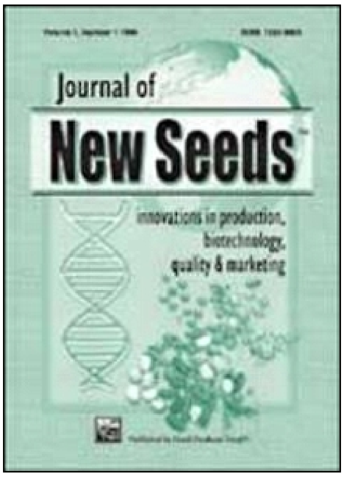

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An Agrobiodiversity Perspective on Seed Policies

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An Agrobiodiversity Perspective on Seed Policies

Bert Visser

SUMMARY. The genetic erosion that followed the emergence of scientific plant breeding and the changes in agricultural production are the result of globalization and cannot be attributed to seed policies and legislation in particular. However, seed regulations can have a very important and often negative impact on local seed systems and the genetic diversity that is used and maintained in such systems. Also, seed legislation and intellectual property rights have a marked effect on formal and participatory plant breeding programs and on the number of varieties released to farmers. The recent developments of international regulations on intellectual property and the upcoming biotechnology revolution are likely to aggravate the current trend. Thus, policies on plant genetic resources and agrobiodiversity on the one hand and seed policies on the other hand influence each other and should be closely connected.

International agreements such as the FAO International Undertaking on Genetic Resources for Agriculture and the Convention on Biological Diversity may have a positive, regulating effect on the balance of power, but it is not yet clear whether these agreements will indeed have the desired effects on agrobiodiversity. Policy makers that develop or redesign seed policies and legislation should take international and local biodiversity issues and the objectives of the international agreements into account. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <getinfo@haworthpressinc.com> Website: <http://www.HaworthPress.com> © 2002 by The Haworth Press, Inc. All rights reserved.]*

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INTRODUCTION

Seeds form the subject of policies and their formalized version, legislation. Seeds are subjected to policies and legislation because they represent major values. Food production and food security are largely based on seeds, and in many countries seed production and seed supply involve major economic activities.

The capacity to produce food is, however, only one essential characteristic of seed. The fact that seeds are living material and, like all living materials, display diversity forms another essential property. This paper focuses on the genetic diversity encompassed in seeds, and in particular on the experienced and potential effects of seed policies on seed diversity. It also takes into account the diversity of human actors who deal with seeds and their diversity.

The design and revision of seed policies and intellectual property rights systems should accommodate for these effects on genetic diversity, and indirectly on food production, food security and cultural identity, and should recognise the roles of various stakeholders in the production of our food and its diversity.

Seed genetic diversity is regarded as part of agrobiodiversity. The function of agrobiodiversity in securing future food production and realizing more sustainable forms of agriculture is briefly discussed. How traditional seed supply systems developed into large global economic enterprises and how this affected the diversity of seeds are issues subsequently touched. Investments of the private seed industry require protection by intellectual property rights. The effects on acces to and utilisation of seed genetic diversity exerted by intellectual property rights form a central aspect of the relationship between seed policies and the management of agrobiodiversity.This includes:

- plant breeder's rights according to UPOV as an example of a *sui generis* property right system,
- patent rights, which invaded plant production from technology industry, and
- current efforts to develop an analogous system of farmer's rights play in this process brings us to the heart of the link between seed policies and management of agrobiodiversity.

It is questioned whether the current versions and uses of intellectual property rights follow from the need to promote inventions in biological and genetic properties of seeds, or whether they mainly follow from established economic interests.

SEEDS AS A CORNERSTONE OF AGROBIODIVERSITY

Various definitions of the terms biodiversity and agrobiodiversity have been formulated by policy makers and scientists. Here, widely accepted descriptions are reiterated. The Convention on Biological Diversity, agreed in 1992, defined biodiversity as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (CBD, 1992, www.biodiv.org). Thus, this definition distinguishes three levels of integration with increasing complexity. Sublevels can be recognized within each level. Issues of diversity within species, i.e., genetic diversity, can be addressed at the species and population levels. The central criteria of distinctness of the UPOV treaty deals with genetic diversity at the species level between populations, whereas the criteria of uniformity relates to the within-population diversity. Traditional farming systems employ within-population diversity to obtain yield stability.

Genetic resources signify all materials containing genetic diversity of actual or potential value for food and agriculture, and the term most often directly refers to the diversity within species.

Agricultural biodiversity, also known as agrobiodiversity, forms a subset of total biodiversity. It refers to biodiversity related to agriculture and can be described as "the variety and variability amongst living organisms (of animals, plants, and microorganisms) that are important to food and agriculture in the broad sense and associated with cultivating crops and rearing animals and the ecological complexes of which they form a part." It includes the diversity found in farming systems as well as their surroundings to the extent that the latter influences agriculture.

However, these seemingly well-formulated definitions appear not all to be workable in practice. From a recent website discussion amongst the various stakeholders in the food production chain on options for an enlarged role for agrobiodiversity in Dutch agriculture it appeared that most participants had only a vague perception of agrobiodiversity, and consequently many participants disagreed in the value and role of agrobiodiversity in current agriculture (Pistorius et al., 2001). Such results reflect both the low degree of recognition of the value of agrobidiversity in agriculture as well as the complexity of the defined systems. Seed policies are often unconnected to (agro-)biodiversity policies. Seed policies heavily influence the development of production and seed supply systems. Whether agrobiodiversity can be equally sustained in strongly diverging production and seed systems or not, is explored to better understand how seed policies influence agrobiodiversity.

THER ROLE OF AGROBIODIVERSITY IN FOOD PRODUCTION

It is obvious that seeds play a major role in the maintenance of agrobiodiversity. At the within-species level, seeds contain the genetic diversity within a crop species, and are the vehicle of recombined genotypes and newly formed diversity. At the species level, availability of seeds determines the survival of neglected crops whose existence is threatened. And by influencing the cropping pattern, seeds influence the agro-ecosystems, in particular their environmental fitness at large and their sustainability. In other words, seeds are important at all three integration levels of agrobiodiversity.

But why is maintenance of agrobiodiversity important? In short, a high degree of agrobiodiversity in agro-ecosystems improves the buffering capacity and resilience of such systems when biological or climatic factors influence or alter these production systems: new pests and diseases may emerge, temperatures or rain fall patterns may gradually change. A high degree of agrobiodiversity means that humans keep access to resources that can help them to cope with such changing circumstances. When some crops or some varieties within crops fail because of lack of rainfall, others may survive and produce food. When new diseases occur, existing genetic diversity may be screened and exploited to detect resistances to such diseases. Consumer preferences might change due to urbanization, increased communication and exposure to other food habits. Foreign or forgotten food and crops might (re)gain importance and the demand for such crops might increase. Such developments require adaptation of production systems as well, and are dependent on the capacity of agro-ecosystems to respond to such shifting demands. A high degree of agrobiodiversity also decreases the dependence on high-external inputs, whether pesticides or chemical fertilizers. New pests can be better controlled by predators or antagonists present in the agro-ecosystems and green or animal manure may replace part of the need for chemical fertiliszers. In few words, agrobiodiversity has a major value for securing future food production and improved sustainability, but it also influences the capacity of the production systems to respond to short-term changes. Finally, it should be recognized that agrobiodiversity does not only reside in the crop but also in the knowledge in the use and properties of that crop. Indigenous knowledge is an integral part of agrobiodiversity.

Some additional remarks should qualify the notions mentioned above. The rather recent term "agrobiodiversity" only offers a new perspective on agricultural production factors. In fact, traditional agroecosystems have always relied on the principles contained in this concept, and modern western agriculture and seed industry may well be able to integrate the principles involved. Management and conservation of agrobiodiversity is not a goal in itself, but an instrument in achieving the goals behind it, securing food production and enhancing sustainability, in recognition of the fact that agrobiodiversity is only one factor to contribute to these goals. The use of the concept of agrobiodiversity resides in viewing farm production from a wider and integrated perspective, and in focussing on the relationships between various production factors and their environment. With regard to genetic resources, major efforts have been undertaken in the last few decades to conserve genetic diversity in genebanks, thus reducing our dependence on the survival of diversity in the field. However, it has become apparent that genebanks can only fulfil a limited role in conrsevation efforts, and on-farm conservation has been recognized as an important complementary strategy.

TRADITIONAL SEED PRODUCTION AND EXCHANGE

Until the end of the 19th century, everywhere in the world farmers produced seeds and consciously or unintentionally improved their crops, now known as farmer's varieties or landraces. Such improvement might simply stem from an on-going genetic adaptation of the variety to the agroecosystem. It might also involve a conscious selection, mass selection or pedigree selection, by farmers of germplasm with desired qualities. The term farmer's varieties better reflects the latter practice.

Farmer's varieties generally have some distinct features. First, they are adapted to the local circumstances under which they were developed. Such circumstances may be rather constant or they may vary greatly from year to year, and from field to field. At the one extreme the agroecosystems of the North-West European Plains and the Great Plains in the USA and to some extent irrigated lowland rice cultivation systems in Southeast Asia can be grouped, on the other extreme can be found the poor-soil, rain-dependent production systems at various altitudes in sub-Saharan Africa. Second, farmer's varieties often exhibit a considerable degree of genetic heterogeneity. It is precisely this heterogeneity which renders these varieties more flexible and capable to change in reaction to altering natural conditions. Third, because of this heterogeneity and the circumstances under which these varieties are grown, farmer's varieties are not stable. And finally, because they change over the years and are managed independently by different communities, they may or may not be regarded distinct from each other.

Not only the farmer's varieties themselves have some distinct features, this is also true for the way they are maintained and exchanged. In traditional farming systems food production mainly serves self-subsistence. The surplus can be exchanged through informal mechanisms between farmers, often under principles which are widely known as "common heritage of mankind." Seed is given away under the assumption that one day such gifts will be reciprocated. Both sides benefit because it increases their access to seed diversity and therefore the resilience of their production system. Often the surplus is also marketed through local distribution channels, involving middlemen. In all cases, the further use of the seed is free and no informal or formal property rights are recognized in such systems.

Farmer's varieties have almost disappeared from western and transition countries, where they mainly survive in the hands of hobbyists or in alternative production systems. But they are still dominant in many crops in tropical countries, in particular the non-staple crops. Similarly, local exchange mechanisms have almost vanished in western countries but are still dominant in tropical countries.

In conclusion, farmer's varieties form an inherent component of traditional small-scale farming systems. Farmer's varieties exhibit a relatively high degree of genetic variability, they are often not distinct, uniform and stable, they are exchanged freely, and property rights are foreign to such varieties. And, of course, seeds embody these varieties.

FROM TRADITIONAL TO MODERN SEED SUPPLY SYSTEMS

Concomitant with the industrialization of agriculture in western countries during the 20th century, variety development and seed production became an affair of specialists. Farmers who were skilled in selection and crossing of plants made their living of these skills and small breeding companies developed. Farmers who had access to good soils and good production circumstances in general specialized in seed production.

The industrialization of agriculture not only involved a gradual specialization in breeding from expert farmers to small specialized family-owned breeding companies. It should be stressed that in current traditional farming systems such specialization can be recognized as well. The industrialiszation exhibited many more features. Most family-owned breeding companies have gradually merged into a small number of large international breeding companies. Industrialiszation also involved:

- the creation of global markets in which a few crops dominate and form the main target of modern breeding efforts;
- the growing importance of food processing, in which a limited number of raw product materials are used to generate a large array of consumer

products (e.g., the dairy industry), and in which different crops can be used to generate the same consumer goods (e.g., vegetable oils); and
- the development of uniform standards applied to new crop varieties to allow for mechanical treatment and harvesting of crops, and to animal races to rear them under standardized conditions.

Along with these developments, the use of heterogeneous plant varieties decreased, and this was reflected in a decreased number of non-uniform varieties in the market. These are two aspects of genetic erosion.

Whereas these developments first occurred in industrialized countries from the turn of the 19th into the 20th century onwards, a similar event took place in the nineteen seventies and eighties with the Green Revolution. Again, thousands of local varieties of staple crops such as rice and wheat were replaced by high yielding varieties which had been developed by the international agricultural research centres (IARCs), notably IRRI and CIMMYT. Although these changes took place in different production systems, often still small-scale, again the effect of globalization resulted in improved food production depending on increased external inputs for a small number of varieties, soon covering large areas of tropical production systems.

In the last decades, public funding in agricultural research, including breeding, decreased sharply. In western countries public expenditure now focuses on pre-competitive fundamental crop research, whereas in many tropical countries, few staple crops which are essential for food security (mainly cereals) or crops which are major foreign exchange earners (e.g., sugar cane in Cuba, oil palm in Malaysia) receive most attention in public research. An estimated two-thirds of all investments in breeding are currently private (Pistorius and Van Wijk, 1999).

Following these developments, a few dominant transnational companies now cater for the needs for seeds and new varieties of farmers in western countries and large-scale farmers of export crops in tropical countries (maize, soybean), either directly or through joint ventures with local companies (Pistorius and Van Wijk, 1999). This does not mean that farmers return yearly to the seed companies to obtain their seed. Contrary to widely held views, in many countries including western countries the majority of farmers produce their own seed or obtain it from sales "over the fence" (western countries) or through local markets (tropical countries). Similarly, improvement of staple crops in tropical agriculture has become highly dependent on the products of the IARCs.

A salient feature of this modern international seed supply system is that it has produced uniformity, not because of UPOV requirements but because of economies of scale. Breeding companies could grow because markets extended when the production environment was adapted to the crop rather than the other way around. Such adaptation was achieved through the introduction of land management, and the use of external inputs to improve soil fertility and to protect crops from pests and diseases. So lesser varieties were sold in growing markets. But also, as explained above, the remaining varieties had to conform to uniform cultivation standards to allow mechanical management and harvesting. So these lesser varieties contained and exhibited less genetic diversity.

Again, some qualification of the statements above is necessary. An effect of the growing size and international character of breeding companies is their increased access to genetic diversity which may result in genetically improved varieties, and their increased financial resources to exploit this diversity. In particular, pest and diseases resistance genes from wild relatives of any source have been introduced in several crops (e.g., cereals, potato, vegetables). This tendency partly counteracts the loss of diversity due to uniformity requirements.

SEED POLICIES RESULTING FROM SEED TRADE

Seed trade has become commercialized and has become an international if not global affair. Seed policies and seed legislation serve various goals. They serve to guarantee quality standards (viability, identity) to farmers buying seeds which come under seed regulation, and they serve to guarantee other quality standards (identity, properties of the produce) to the food processing industry and to consumers. In a large number of countries various seed quality control measures and regulatory forms of variety registration as a prerequisite for marketing have been introduced. The scope of such measures may differ, and may involve major crops only, or a wide array of crops (e.g., Indonesia, Morocco, Uganda and the European Union), and seed certification or variety labeling only (USA). These regulations may outlaw farmer's varieties where still in use (e.g., for maize and sorghum in Zimbabwe, Cromwell and Van Oosterhout, 1999) or the reintroduction of older varieties which form a cultural heritage or are believed to better fit in organic practice (e.g., Britain, the Netherlands). Such regulations have become feasible because of an increased dependence of farmers on large-scale seed markets: through these seed markets national governments were able to interfere.

But plant breeding and seed trade under conditions of modern agriculture required yet another form of protection: intellectual property rights.

Investments by private breeding companies to develop new crop varieties can only be justified if returns on these investments can be realized. A seed trade and production system which allows any third party, whether competing breeding or seed company or a large number of farmers, to grow and market the seeds of new improved varieties is incompatible with such private breeding investments. Yet, free exchange and use had been the rule and seed legislation was needed to change the rules, since biological means of protection through the development of hybrid varieties were only partially successful and not amenable for all crops.

Plant breeder's rights were introduced in the international arena though the UPOV convention, agreed in its first version of 1961 (Ghijsen, this volume). From a diversity perspective both the breeder's exemption and farmer's privilege are important provisions, allowing the further use of protected varieties for breeding, selection and adaptation. Any measure to limit the scope of these provisions is potentially detrimental to on-farm crop development.

As a new development and consequence of the growing role of plant biotechnology in breeding, patent rights have now also entered the scene. Patent rights originate from industry and were developed to fit the needs for protection of industrial processes and products. Patent rights do not fit breeding and will harm the interests of many stakeholders in the food production chain. In contrast to plant breeder's rights under the UPOV convention they do not allow seed production of protected varieties and their use for further breeding by third parties, whether smaller local companies or farmers (Visser and Engels, 2000). Therefore, the introduction of patent rights in plant breeding will have a negative effect on genetic diversity.

EFFECTS ON SEED DIVERSITY

To what extent have the changes in seed supply systems and subsequent seed policies and seed legislation influenced seed diversity?

The industrialiszation of agriculture in western agriculture resulted in a small number of major players. These players together employ less breeders in less countries with more limited local networks compared to the previous phase in which small-scale family enterprise was the dominant form, let alone the traditional organization in which innumerable farmers carry out selection and more advanced forms of breeding. By necessity, the number of varieties was gradually reduced and the genetic diversity in these varieties decreased because breeders drew from less sources. Far from a conspiracy, these developments were the results of the economies of scale.

But other stakeholders also influenced diversity. Since food trade has become internationalized and consumer habits have changed as a result of exposure to new food, the diversity of crops consumed after industrial or home processing has also decreased. Here, the seed market and industrial seed producers are certainly not the only factor in changing the seed supply. A change in food demands by consumers has also changed the seed supply.

In addition, the products of the Green Revolution have often been strongly promoted by national governments through linking loans and other benefits to the cultivation of these varieties. Seed policies by these governments were understandably driven by the prospects of high yields for staple crops and the need to feed a fast growing population.

In the FAO State of the World (1996) the Republic of Korea reports that 74% of varieties of 14 crops grown on particular farms in 1985 had been replaced in 1993. China reported that nearly 10,000 wheat varieties were used in 1949, but only 1,000 in the 1970s. Fifteen million hectares of hybrid rice in China share a common cytoplasmic male sterility source. Till 1970, about 5,000 varieties of rice were grown in India, but currently about 500 varieties are grown of which 10-20 may be covering a large part of the country. Only 20% of local maize varieties in Mexico reported in 1930 are still known today, although it should be noted that loss of varieties does not necessarily mean loss of diversity, since this can be conserved in new varieties. Although an estimated 7,000 other plant species have been used as food by humans at some time, approximately 60% of global food supplies are now provided by rice, wheat and corn, and 90% by a total of thirty crops only.

In addition to factors mentioned above, legislation on seed quality control and variety registration as an instrument to support increased crop production has frustrated efforts to generate or maintain varieties in local farming systems, to develop local seed enterprises, or simply to cultivate the best adapted varieties. The best-adapted varieties may not conform to DUS standards. Alternatively, local enterprises that would supply niche-markets with specifically adapted materials may not have the resources to allow seed inspection, or government agencies may not have the resources to select and list the large numbers of varieties of specifically adapted varieties. In particular, activities employing participatory variety selection (PVS) and participatory plant breeding (PPB) have suffered from interference by legal provisions. Examples are the prohibition of open-pollinated maize varieties in Zimbabwe (Louwaars & van Marrewijk, 1996), the selection of optimal rice and chickpea varieties in India (Witcombe et al., 2000), and the breeding of new bean varieties in Uganda (Louwaars, pers. comm.).

Even if seed legislation is not fully responsible for these developments, it definitely has strengthened the effects. In the current 1991 version of the UPOV convention, the farmer's privilege has been limited and sales across the fence are no longer allowed. Maybe more important is that as a result of the WTO Trade-Related Intellectual Property Rights (TRIPs) agreement the number of countries which have enacted UPOV-compatible and similar laws has drastically increased. Since informal marketing of protected seeds by local producers is thus increasingly controlled, the distribution of protected seeds and the subsequent incorporation of their preferred traits into local varieties may slow down. Alternatively, protection of these seeds and the higher prices requested by official traders may not only limit their use, but also divert attention to local varieties with their own variability which are freely available.

In conclusion, seed policies other than intellectual property rights seem to have had the most profound impact on genetic diversity in the field. This picture might change under the influence of biotechnological innovations in plant breeding.

ALTERNATIVES RECOGNIZING THE NEED FOR DIVERSITY

Several alternative strategies and corrective measurements have been proposed in the course of the last decade. Some of these corrective measures are modest. For example, it has been proposed that for countries which wish to join the UPOV convention as new members, options should be created to enter on the conditions of the earler versions of the convention, which sets more flexible conditions for the breeder's privilege and in particular the farmer's exemption. It has also been suggested to restrict the coverage of national legislation following a UPOV membership to a few staple crops and not to include an array of smaller crops which often exhibit higher levels of variability. In fact, this is a common feature of a number of seed laws; for example, Bangladesh has enacted restrictive seed regulations covering only five major crops. In general, seed regulations tends to discriminate between crops in contrast to IPR legislation. Another suggested corrective measure is to exclude traditional varieties from the need to register these as varieties, and to allow modest trade in such varieties. A proposal for EU legislation along these lines has been forwarded by Germany and is still being debated.

Still another corrective measurement is to revisit and revise the often strict criteria for variety registation and certification allowing a recognition of traits of particular importance for organic production. In organic production a yield penalty may be acceptable if counterbalanced by better resistance, better rooting and soil coverage, and improved taste. A "green" variety list has been suggested to accommodate the specific requirements of organic agriculture (e.g., in the Netherlands). Such a development would widen the genetic diversity effectively used in the field.

Finally, it has been suggested to remove the obligatory character from current seed legislation and to make variety registation voluntary or to make the national variety lists a recommended list only. Such a change has been suggested for sorghum and maize in Zimbabwe, as well as for the variety registration system on arable crops in the EU.

The common feature of each of these initiatives is that they are corrective: they accept the principles of current seed policies and only wish to decrease the negative effects. They are proposed and supported by different stakeholders:

government authorities wish to limit their involvement, the seed industry wishes to replace the obligatory status of seed variety registration by voluntary because of the high costs and lengthy time schedules involved for crops for which biological property protection is available (in particular hybrids), whereas small-scale farmers, organic farmers and hobbyists seek to widen their options to grow and market other varieties than the latest recommended high-yielding ones from the seed industry. In other words, whereas not all stakeholders seek to promote diversity, the net effect is probably that a wider diversity can develop in the field.

A more fundamental question to be asked is whether the current provisions of plant breeder's rights under the UPOV convention really stem from genetic necessity or whether they are the result of economic considerations from a time before the introduction of biotechnology in general and of molecular genetic markers in particular (Visser, 1998). The elements at stake are those of distinctness, uniformity and stability. Distinctness of a new variety from existing cultivars should be apparent through a sufficiently different and phenotypically expressed trait. Accepting a molecular difference at the genotypic level might form an alternative and complementary approach, rendering additional germplasm available through market mechanisms for further breeding. (The characters that determine DUS have nothing to do with agronomic value.) The requirement for uniformity somehow follows from the requirement for distinctness. If legislation requires distinctness between varieties it should create sufficient "room" for new varieties by limiting the genetic coverage of registered varieties. Indeed, this is an argument for uniformity which stems from economic but not from biological principles. One might argue that uniformity also serves the farmer in economizing on cultivation measures and improving the price for his produce, as well as the other players in the production chain. However, this argument is mainly valid for current large-scale modern production, and not for the organic sector, the small-scale sector, and probably other resource-intensive production sectors. Molecular markers offer options to relax the current rigid requirements for uniformity. A certain level of heterogeneity might be acceptable as long as this can be monitored and per variety documented through the use of molecular makers. Under this scenario populations of different varieties might even contain genetically very similar individual genotypes: what counts would be the overal molecular pattern of the entire variety. Relaxation of the requirement of uniformity might benefit the organic and small-scale production sector for which genetic variation might contain the necessary buffering capacity in production and the genetic make-up required for farmer breeding. In this respect, the current trend amongst maize breeders to introduce a strict interpretation of the provision on dependency between varieties (see Ghijsen, this volume) may be challenged. It is obvious that stability should also be reinterpreted: genetically mixed populations might conform to new stability standards which allow a change in frequencies of individual genotypes constituting the variety. In this respect, it should be stressed that even many of the varieties which pass the much heralded DUS requirements of plant breeders' rights appear not so genetically uniform as they appear phenotypically, when studied using molecular markers. This means that relaxing current DUS standards would not be an absolute but only a quantitative change in interpretation of the variety protection legislation.

THE MENACE OF PATENT RIGHTS AND TRANSGENIC CROPS

The number of marketed transgenic varieties is still limited, but the investments in their development by seed industry are substantial and it can be expected that a growing number of transgenic varieties will appear in the market in near future, regardless the exact size of their market shares. Under patent rights not only the marketing of protected varieties is forbidden. Genetically modified crops can be protected by patents on the introduced transgenes and the patent legislation does not allow for breeding and free regrowth of the seed. A first issue to be solved should be scope of the patent protection of a transgene. Is it the DNA sequence and the value of the trait in its particular (genetic) environment only, or can a patent on a gene and the trait also cover the use of that gene in traditional cross breeding? Undoubtedly, the latter interpretation would severely hamper crop improvement and limit genetic variability in future crop varieties through the privatization and exclusion of specific DNA sequences.

Patent protection on specific transgenes will mean that genetically-modified crops may no longer be used for small-scale breeding efforts by small breeding companies or farmers, and that farmers who grow crops in which these transgenes occur, consciously or unwillingly introduced, trespass legal provisions. The net effect of the introduction of patent rights in breeding will be that breeding with any genetic material is no longer a universal right and this may negatively influence further crop improvement, small-scale and large-scale alike. And by consequence, the development and long-term sustainability of local genetic diversity may be hampered. This is not a theoretical scenario, as several authors (e.g., Louette, 2000) have documented cases in which small-scale farmers had used commercial varieties to introgres desired traits from commercial varieties into their local germplasm.

From this perspective plant breeders rights systems should be strengthened to withstand their gradual replacement in breeding by patent rights, and such strengthening might also be achieved by removing some of the disadvantages of the current interpretations of plant breeder's rights under the latest UPOV Convention.

FARMERS' RIGHTS AND SEED POLICIES

The FAO International Undertaking on Plant Genetic Resources for Food and Agriculture has first described farmers' rights as the rights of farmers and farming communities to manage and develop, and benefit from their *plant genetic resources*. Several groups have subsequently proposed farmers' rights as a legal counterpart of plant breeder's rights. However, implementation of this principle encounters many obstacles, including the absence of clearly defined groups of legal right holders, the different variety concept used by small-scale farmers, and last but not least the culturally foreign concept of such a property regime to most farming communities. It can also be questioned if such a legal interpretation of farmers' rights would not harm the optimal exchange and utilization of diversity stemming from farmers' varieties. However, an economic interpretation of the concept, according to which communities which manage on-farm crop and genetic diversity are supported to continue such practices, might thus be beneficial to the survival of genetic diversity on-farm, and not only in the hands of breeders and genebanks.

In addition, the CBD recognizes the role of indigenous and local communities and agrees to "respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant to the conservation and sustainable use of biological diversity and promote their wider application." This provision of the CBD reconfirms the concept of farmers' rights formulated in the FAO International Undertaking in a wider context and supports approaches to retribute and support farming communities maintaining genetic diversity and the associated knowledge in the form of concrete measures.

At the very least, seed policies should not be detrimental to efforts to maintain and develop crop genetic diversity. But even more important is that seed policies should encompass measures safeguarding the maintenance of genetic diversity on-farm and of agrobiodiversity, thus contributing to future food security and a more sustainable agriculture.

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