms by a few large private companies; (ii) threats to agricultural biodiversity; (iii) deprivation and exclusion of peasant farmers; (iv) threats to the environment; and (v) threats to health.

- Domination and appropriation by giant private companies

Privatisation of plant genetic resources has had as consequence a rapid growth of a powerful private sector. Five private multinational companies (Monsanto, DuPont, Syngenta, Limagrain and Land O'Lakes) had reached a turnover of more than USD one billion by 2009 (see box).

Turnover of the ten largest seed companies in 2007 and 2009 (in million US dollars)

	2007	(%)	2009	(%)
Monsanto (USA)	4.964	23	7.297	27
DuPont (USA)	3.300	15	4.641	17
Syngenta (Switzerland)	2.018	9	2.564	9
Groupe Limagrain (France)	1.226	6	1.252	5
Land O'Lakes (USA)	917	4	1.100	4
KWS AG (Germany)	702	3	997	4
Bayer Crop Science (Germ.)	524	2	700	3
Sakata (Japan)	396	2	491	2
DLF-Trifolium (Denmark)	391	2	385	1
Takii (Japan):	347	2		
Dow AgroSciences (USA)			635	2

In 2007, the ten largest seed companies represented 67% of the seed market (USD 22 billion or 1% of the world agricultural

The seed market is undergoing rapid growth and concentration. Its value increased by close to 25% in two years between 2007 and 2009, going from USD 22 billion to USD 27 billion! The ten largest companies accounted for 67% of the total turnover in 2007 and 73% in 2009. when the three largest contributed 53% of the total turnover. Monsanto alone controlled more than 85% of the GMO world market. Moreover, these large companies continue to purchase smaller companies, particularly in non-industrial countries so as to build up a long-term presence in those countries.

These companies have acquired a strong economic as well as political presence, in particular by taking over local companies, to the extent they can have a strong influence over decisions taken by governments in the South. They have also very close relations with countries in the North, through the frequent transfer of personnel between these companies and public organisations (research organisations and ministries in the US, food safety authorities in Europe, for example). Their interests are also intertwined with those of pesticide producers (six among the ten major seed companies are also producers of agrochemicals).

These companies have a considerable research capacity, both individually and in groups. They have launched huge research programmes, such as the productivity increase and drought resistance research and development programme of USD 1.5 billion launched by Monsanto and BASF in 2007 on maize, cotton, rapeseed and soybean. Another example of the confidence that these companies have in their future is the investment by DuPont in 2012 of USD 1.7 billion in research and development programmes of which 61% is devoted to achieving increase of food production[3]. With such large resources available, the gap between private and public research will certainly increase further!

A system is therefore in place that can continue to grow and increasingly dominate world agriculture and make even larger profits

- Threats to agricultural biodiversity

Agricultural biodiversity (or agrobiodiversity) is constituted by the diversity and variability of living organisms that are used in food and agricultural production, and by the related knowledge. Agrobiodiversity is therefore a concept related both to natural resources *and* to the social and economic characteristics of agriculture.

In a report dated 2004[4], FAO had already stressed the great fragility of agrobiodiversity, of which the genetic material used in agriculture is a key component. FAO was summarising this fragility by a few telling figures which described the situation at the end of the XXth century:

- In one century, around 75% of genetic diversity in crops was lost because farmers had abandoned their local varieties to grow new high yielding varieties
- 30% of the races of domesticated animals used in agriculture are at risk of extinction: every month sees 6 races lost!
- 75% of world food comes from only 12 plant and 5 animal species

[3] http://www2.dupont.com/Media_Center/en_US/daily_news/august/article20110816.html

[4] FAO, **What is Agrobiodiversity?** 2004

- Out of some 250,000 to 300,000 existing edible plants, estimates are that only 10,000 have actually ever been consumed as food, but only 150 to 200 are used currently, and three (rice, maize and wheat) represent almost 60% of the current human vegetarian diet.

This reduction of agrobiodiversity is not without consequences. Research and experience has shown that agrobiodiversity can:

- Increase productivity, food security and economic results
- Reduce the pressure exerted by agriculture on fragile areas, forests and threatened species
- Make agrarian systems more stable, robust and sustainable
- Contribute to a better pest and disease management
- Protect the soil and improve soil condition and fertility
- Contribute to sustainable intensification
- Diversify production and sources of income
- Reduce risks
- Contribute to maximise the effective use of natural resources and the environment
- Reduce dependency on external inputs
- Improve nutrition and offer sources of vitamins and medicines
- Preserve the structure of the ecosystem and stability and diversity of species.

It is clear from this list that the loss of biodiversity contributes to push farming towards an agriculture that will require more and more external inputs (fertilisers and plant protection chemicals) and will put an increasing pressure on the environment, including climate change.

- Deprivation and exclusion of peasant farmers

From an economic and legal point of view, the main threats created by privatisation of genetic resources for small-scale farmers are:

- *Acquisition of exclusive rights to breeding methods and genetic resources from the domain of 'primary' production, because process patents make it possible to transfer primary biodiversity from the commons into private ownership;*
- *Withdrawal of traditional breeding methods from the public domain into private ownership and, once a monopoly has been established, perpetuation of the monopoly by follow-on patents and other strategies of "evergreening"*[5].

The recognition of intellectual property rights by the WTO agreement on Trade-Related aspects of Intellectual Property Rights (TRIPS) for biological inventions and the possibility of extending the protection of inventions beyond 20 years as well as the extending of the authorised domain for patenting, are open doors for a very broad appropriation and privatisation of genetic resources.
These provisions of the TRIPS agreement are likely to reduce progressively and extensively what is available free-of-charge to farmers in the public domain and induce them little by little to pay fees to do what they were doing independently for time immemorial, or, in the case they are not able to pay these fees, to push them out of

[5] Feint et al., **Biopatents – A Threat to the Use and Conservation of Agrobiodiversity?** Position Paper of the Advisory Board on Biodiversity and Genetic Resources at the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), 2010, Bonn Germany

agriculture, migrate to the cities, or even, as can increasingly be observed in India and elsewhere, to commit suicide.

Indeed, legal action is virtually inaccessible to small producers even when they are assisted by international civil society organisations, as the seed giants have the means to cope with never-ending legal processes and can pay the services of the best and most expensive lawyers.

The acceleration of patenting of living organisms is likely to reduce the domain of action of small farmers. It may also contribute to further standardise production and reduce the genetic material and selection processes used, thus further accelerating the loss of biodiversity and the development of an agriculture that is heavily dependant on external inputs. Instead of encouraging innovation, which is the initial purpose of patents, the risk is that the effect will be exactly the opposite, as can already been seen now.

In 2001, the International Treaty on Plant Genetic Resources for Food and Agriculture was finalised after seven years of difficult negotiations at FAO. The Treaty, which is consistent with the Convention on Biological Diversity, seeks to achieve the conservation and sustainable management of plant genetic resources for food and agriculture, and the equitable sharing of benefits generated by their use. The Treaty proposes a multilateral system of access and sharing of benefits drawn from genetic resources. The Treaty also gives the responsibility to signatory countries to respect farmer rights (protection of knowledge and participation in decision making in the area of genetic resources) and implement an appropriate national legislation. The Treaty entered into force in June 2004, following the ratification by 40 countries. Altogether, 128 countries are contracting parties for the treaty, but these do not include China, Japan, Mexico, New Zealand, Russia, South Africa and Ukraine.

The Nagoya Protocol drafted in October 2010 in the framework of the Convention on Biological Diversity, seeks to establish national legislation to organise the access and sharing of benefits accrued from the use of genetic resources and the monitoring of their use with the ultimate objective of improving food security. By March 2013, the Protocol had been signed by 92 countries and ratified by 15. It aims at protecting the interests and knowledge of local and indigenous communities and ensuring that they have really given free and consented agreement in case of use by others of the genetic resources they own. China, Pakistan, the Philippines, Russia, the USA, Vietnam and the majority of African countries have not signed the Protocol.

There are two main questions here. On the one hand, will governments have the political will to really implement the legislation and the mechanisms proposed by the Treaty and the Protocol? On the other hand, will poorer countries really benefit from the technical and financial assistance envisioned by these international agreements? Unfortunately, local conditions and experience with other similar agreements leave observers rather sceptical regarding their implementation in the near future.

Meanwhile, poor producers will have the ‘‘choice’’ between paying regularly the price of access to better seeds, when available, or produce using their traditional means and compete on the market with producers who use more advanced technologies, benefit from subsidies and are not liable for the possible environmental and health costs of the technologies they use. This means that, in the future, these poor producers will become increasingly marginal.

This evolution will only be reversed if agricultural policies that favour conventional chemical agriculture are reformed and if public research takes the initiative to develop new higher yielding varieties adapted to the conditions of small farmers and available in the public domain, and to generate new technologies that are adapted to the situation found on smallholder farms (see for example the rice variety disclosed by IRRI in August 2012)

- Threat to consumer health

The research by Prof. Séralini raises the issue of health risks related to the consumption of certain (not all) GMOs. It appears urgent that indisputable studies be conducted to clarify this issue and that the procedures for approving the release of GMOs should be made make more robust in conformity with the precautionary principle.

- Threats to the environment

This is another domain where risks are generated because of the creation of “artificial” organisms with unknown effects on the environment. This risk requires the development of processes to test the harmlessness of newly created varieties. Unless such reliable processes are in place, the development and dissemination of GMO varieties should be interrupted, particularly as these varieties do not appear to be indispensable to meet the future demand for agricultural commodities in the decades to come. It is important to know that at present there are 28 countries in the world using GMOs. The first user in terms of area covered is the USA (near to 70 million ha), followed by Brazil (37 million ha). In 2012, the area cultivated under GMOs in the world was 170 million ha (3.5% of total agricultural area), 100 times more than in 1966 when GMOs were for the first time cultivated with a commercial purpose.

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(March 2013)

To know more

- ETC (Action Group on Erosion, Technology and Concentration), **Who will control the green economy?** 2011
- **Are GMOs the solution for world hunger?** www.hungerexplained.org 2012
- **Genetically modified crops** FAO's point of view (2001)
- **Biotechnology: meeting the needs of the poor?** (FAO 2004)