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PROCEEDINGS OF THE FIRST PLANT BREEDING SYMPOSIUM

PLANT GENETICS FOR INNOVATION

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Edited by
Daniel Basigalup and Ariel Odorizzi

INTA – Centro Regional Córdoba
Córdoba, Argentina

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PREFACE

In the agricultural sector, the fourth industrial revolution is reflected in the concept of Agriculture 4.0. In this context, obtaining a large amount of specific data -at constantly decreasing costs by the use of sensors, drones, machines and satellites- and processing it using increasingly sophisticated statistical models, offers the potential for significantly improving the efficiency in the allocation of resources, with positive impacts on both the profitability and the environmental sustainability of agricultural production. Digital agriculture and advances in genomics and new plant breeding techniques are, among other scientific and technological fields, part of this fourth industrial revolution. In addition, the demand for foods with differentiated attributes is also growing yearly.

The most important challenge of today's agriculture is to produce more and better food in a sustainable and safe way for a growing world population. All this within the framework of a sustainable use of natural resources, increasingly compromised by climate change. Faced with this complex scenario, the development of high-yield varieties with higher nutritional value, a more efficient use of water resources and appropriate levels of resistance to pests and diseases -which not only protect crops but also and restore territorial ecosystems by reducing the use of agrochemicals-, appears as a tool of great potential. Complementing conventional breeding with the application of biotechnology, eco-physiology, bioinformatics, new breeding high throughput phenotyping and genotyping techniques, and the conservation and use of genetic resources, will allow the achievement of those needs.

Based on the above, this 1st International Plant Breeding Symposium intends to provide a platform for the discussion and application of scientific advances at the service of agri-food innovation through higher value plant varieties. In this regard, the nine sessions that conforms the scientific program aim to update knowledge on creation and use of genetic variability, use of molecular markers, high throughput phenotyping and genotyping, bioinformatics and omics, deregulation of GE products, patents and intellectual property, and advancements in cereal, oil seed and forage crops.

We certainly hope that this symposium can also contribute to promote cooperation between the public and private sectors to both national and international levels. Despite the ups and downs that may arise due to temporary situations (such as COVID-19), the public-private synergy is expected to continue growing in the long term. In addition, the formation of networks and articulations of various types for R&D innovations has been gaining more and more strength. Nowadays, competitive advantage is not based so much on accumulating knowledge but rather on having access to flows of knowledge that allow permanent updating.

On behalf of the Organizing Committee we would like to express our deepest gratitude to all the sponsors and institutions that generously supported this meeting, as well as the invited speakers, the session chairs, the scientists who presented poster works and the general audience that followed this symposium. To all of them: thank you very much!

The editors

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INTELLECTUAL PROPERTY IN THE PROCESSES OF INVENTION/INNOVATION IN PLANT BREEDING

Rapela, M.A.*

Centro de la Propiedad Intelectual, Facultad de Derecho, Universidad Austral
Plataforma de Genómica y Mejoramiento, UBATEC SA

***e-mail**: mrapela@austral.edu.ar

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Introduction. The terms "invention" and "innovation" are not synonymous and apply to different goods and services. "Invention" is the creation of something new and is a term that refers to the generation of a new idea or knowledge whose purpose is to solve a specific technical problem, and to the creation, design or development of a product or process that has not existed before. “Innovation" is the commercialization of the invention and refers to the introduction of such products and processes to the market. "Invention" and "innovation" differ in the way they are protected and regulated. While inventions can be protected by the various existing Intellectual Property Rights (IPR) tools, such as trade secrets, utility models, patents and, in the case of plant varieties, by Plant Breeder's Rights (PBR), innovations are usually protected by registration and commercial authorization for sale. Thus, "invention", "innovation" and IPR form a triad of interrelated elements that are critical for the development of countries (10, 11).
Global agriculture faces the triple challenge of raising productivity while ensuring sustainability and improv-ing resilience. To achieve these goals, invention and innovation in the form of high-performing varieties is essential (2). IPRs can play an important role as an incentive to foster invention/innovation cycles in modern plant breeding but could also be an obstacle to maximize innovation use if they are applied in a wrong way (2, 12).

Unresolved challenges of the last 20 years. Among the different types of IPRs, PBRs within the framework of the International Convention for the Protection of New Varieties of Plants (UPOV) are the system of choice to protect plant varieties for most countries and it achieves a balance between the protection of such new varieties and access to protected breeding material for further improvement (2). Besides PBRs, Patents is the system of choice for the protection of biotechnological inventions, like gene constructs but, different from PBRs, the patent system does not have experimental clauses for further improvement. Due to these facts, in a transgenic variety a coexistence of rights can exist when such variety protected through PBRs contains biotechnological inventions protected by patents. So, a scope conflict between the two rights arises (4, 6).
The coexistence of patents and PBRs is a reality, but the fact that the PBR exceptions for breeding and farm-saved-seed can be abolished by patents covering the variety is a highly controversial and resisted issue. After more than 20 years of conflict, the problem of coexistence of rights in plant varieties has not been solved. Although there is important international doctrine and jurisprudence, in particular the system of cross-licensing in European legislation through the directives for the protection of biotechnological inventions (1), they have had an impact on few European legislations which have reacted by including the classic exceptions to plant breeders' rights in patent legislation. In the rest of the world, and particularly in Latin America, there are no legislative solutions proposed to establish the scope and exceptions of rights in case of coexistence in plant varieties (4).

Current but also unresolved challenges. Besides such developments, in the last years seed companies and public research institutes have been adding genomic approaches to conventional and transgenic breeding, integrating them in a series of novel plant breeding techniques to get very specific results in less time. Many of these techniques—collectively and improperly known as “New Breeding Techniques” (NBT), allow for gene editing by the practical use of homologous and non-homologous recombination, with the potential to create plants with agronomically valuable characters without the addition of exogenous DNA. This would be an alternative to transgenesis, which is exactly the opposite (3, 5, 13)

The first products developed with NBTs are already commercially available and this entails legal and regulatory challenges, as it is not clear how to protect such kind of inventions. For example, in almost every country patent law does not protect any matter which is preexisting in nature. This law-of-nature principle, which is supported—but not always observed—by the very origin of intellectual property (i.e. protection is due to products and procedures resulting from human invention and not before any such invention), means that a gene which is present in nature cannot be patented. But would it be possible to obtain a patent over the intentional change in just one nucleotide? Or two? What about three? How many nucleotides in a DNA segment must be changed for it to amount to an invention, so that such a natural gene is no longer "natural"? And if the change could have been caused by the natural event of mutation, would that be patentable anyway? What if the change is epigenetic and there is no alteration of genomic information? Too many questions without answers (7, 8).
Some have said that patent law should not apply to living matter. In that case, we would have to protect new edited plant varieties with PBRs stemming from the UPOV Convention, which entails—given the definition of "plant variety"—that there must be a difference in the expression of a genetic character. So, how would a novel plant variety be protected which has been obtained via gene editing whose phenotypical effect is the same as that of a natural mutation or that of a prior variety? (9).

Future challenges. Surrounding these contexts, the invention, obtention and all the scientific and technical development of modern plant varieties, including the development of beneficial microorganisms, the access to and use of plant genetic resources, and the development of biotechnological and biosafety inventions, are regulated at the international, regional, and in the form of many treaties, conventions, protocols, international agreements, and other regional and domestic rules. This complex set of rules has resulted in challenges to make global interpretations, due to overlapping, gaps, ambiguities, contradictions, and lack of consistency. The big picture is even more complex, as NBTs in general and gene editing have rendered these international regulatory frameworks partial or completely obsolete. It is worth noting that almost all of these international treaties and conventions were drafted before the current developments in modern plant breeding techniques (8, 9).
At the same time of these developments, feeding and providing energy to the world requires doubling agricultural production between 2010 and 2050. Attaining this goal demands a yearly 2.4% growth rate in the main crops. A series of studies and analyses from different sources point to the fact that the productive growth rate of the main crops is at a critical point at half that value (8).
The conclusion seems clear: we are in trouble. But what should be done in terms of intellectual property rights to accelerate plant breeding invention and innovation?

How to foster invention/innovation through IPR. There are three possible solutions: 1. Leave everything as it is, which is clearly the majority trend. 2. Refine and improve the wording of all treaties and agreements individually to resolve overlaps, gaps, ambiguities, contradictions and lack of coherence of the whole. 3. Reformulate the problem in an integral way, developing a single, holistic, up-to-date, and comprehensive *sui generis* protection system for all types of plant germplasm adapted to the developments of modern plant breeding under open innovation processes (9).
Although Solution # 1 is basically denying the problem, the explanation is clear: there is a huge and widespread fear that modifying the letter of the main international treaties and conventions related to IPR and genetic resources may result in something much worse than the current situation. Solution # 2, or in other words, improving the synergistic interaction between legislative changes and modern plant breeding is a task that could take decades of work and also have an uncertain outcome. Besides, it is extremely difficult to accomplish and it unlikely provides a long-term solution. Solution # 3 could be the logical option. As have been already proposed by Rapela (9) and Kock (2), a system failure can only be prevented by a fundamental redesign of the IPR system for plant inventions and innovations into one holistic system which combines elements of patents, PBR, the Convention for Biological Diversity and the FAO Treaty into an open innovation framework. There is no doubt that this solution requires a formidable international effort, but this should be the logical approach to fostering invention/innovation in modern plant breeding.

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