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Mini Review

Contributions of genetic improvement in food production

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Abstract

Plant breeding has had major impact in food production from the early 1900s to present days. With the development and expansion of agriculture, man began to entrust his diet to a restricted group the plant species. In 1996, about 90% of world production already fell only 15 species. During early years in the nineteenth century, breeding of plants occurred in rather rudimentary way and without any scientific basis. The rediscovery of Mendel's laws and principles of heredity were the main basis advances in the science of plant breeding. Today, biotechnology has been a new face of plant breeding by modifying genome plants the aiming economic interest, developing new, better cultivars.

Key-words: Food production, Plant breeding, Development

Introduction

With the development of agriculture, the number of individuals required to produce a given amount of food has been reduced over the time. Thanks to the efficiency of the modern agriculture, endowed with technology and science, in small area, much is produced when comparing other means that mankind obtained food the during time Among technologies and sciences that compose modern agriculture, we highlight genetic improvement of plants, the main responsible for high productivity rates achieved in the contemporary crops (Paterniani, 2001).

Plant breeding has the bigger impact on food production from the early 1900s to present (Borlaug, 1983; Fu, 2015). It is present in the science today because, due to the increasing development of the world population, it is necessary to produce more high-quality foods at lower costs (Tester and Langridge, 2010). One can conceptualize breeding plants as "the art science of genetically modifying plants". It is art because deals with aspects aesthetics, shape and color of the vegetables. It is science because obeys a set of specific laws, like laws of genetics (Bisognin and Silveira, 1996). From the moment man stopped collecting plants and began to cultivate them, the process of domestication and subsequent adaptation of these plants became effective (Meyer and Purugganan, 2010). With the development and expansion of agriculture, man began to entrust his diet to a restricted group of the plant species (Murphy, 2007). In 1996, about 90% of the world's production already relapsed only 15 species (Bisognin and Silveira, 1996).

The major contribution plant breeding mankind has been to develop new cultivars that offer greater productivity and quality, as well as extreme resistance for conditions of temperature and humidity, pest and disease attack, with a view to reducing losses and stabilizing production (Bisognin and Silveira, 1996). The objective of this work was to make a bibliographical review on contributions of the genetic

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improvement on food production, and how it has developed from earliest days in agriculture to the present days.

Historic

Due to the continuous climate changes that have occurred in the last thousand hundred years, the process of obtaining large animals food has become increasingly difficult. As an alternative, the Paleolithic and Neolithic men, in particular, began experimenting new ways to obtain food with many types of plant exploitation (Borlaug, 1983; Murphy, 2007). It is believed that the largest domesticators of plants and animals that existed were the men of the Neolithic period. This is because in a relatively short time span of about 30 centuries, all major cereals, grain legumes and root species have been domesticated, which still remain as the main sources of human food (Borlaug, 1983).

The process of plant breeding began unconsciously during agricultural revolution. Over time, man has progressed of conscious selection of the best individuals according to valued characteristics, such as seed size, vigor or productivity (Murphy, 2007; Machado, 2014). Thus, this process allowed a new dimension to the process of domestication of the plants, provoking a pressure of selection and bringing up in the population higher individuals with the valorized characteristics (Machado, 2014).

Evidence of this remote breeding process can be obtained through Archeology. In America, for example, beans were found in ruins of the indigenous civilizations almost 100 times larger than contemporary wild varieties of the region. Another example is in the North American Indians, who performed the corn improvement, promoting increase of spike considerably when compared to the ancestor of this species (Machado, 2014). At end of seventeenth century, Dutch breeders undertook the first ornamental flower breeding program, in which they produced the first. In 1825, in the United States, John Lorain demonstrated the world that it is possible to produce maize in hybridization, and guaranteed increases in crop production (Murphy, 2007).

Selection, domestication and diversification

Selection can be considered as the backbone for plant breeding. During its early stages, breeding occurred unconsciously and unintentionally, with evolution of cultivated species only when the human being stopped practicing collection and started the cultivation of the species (Murphy, 2007; Meyer and Purugganan, 2013; Machado, 2014). Man domestication of plants is the beginning of the process of evolutionary divergence wild ancestral species and tends to decrease suitability of improved plants in the wild, while increasing it when subjected to human exploration. It is considered complete when there is total dependence on man to survive (Paterniani, 2001; Meyer and Purugganan, 2013).

The process of plant domestication began about 12,000 years ago in the Middle East and Crescent Fertile, and has spread to other regions of the globe over time. Currently, domesticated plants are found in 160 taxonomic families, with estimates of 2,500 species that have already undergone breeding, and 250 fully domesticated species (Meyer and Purugganan, 2013). Diversification is the phase where the dispersion and adaptation of these species in new environments are involved. It is the subsequent process the evolution of new varieties, which promotes higher productivity, adaptation and quality of cultivated species.

The processes of domestication and diversification plants can be divided into four stages. The beginning process of domestication is marked by the interference man in the wild species, reshaping the evolutionary trajectories of these species and transforming them into domesticated (Step 1). From the moment they adapt to different agroecological environments, various selection pressures act on the individuals, generating phenotypic and genetic divergence among the domesticated species, thus appearing highly diversified populations with many characteristics to be evaluated (Step 2). The adaptation of the domesticated species to different environments and submission to the cultural practices of man made different populations culture endowed with characteristics of interest (Step 3). Finally, in order to increase productivity, uniformity and quality of these species, breeding strategies were established through cross-breeding (Step 4) (Meyer and Purugganan, 2013).

Improvement of Plants as Sciencs

Until the nineteenth century, plant breeding was practiced in a rather rudimentary way. Farmers selected the seeds of their favorite plants for later sowing. In North America a progressive number of farmers developed and sold material from superior varieties based on individual plant selections (Borlaug, 1983). The science of plant breeding owes much works of two nineteenth-century scientists: Mendel and Darwin. The rediscovery of Mendel's laws and the principles of heredity were the main basis for the advances in the science of plant breeding (Faleiro et al., 2007). With it, writings of Charles Darwin also contributed to knowledge in the variation of species of living beings, in which he proposed natural selection hypothesis with the purpose of explaining the evolutionary process in which changes occur gradually as time passes by time (Borlaug, 1983; Machado, 2014).

Plant breeding and biotechnology

Traditional crops are being replaced by improved cultivars and transgenic plants. Thus, it was possible to modernize agriculture with new discoveries of plant genetic improvement. Aiming to increase productivity of the crop meet demand for food. (Leite and Munhoz, 2013). The transgene is nothing more than the addition of small segments of exogenous DNA sequences and incorporation there into a genome of a receptor organism (Murphy, 2007). Thus, when a desirable trait is not found in the genome of an interest species, but if that trait is found in another species, transfer can be made by improving the species. Brazil and countless countries destine researches to obtain new transgenic varieties. They stand out from the characteristics evaluated, tolerance herbicides, resistance insects, viruses and fungi, quality, besides improving productivity. All that in order to minimize the use of agrochemicals in the production of these varieties. (Paterniani, 2001).

The creation of a new genotype in a plant community can provide undesirable effects such as elimination of unidentified species, exposure to new pathogens, generation of resistant weeds and insects, and genetic erosion. In addition, ecological impacts such as transfer of contaminated pollen. Among the risks to agriculture, the increase in the population of resistant pests is worrying, since those susceptible today, may be resistant in the future, allowing the growth of pest resistant. According to Paterniani (2001, p. 175). "Transgenics have been evaluated with much greater rigor (precautionary principle). The multi-year experience of millions of people consuming transgenic products has not revealed a single case of health damage. So the risks that have been announced are just hypothetical. The only concern of the researchers is with the possibility of new foods causing allergenic effects. " The possibility of new foods causing allergenic effects is the concern of the researchers. An improved bean with good protein composition, higher methionine content, an essential amino acid, was obtained by incorporating a nut gene. However, the research was discontinued, since it was possible that certain people allergic to Brazilian nuts were also allergic to modified beans (Paterniani, 2001).

One of the controversies related to transgenics established worldwide, arises from the lack of understanding of biotechnology and biosafety that different nature and objects, since biotechnology uses microorganisms, plants and animals to generate products of interest biosafety focused prevention of originated products in biotechnology. However, the fact is that transgenic products increases productivity, competitiveness and quality considerably. For example, golden rice that promotes the synthesis of beta carotene, is rich in vitamin A, which is very important for the human being. But the quality of the product does not justify that the human should be subjected to use. It is necessary, the investment in leading technologies that prove that some genetically modified organisms good to humans and that their intake does not cause any unfavorable reaction/mutation.

Improvement of Plants and the Environment

In contemporary agriculture the use of chemical products is constant to guarantee the development of plants free from pest attacks. However, these agrochemicals cause degrading effects on the environment, and constitute a reason to seek new ways to meet this demand (Costa and Queiroz, 2015). In Brazil the sale and use of fungicides, insecticides, herbicides, nematicides, acaricides, formicides, regulators and growth inhibitors are very common, aiming to protect planting of pests from nature, which demage development of cultivation (London, 2011). These activities are progressing to increase air, soil and animal and human pollution levels, as the prolonged consumption of foods treated with the excess use of these substances can cause them to accumulate in the body of those who ingest it, causing intoxication, or in more serious cases, increasing the incidence of devastating diseases, such as cancer (London, 2011).

The problems caused by improper use of chemicals in the chemical industry become more noticeable, sustainable ways of replacing them are sought and studies in this area become more scientifically interesting, especially in Plant Genetic Engineering, which has already made high contributions such as genetic selection and transgenics, which aims to dominate the expression of characteristics capable of conferring resistance to abiotic pests and stresses (Costa and Queiroz, 2015).

Contributions of genetic improvement plants cultivated in Brazil and in the world

Agriculture is sector in which biotechnological research has allowed the improvement of several crops and consequently an increase in productivity, of grains such as soybean (*Glycine max* L.), cotton (*Gossypium hirsutum* L.), canola (*Brassica napus* L.*)*; and other crops such as sugarcane (*Saccharum officinarum* L.), coffee (*Coffea arabica* L.), eucalyptus (*Eucalyptus globulus* Labill.), tomato (*Solanum lycopersicum* L.) and potato (*Solanum tuberosum* L.). As discussed above, traits of interest are introduced into these crops giving them capabilities such as pest resistance, and adverse weather conditions (Gusmão et al., 2017) (Figure 1).

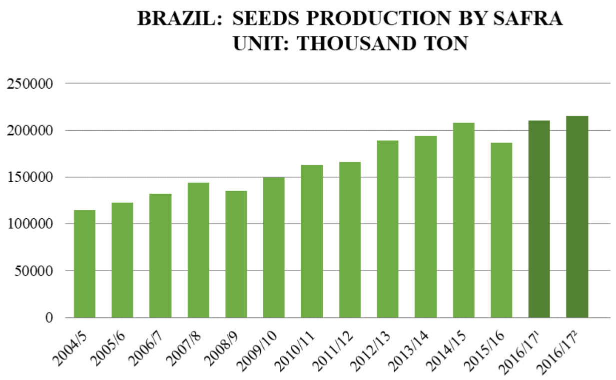

Fig. 1. Brazilian seeds production by safra.Adapted from: Companhia Nacional de Abastecimento. Accessed in: June 19, 2017, at 16:20 hours, in: https://www.scotconsultoria.com.br/bancoImagensUP/161006-artigos-1.png

Such techniques influence both productivity and product quality, whether fruits or seeds. Some of the most popular techniques are: the production of a lineage of bacteria of the species *Pseudomonas sygringae* that has been genetically modified and acts to prevent the formation of ice on the surface of plants; the production of tomatoes that delay the process of softening the fruit, thus conferring a greater resistance and conservation when transported over long distances besides a longer shelf life; modified rice induced to produce beta-carotene which is the precursor of vitamin A; and corns that contain high amounts of hormones for human growth (Gusmão et al., 2017).

Corn (*Zeamays*)

Corn is one the greatest examples of crop benefiting from genetic improvement. It was observed, based on document analysis, that this species of cultivation holds a greater predominance among commercially released transgenics when compared to cotton and soybean (Costa and Queiroz, 2015). It is an ancient culture that originated in the Americas and is now cultivated in many parts of the world. Corn is considered an strategic product for the food security in the world population, used for human and animal feeding, mainly in poultry, swine breeding and cattle breeding, both dairy and dairy. Not restricted to these industries, corn is also used for the extraction of bioethanol, and in the chemical and food industries, giving rise to more than five hundred derivatives (Alves and Amaral, 2011). According to Duarte et al. (2011), Brazil is currently among the world's largest producers of corn with a production surpassed only by the United States and China (Figure 2).

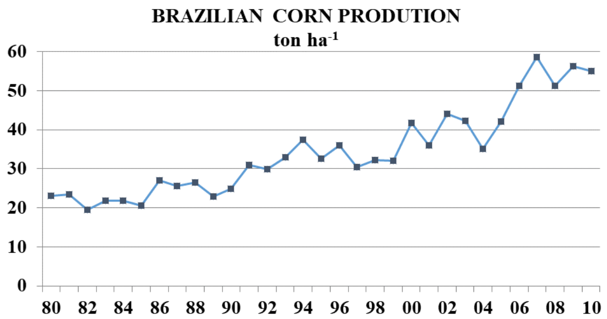

Fig. 2. Brazilian corn production. Adapted from: Accessed in: July 10, 2017, at 15:53 hours, in: http://www.graosesoja.com.br/imagens/graficos/soja/PROUCAOSOJABRASIL.jpg

In order to increase crop productivity by meeting the demand, numerous cultivars were developed through the genetic improvement that has made the planting as efficient as possible. In addition, through selection, genotypes adapted to a variety of environments that allowed the implantation of this culture in any region production system of Brazil. Nowadays, there is great use of improved hybrid, transgenic and conventional cultivars (Alves and Amaral, 2011).

Soybean (*Glycine max*)

A nother great example of crop that benefits greatly from the advances in genetic engineering and which could not be ignored is the genetically modified soybean that has high resistance against herbicides based on glyphosate, which corroborates with ease and practicality elimination of plants in the middle the crop (Gusmão et al., 2017). Because it is an exotic species in Brazil, genetic improvement was not favored only for simple increase of production and productivity, but to enable proper implementation of culture in the national territory. That is the fact why Brazil is the only one that holds the commercial liberation of transgenic soybeans against other countries (Costa and Queiroz, 2015) (Figure 3).

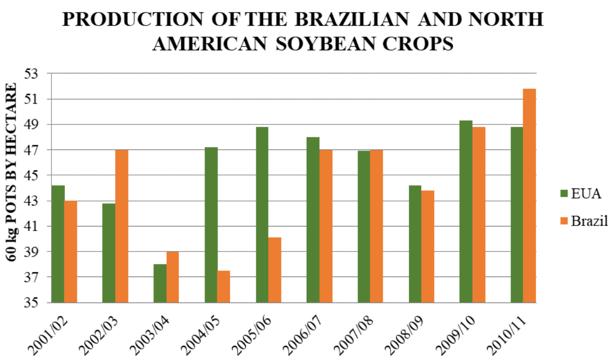

Fig. 3. Brazilian corn production.Adapted from: Accessed in: July 10, 2017, at 15:53 hours, in: http://www.graosesoja.com.br/imagens/graficos/soja/PROUCAOSOJABRASIL.jpg

Conflict of interest: All authors declare no conflict of interest.

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