NEWEST DEVELOPMENTS IN PLANT BREEDING

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1. Introduction

Over the last decades, volumes of global agricultural production have increased significantly, thanks to specialization of farming systems and breeding of high yielding varieties.

We have an increase in world population, which currently stands at around 7 billion, and is expected to rise to 9 billion, by the year 2050. That increasing population and its need for food, combined with the need for renewable sources of energy, has placed a great deal of pressure on arable land, and has meant, that there is scarcity of such land. At the same time, we have the phenomenon of climate change, producing a number of different impacts on productivity in agriculture.

So, in consequence the need for innovation, mainly through new plant varieties is more relevant, than ever. Research is the future of agriculture, be it in terms of productivity, food quality and protection of the environment.

2. Characteristics of modern plant breeding

A dynamic and sustainable agriculture depends on scientific progress and the application of science to crop development through plant breeding. During the twentieth century, half of the increases made with regard to agricultural productivity were the result of progress in terms of research in field of genetics. It is now more than ever, of vital importance in the interest of food security to promote the development of varieties which can help us to achieve good productivity, while at the same time needing less inputs, being more resilient and better adapted to the effects of climate change.

The Second World Seed Conference, Rome 2009, emphasized, that Governments need to develop and maintain an enabling environment, to encourage innovation in plant breeding and seed production. Many States share this view, and has recently increased its investments in plant breeding research.

To satisfy increased demand, under increasingly challenging conditions – climate change, greater weather variation (drought, flooding, temperature shocks, natural resource scarcities) farmers will need crops that can tolerate those stresses. This is a huge order, but modern plant science is able to provide ways to meet those challenges.

Over the last decades, plant breeding has greatly benefited from rapid advances in bioinformatics, precision phenotyping and genomics and others. Now, we can genotype, a significant portion of the entire native genetic diversity for major food crops (wheat, maize, barley, rice). Precision phenotyping has greatly contributed to developing many stress tolerant varieties in different plant species in all parts of the world.

Biotech. tools are allowing further improvement of different traits and their transfer to commercial varieties in different regions, where adverse environmental conditions affect our crops, especially of resource – poor farmers. Transgenic approaches have opened opportunities to protect major crops from insects and weeds or to improve their grain or feed quality. Newest research and breeding technologies offer solutions, but still need to be deployed more widely in a efficient way.

Seed and plant variety legislation, including intellectual property (IP) issues, are at the core of bringing modern varieties to farmers fields. Many countries are struggling to facilitate ready access by farmers to recent breeding gains. Millions of farmers in Africa, Asia and Latin America grow outdated varieties and lack of information about newer ones. Markets in these areas often do not support the development of a completive seed sector, involving effective plant breeding. Furthermore, there is a large gap between farmers yields and those obtained in experimental stations, especially in many low – and middle – income countries.

Current plant breeding work, concentrates on two main approaches, e.g. on line varieties developed in conventional plant breeding and on heterogeneous plants material, mostly composite cross populations coming from evolutionary plant breeding.

Line breeding approach

Recently, plant breeding has almost only focused on the selection of line varieties, protected for breeders in a rigid legal framework. By continually restricting genetic variability, the pedigree line breeding approach, has narrowed the genetic base of many of our crops. As a result, monocultural plant communities dominate modern agriculture. and pedigree lines are successful in agriculture, because synthetic inputs are extensively used to raise fertility and control weeds pests and diseases. Monocultures are crops of a single species and a single variety, hence the degree of heterogeneity within such communities is severely limited. However, monocultural plant communities, very popular in world food production, has today many failures, due to the loss of genetic diversity, and the low resilience in many agro-ecosystems.

More recently, major questions have arisen concerning the economic, social and environmental costs associated with line breeding approach and high input production, using genetically narrow modern varieties, grown in monocultures.

As a result, government policies are now directed frequently towards more sustainable approaches to crop production. The problem of maintaining stability of output of crops in variable environments, has generated renewed interest in alternative breeding approaches, including the possible use of genetically diverse composite cross populations. Such populations can be produced using evolutionary plant breeding approach.

Evolutionary plant breeding approach

Evolutionary plant breeding has a long history, but has so far not become part of mainstream breeding research, nor has it been implemented in practice, to any substantial degree.

Conventional breeding relies on active selection of the best performing plants from multiple crosses, while discarding the remainder of the offspring. In evolutionary breeding ,on the other hand, the entire offspring population is sown in bulk, without active selection. Instead, by using a random sample of the harvested grain as seed for the next generation, year after year, evolutionary breeding lets natural selection act on these composite cross populations (CCPs). Since the more productive plants will contribute more seed to the next generatio0n than poor performers, this process can lead to yield improvement of the populations.

Over the last decade, research in evolutionary plant breeding has markedly intensified. For example, there are currently major research projects on-going in this area, including the EU funded project SOLIBAM, the Wheat Breeding LINK project in the UK, the Danish Biobreed project and the international research project called COBRA. The last project brings together over 40 partner organizations from 18 European countries.

In addition, interest in evolutionary plant breeding is growing among farmers, breeders and policy makers. In fact, there are currently encouraging developments in the revision of seed legislation in Europe, that could lead to more room for evolutionary plant breeding approaches in the future.

This renewed interest in evolutionary plant breeding is partly due to, the recognition that mainstream pedigree line plant breeding is limited, in terms to be able to cope with more and more variable, contrasting, fluctuating, and generally more unpredictable growing conditions.

With this background, it is now being recognized that crops need to be able to deal with this large and increasing environmental variability. As a consequence, plant breeding needs to become more decentralized , providing genetically diversified varieties. Evolutionary plant breeding offers great potential in this respect.

An added value of the evolutionary plant breeding , is that increased genetical diversity of breeding products, helps deal with biotic (pests, diseases) and abiotic (drought, temperature shocks) stresses.

3. Intellectual property protection in plant breeding

In order to stimulate innovation in plant breeding and to avoid plagiarism, an effective legal protection mechanisms of intellectual property of varieties and plant- related innovations, are needed.

The plant breeding community considers UPOV-like (International Union for the Protection of New Varieties of Plants) plant variety protection as an effective and tailor-made IP system for the plant breeding industry. Plant variety protection provides breeders with a breeder's right for new varieties, while making them accessible to third parties for research purposes, including the breeding of new varieties. The breeder's exemption within UPOV system of plant variety protection is a key enabler for investment in the development of new plant varieties, essential to strengthen sustainability in food production around the world. New plant varieties will play a central part in helping combat the challenge of food security for the benefit of the global community during the next decade and beyond.

Although it is a big challenge, I see very good potential for farmers, especially in developing countries to make further progress, by using the UPOV – like system for plant variety protection.

On the other hand, biotechnological plant-related innovations are suitable to be protected by patents. The plant breeding industry stakeholders are highly concerned about existing overlap between plant breeder's rights and patents. With the development of biotechnology, the two above mentioned legal instruments overlap increasingly, undermining the effectiveness of existing IP systems, both in plant breeding industry and biotechnology. In practice, patented biological invention can only be used by the third party (e.g. breeders), after selling the innovation by the patent holder or with his consent. . So, we must find a new balance between both intellectual property protection systems in seed sector and agriculture.

Furthermore, seed organizations and other stakeholders are in favor of fair and easy access to plant genetic resources for the breeding, and are convinced that, this access is in the long-term of interest of the plant breeding industry, the farming community, and society in general.

4. References

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