FOOD SECURITY AND INNOVATIVE TOOLS WITH A GLOBAL FOOD SYSTEM APPROACH (*)

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EXCECUTIVE SUMMARY

The current challenge of agriculture is to ensure sustainability, being aware that in the next half century we must produce as much as in the previous ten thousand years. At the same time, we should improve crop resilience, in an unquestionable scenario of climate change. The World Food and Agriculture Organization (FAO) urges us to achieve **Food Security**, which is the situation in which everybody, has physical and economic access to sufficient, safe nutritious food at all times, to satisfy their nutritional needs and preferences, in order to lead an active and healthy life.

In recent years we have seen an exponential increase in the knowledge of the molecular basis of genetic traits that are important for food production. Some of these **technologies** have been developed in Europe, and benefit producers from other parts of the world, from whom our countries then import its products for our consumption. It has been possible to increase the micronutrient content of fruit, delay their ripening or incorporate resistance to viruses, fungi and bacteria. Thus, using tools borrowed from bacterial defence mechanisms (CRISPR-Cas9 and derivatives), it is possible to act in a controlled and timely manner on the desired areas of DNA (Deoxyribonucleic Acid), as could be the case in the fight against TR4 fungus in the banana. This crop occupies about ten million hectares with an annual production of one hundred million

tons. It is part of the basic diet of four hundred million people and is cultivated in all tropical and subtropical regions constituting the fourth food crop only behind the rice, wheat and corn. No fungicide has been found that allows chemical control of the fungus that remains in infected soils for periods exceeding thirty years, so it is urgent to obtain new resistant varieties.

The document aims to **sensitize society and legislators** about the importance of science and technology, with a sustainable global food system approach (availability, policies, economy and culture) to meet the food challenges of the 21st century.

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BACKGROUND

The growth of humanity must be harmonious and sustainable in an ethical framework. This will not be achieved, if simultaneously the same evolution does not occur in the global food system and for this the role of science is fundamental. Science is the motor of human development in all its aspects.

The TRIPTOLEMOS Foundation for the development of the food system was created in 2002 with a universal projection under the Presidency of Mr. Federico Mayor Zaragoza, Director-General of UNESCO (1987-1999). The Foundation contributes to optimize the food system with its activities, and thus achieve adequate food for the entire population, the confidence of the consumer and the dignity of the sector. Its vision and activities are supported by validated and updated scientific knowledge. Today its numbers universities, the CSIC (*Spanish National Research Council),* companies, consumers and various representative institutions among its members.

Their approaches and actions have led to recognition by UNESCO with the creation of the Chair "Science and Innovation for Sustainable Development: Global Food Production and Safety" with the UNED (National Distance Education University), from which the Foundation develops part of its national and international activities. The Foundation is also a member of the Global Soil Alliance and the Global Food Safety and Nutrition (FSN Forum) both FAO working groups.

Recently it has prepared the "Declaration of the Triptolemos Foundation on fake news and recommendations in food", a document in favour of science, scientists and legislative institutions aimed at applying knowledge. This document already has more than a hundred signatory scientists and multiple adhesions.

In its history, the Foundation has published books and studies on specific topics that concern society in food issues. One of the issues that continues to be a problem today is the use of biotechnology and especially that of genetic engineering. In this regard, in 2006 the Foundation published the study "Triptolemos Report on safety in the use of GMOs and derivatives as food ingredients". The document, which contains extensive scientific and social information and was prepared by seven experts from different disciplines, including consumer associations, can be consulted on its website.

Although the general principles, both in genetic engineering and the ethical and social environment, are maintained, the Foundation has considered it necessary to hold to the validity of the document, preparing a complementary dossier that gathers the important new contributions of science, which help to perfect the genetic techniques. We refer, for example, to the entire environment that has allowed the achievement of CRISPR techniques, which will be treated with informative breadth, but with the necessary rigor, and incorporating some examples, of how your real contribution to food sustainability can be.

1. GLOBAL FOOD SYSTEM

The right to food is a universal human right recognized by international law, which protects the right of all people to obtain food, either by their own production or by the means necessary for their acquisition.

The current international human rights system dates from 1948, when the General Assembly of the United Nations approved the Universal Declaration of Human Rights, an essential element in a modern state and linked to the availability of food.

The world population grows with a tendency to concentrate in urban areas. The right for adequate food for the entire population is an important challenge in the current context. The role of science and technology are the keys. We must do more with less.

From the Triptolemos Foundation the Global Food System is focused on 4 basic main axes: availability, economy, politics and culture and each of them are developed in multiple aspects. All of them must be in harmony for the proper functioning of the Global Sustainable Food System aligned with the Sustainable Development Goals (SDG).

• The axis of Availability considers all the elements that make it possible to ensure that quantitatively enough food is available for its destination: adequate food for the human being.

• The axis of Economy includes the economic activity, from the field to the table. The model considers the economy of the consumer which indicates their ability, to acquire food in their environment, a concept that has a very close relationship not only with the global aspects of the economy (macro and microeconomics) but also with aspects of the axes of politics and culture.

• The axis of Policy considers all activities that society, as a political entity, generates around the food system and is based on a fundamental right: the right to life. The availability and safety of food must be guaranteed.

•The axis of Culture: knowledge, education, social behaviour (sociology, anthropology, consumption trends, cultural and religious taboos ...) are considered. Feeding goes beyond the scientific basis, has important emotional implications (beliefs, pleasure ...).

With this Global Food System approach, we will address the challenge of food security and innovative tools.

2. AGRICULTURE AND SOCIETY

Directly or indirectly, humanity provides itself with most its food through agriculture, as well as a very important proportion of its clothing and medicinal, industrial and energy products. Agricultural progress has allowed us to overcome continually the demographic challenges we have faced and will undoubtedly successfully overcome the planetary challenges of the coming decades. Megan Clark, former director of the CSIRO (Australian National Research Agency) is credited with the phrase "In the next 50 years we will have to produce as much food as we have in the previous ten thousand," which reflects the food challenge we face. In order to overcome it, a new agriculture is being developed, incorporating new tools from information technologies, data science, artificial intelligence, terrestrial and spatial sensors and all molecular tools, particularly genomic, available to the more conventional techniques.

In relative terms, **food production** per unit area has remained, more or less constant from the origin of agriculture until just over a century or two ago, with the agricultural area increasing at almost the same rate as the population. Globally, if we compare the growth in world population in relation to the increase in agricultural production in the last 60 years, the **population** has multiplied by almost 2.5, while cereal production, as well as that of many other crops, by 4. In the last 50 years, the hectare of agricultural cultivation required to feed a person for a year has been reduced to just 30% of what was before. It is estimated that 50% of all these advances in production are due to **genetic improvement**, that is, the manipulation, relatively unconscious until a few decades ago, of genomes. But naturally these increases in production, continued over time, are not only due to the new improved varieties. Particularly in the second half of the last century, during the undermined Green Revolution, they have been the result of increased use of inputs, such as fertilizers, other agrochemicals and energy products (mechanization). However, over the past few decades, this use (and sometimes abuse) of inputs is being replaced by the more responsible application of greater technical scientific knowledge aimed at increasing the efficiency of these same inputs. This is due to the implementation of **Sustainable Agriculture**, a direct consequence of the environmental concern generated by the Green Revolution.

As a result of **agricultural advances**, we have never had access to so much food and quality in human history. In the agricultural field, the quotation of Jonathan Swift (1667-1745) that appears in Gulliver's Travels is frequently mentioned: "….whoever could make two ears of corn, or two blades of grass, to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together…". This is the objective and the result of agricultural activity. However, in recent decades agriculture, and particularly genetic improvement, has been a victim of its own success, abandoning the privileged position occupied on the social scale. Current society, particularly in the most industrialized economies, assumes that with little effort agriculture, is able to provide more and better food for the entire population, which is why has ceased to be valued its activity. In a few years, it has gone from trust and full social recognition to questioning. We hear more allusions to the polluting effects of agricultural production, to the loss of biodiversity that it produces, to the lack of food security, than to its critical role in food supply.

A **false sensation of risk** to the environment and to public health, associated with the development of a new industrialized agriculture as opposed to the traditional or ecological one without a deep analysis has been transferred to public opinion, being considered more adequate (in many cases erroneously).However, not only has productivity increased. At the same time, **modern agriculture** has generated another series of very important environmental benefits. It has allowed the reduction of the expansion of new farmland due to the high yields achieved, which could hardly have been available for its ploughing. It has improved efficiency in the use of resources and the sustainability of agricultural production. All this has led to a decrease in erosion, better conservation of biodiversity, saving fertilizers, improving the balance of greenhouse gas emissions, reducing total water demand, reducing environmental pollutants and residues in food, etc.

Humanity has advanced extraordinarily throughout history, accepting and adopting the innovations that have been produced in all disciplines. Thanks to the development of knowledge and innovation, increases in productivity and quality of agricultural products and, to summarise, the profitability of agricultural exploitation has been achieved. Humanity has been particularly bold in its diet for example by incorporating, exotic plants in our diets from other continents. The acceptance in Europe of species such as potatoes or tomatoes of American origin in the 16th century could not have been easy. It is therefore **paradoxical**, that now when we know more about the structure and function of plants, part of society is more opposed to certain technological innovations.

The **current challenge of agriculture** is to ensure sustainability, being aware that in the next half century we have to produce as much as in the previous ten thousand years, at the same time, having to worry about improving crop resilience, in a unquestionable scenario of climate change. Will it be possible to continue with these increases in a context of social sensitivity?. Without any doubt, the answer is positive, based on a new scenario of **sustainable intensification** in which, among many other agricultural disciplines, genetic improvement will continue to play a predominant role. However, for this, it is important that some obstacles, many of them administrative, that have been introduced to new scientific developments could be eliminated in the European Union. Producers from other parts of the world benefit from them, where they end up being imported for consumption in our countries. **It would be ironic** if agriculture, largely responsible for current social development, could not benefit, like other disciplines, from the latest technological advances, many of them created by our own research groups in Europe.

3. GENETICS AND ITS EVOLUTION

For a long time, the farmers, who also acted as genetic breeders, chose the seed from individuals they considered superior as the founders of the new crop generation. By not controlling one of the parents, progress was slow but consistent. They also discovered that in cases where vegetative multiplication was possible (through cuttings), the individuals resulting from this multiplication were much more similar to the parent plant than in most cases where seeds from crosses were used.

The next big step in the history of improvement was the control of pollination or mating in the case of animals. Thus, by choosing the two parents, it was possible to generate variability aimed at some practical objective. For example, crossing two very productive individuals achieved offspring that were often more productive than the population average. We had increased our ability to generate variability in a targeted way as we went from the control of one parent to the control of both. Crosses in sheep in England, Moravia and Silesia, at the beginning of the 19th century, created the basis for subsequent pea experiments carried out by Mendel in Brno and the enunciation of his famous laws of inheritance.

Mendel recognized guidelines in the transmission of some simple characters. Although his observations were not widely accepted until the early twentieth century, they formed the basis of scientific knowledge of the inheritance that allowed modelling on the biological substrate of the same but also recognition of the role of the environment in the final manifestation of the characters. It was soon discovered that most of the characters of commercial interest did not respond to simple Mendelian logic, and their transmission should be treated in a more complex statistical manner. These quantitative or continuous variability characters were called height, weight, seed, fruit production, etc. It was soon discovered, however, that at their base were the same elementary units that were called genes.

Finally, in the 50s of the last century, the molecular basis of inheritance, the DNA molecule, which stores the information in a long sequence of four nitrogenous bases: adenine, thymine, guanine and cytosine was identified. This molecule has a high stability because the bases are paired with each other, which in turn allows its duplication causing two identical copies of the original. We now know that mutations are random changes in the sequence of nitrogen bases. We also know that nitrogenous bases encode amino acids and constitute elements of regulation of gene reading (groups of bases that have biological significance in the form of protein or regulation zone). We are facing a complex instruction book, called a genome, written with four letters, which acquire meaning in groups of three, or in larger sets.

From this discovery the study of the relationships between what is written in the DNA and its expression in the organism that it encodes being to develop. To decipher the whole process that goes from the instruction book and its language, to the already assembled and functional individual. It is not an easy business because the biological processes are very complex, but each new advance in the understanding of the mechanism has an impact on the ability to make genetic improvement more efficient. Thus, we discovered that we could increase the frequency of mutation using chemical substances or radiation that acted on selective areas of the DNA. We also learned that certain tools borrowed from bacteria (the restriction endonucleases that they use to defend against viruses) could cut the DNA in specific sites, to then study the fragments obtained. We also discovered that some bacteria were able to transfer genes to plants, to alter their metabolism to their advantage. The machinery of this process is the one we still use in many transgene processes that lead to the so-called genetically modified organisms. At the same time, we increase our ability to sequence DNA (know exactly the entire sequence of nitrogen bases responsible for its information) and therefore we advance in the ability to associate sequences of nitrogen bases and phenotype (morphological or physiological characters measurable in the individual).

Finally, using tools borrowed from bacterial defence mechanisms (the CRISPR-Cas9 system and derivatives), we have managed to act in a controlled and timely manner on the areas of DNA we want. We have somehow achieved the ability to rewrite genes as we please.

Basically, all this road travelled means an increase in efficiency in our desire to obtain new plants (or animals) that meet our needs. Induced mutagenesis is a rudimentary way of generating variability, when through controlled crossbreeding we cannot get closer to our goals. Transgene allows us to increase efficiency in generating variability to the extent that it allows us to skip the reproductive barrier. We can transfer genes of interest between plants that be crossed because they are of different species. We can even introduce bacterial or animal genes into plants, to see if we can get them expressed in the plants. Finally, the rewriting of genes (genetic editing) brings us closer to the core of the matter: promptly modifying areas of the DNA, introducing or removing fragments, or changing base pairs. We have reached the rewriting of genes. Bacteria have achieved mechanisms of transgene and *cutting and pasting* of DNA fragments, simply by random mutations and the natural selection of individuals that obtained more resources to perpetuate themselves in a changing environment. It has taken them hundreds of thousands of years.

With the capacity to anticipate the results of our actions as we increase our knowledge, we take advantage of the previous work of the natural history of the earth, extremely rapidly. First, we take advantage of the crossings, then the mutagenesis, after that the endonucleases, of the transgene and finally of the punctual manipulation of the DNA. What is new and disturbing is not so much the growing technological capacity that we are acquiring at high speed, but how we are going to use it because we are unlikely to give it up. **This should be the subject of the debate.**

4. GENOMIC EDITING AND FEEDING

Genomic editing of plants of agricultural interest

In recent years we have seen a sharp increase in knowledge of the molecular bases of genetic characteristics that are important for food production. This is true in plants, but also in farm animals. Two methodological advances have been important in reaching this situation. On the one hand, there has been an exponential acceleration in DNA sequencing techniques that permits the approach to the knowledge of entire genomes very quickly and at low cost. On the other hand, there has been the development of methods that allow the modification of the genomes of plants and animals in a precise and directed way, what we call genomic editing. The opportunities that these advances open are indisputable. The way in which their use will be regulated, especially in Europe, is the subject of lively debate.

The first complete genome of a plant was published in 2000. It was the labor of a consortium of international laboratories for several years at a cost of hundreds of millions of euros. It was the genome of the *Arabidopsis thaliana* plant that became the preferred model for the study of the molecular bases of plant biology. It was also known that its genome was small, about 150 million base pairs, which is about 20 times smaller than the human genome whose sequence was published in 2001. The results demonstrated the importance of the data obtained in the identification of genes that are present in the genome of this plant (about 26000) and in its distribution throughout the DNA (Bevan, et al, 1998). Having the complete sequence of the Arabidopsis genome has become an essential tool in biological research. Genome sequencing work continued with other species, in particular rice, for which an international consortium was formed and was initiated in 1998 in Japan, but included Asian, American and European researchers.

The result of the work of this consortium was published in 2005. However, as early as 2002 two draughts of the rice genome produced had been published, one by a company and the other by a group of Chinese researchers indicating the new trends that would dominate this discipline in the following years.

Since 2000, the genomes of plant species that are of greatest interest have been published either for scientific reasons or for their applications in agriculture. The results have been accelerating due to the importance that its use shown in the improvement of plants, but especially because mass sequencing techniques have been developed which, together with the development of appropriate bioinformatics techniques, have reached levels of speed in sequencing and prices that can currently permit the proposal of projects that seemed unthinkable a few years ago. The data obtained give a view not only of the structure of the genomes and the comparison between different species, but also of how the genomes vary in large collections of genomes of varieties or individuals within the species. The emergence of publications with thousands of plant genomes is now common in international journals. All this allows the study of the molecular basis of the genetic variability of species, a key data for genetic improvement.

While the methodologies of DNA sequencing were reaching the levels that we have described, techniques for the targeted genetic modification of plants (Woo *et al.,*2015) were also being developed. In 1983 it had been shown that it was possible to transfer DNA fragments to plant genomes so that they acquired new characters which led to the production of transgenic plants in large crops that began to be planted massively from 1994. Its use was subject to strict regulations in different countries and especially in Europe in Directives adopted in 1990 and 2001. These include a scientific analysis of a set of data to ensure the safety of food produced from these plants. The cost of these analyses, worth millions of euros, has been a major barrier to the use of transgenic plants. One of the questions raised in these analyses is the possible appearance of unintended effects of modification that can occur in part by the random insertion of DNA fragments into the plant genome. For this reason, intensive research was carried out to try to find techniques that would more precisely ensure where the modification occurs. It is obvious that this issue arises in plants, but the same is true in the modification of the genome of animals without talking about possible applications in humans.

Targeted modification of genomes has been made possible by a set of technologies that have appeared in recent years, such as so-called mega nucleases, nucleases bound to zinc-toed proteins, the technique called TALENS and the one based on the **CRISPR-Cas9 system**. In all cases its function is based on detecting and cutting accurate DNA sequences in the genome. This can disrupt a gene and inactivate it, replace some DNA fragment, or get an external DNA inserted into a predetermined location in the genome. This may result in mutations in known genes or produce a modified plant with a lower risk of unforeseen effects (Nekrasov et al., 2013). Genomic editing methods have been expanding their possibilities of application, for example to modify dozens of genes at the same time, to carry out the modification without the need to introduce any DNA into the cell while appearing variants with new possibilities (Ma *et al*,2015). For this reason, genomic editing has aroused great interest among scientists for its uses in research and among improvers because they open up possibilities very accessible to the generation of new characters of agronomic interest.

The first question to arise is whether plants produced by genomic edition should be considered a type of transgenic plant with the consequences that arise from costs for approval or labelling of products for food uses (Voytas and Gao, 2014). Countries such as the United States, Argentina or Japan have already decided that these products should not be regulated in the same way as a GMO while in Europe a decision of the **European Court of Justice** has ruled that they should fall under the regulations provided for in these cases. The consequences of this decision for the use of such promising methodologies have produced an immediate reaction from the European scientific community to proposals to change European legislation or to be interpreted differently. The difficulties that may arise in Europe with strict enforcement of existing legislation arise when considering examples of the use of genomic editing that are already in the laboratory and existing projects to solve problems of the current agriculture (Casacuberta and Puigdomènech, 2018).

CRISPR/Cas9 technologies are revolutionizing the improvement of harvesting plants.

The ever-evolving CRISPR/Cas9-derived technologies offer efficient alternatives to the improvement of harvest plants and their fruits that are an important source of nutrients, vitamins and minerals. Some of these fruits such as dates, bread fruit, and especially bananas are staple foods in large areas of Asia, Africa and South America. For its part, tomato, which is the most important horticultural crop in the world, brings different micronutrients and vitamins to the diet. The largest tomato producer is China, which produces 50 million Tn out of a global total of 165 million Tn. It is not uncommon, then, that researchers and food companies are using these technologies to improve crops that are fundamental to **food safety**. The first work using CRISPR/Cas9 to edit a gene in tomato (argonaute7) was published in 2014. Demonstrated the good functioning of the technique, since then, numerous works have been published concerning the obtaining of plants resistant to abiotic stress (cold, heat and drought); (caused by viruses, bacteria or fungi); improvement in fruit quality (increased level of metabolites such as lycopene, anthocyanins, malic acid); changes in the color of the fruit (yellow, pink or purple); parthenocarpic fruits for the processing industry; longer-lasting fruits; fruits with a higher number of locules among other characteristics (Wang, T., *et al.* , 2019). A paper has even been published that shows that tomato domestication can be accelerated, a process that has cost to man several thousand years by simultaneously editing just four genes (Li, T., et al, 2018). Time will tell how these technologies contribute to the challenge of preventing the disappearance of banana crops.

The bananos

The World Food and Agriculture Organization (FAO) urges us to achieve **food security**, understood as the situation in which all people, at all times, have physical and economic access to sufficient safe nutritious food, to meet their food needs and preferences, in order to lead an active and healthy life. Among the staple crops to achieve food security are bananas, which are grown in all tropical and subtropical regions, constituting the fourth food crop after rice, wheat and maize. Bananos, including bananas and other cooking bananas, are essential for Food Security, especially in developing countries where subsistence agriculture is practiced. It is a crop mainly from Africa and Latin America, which occupies some ten million hectares with an annual production of one hundred million tons, and which is part of the basic diet of four hundred million people. Bananas that are cultivated are usually polyploids and reproduce asexually by taking advantage of shoots that grow from underground stems. It is a perennial crop and the bunches of bananas mature in a year. Asexual, clone, reproduction of commercial varieties excludes, in practice, classical improvement techniques based on mutagenesis and sexual crossbreeding.

Fungal diseases are a serious threat to banana cultivation.

The vegetative reproduction of elite plant varieties ensures the homogeneity of important food characteristics such as productivity and fruit quality. However, they generate populations of individuals that are also homogeneous in unwanted characteristics such as susceptibility to diseases. This is the case of bananas, which have already suffered from a devastating disease caused by *Fusarium oxysporum* f. sp. cubense (Foc race 1), called the Panamanian Mal, which devastated the banana plantations of the Gros Michel cultivar in South and Central America. This culture was replaced by another, called Cavendish resistant to this fungal race and which has become the worldwide majority, since it accounts for more than 40% of the world's production and almost all of the annual exports of bananas that are worth about eight billion dollars. In the early 1990s a new race of this fungus was detected in Southeast Asia, Foc tropical race 4 (TR4) which is lethal for growing Cavendish as well as for other minority cultivars. This race of *Fusarium* is destroying Cavendish plantations in Indonesia, Malaysia, China, Philippines, Australia and Mozambique. It has also been detected in countries such as Jordan, Pakistan and Lebanon. Recently the Colombian government has declared a national emergency after confirming the presence of a fungal disease that could be caused by the TR4 breed in American growing areas, so global banana production is at risk. More than 80% of the banana crops produced worldwide are susceptible to TR4, so it poses a direct threat also to Latin America and the Caribbean (Bermudez-Caraballoso, I., 2014). No fungicide has been found to allow a chemical control of the fungus which remains in infected soils for periods longer than thirty years, so it is urgent to obtain new resistant varieties.

The role of genomic editing to obtain disease-resistant bananas.

Through genetic engineering techniques using transformation systems mediated by *Agrobacterium* in recent years an increase in the micronutrient content of the fruit, a delay in their ripening or the incorporation of resistance to viruses, fungi and bacteria (Beltran, 2018; Naim *et .al*., 2018 and references cited) has been achieved. In order to develop genomic editing techniques based on the CRISPR/Cas9 system, these authors edited the exon 1 of the *Phytoeno desaturasa* gene (*Pds)* in the Williams cultivar of bananas Cavendish, very effectively achieving trialelic modifications that lead to the development of albinism and dwarfism as expected. These results open the door to the use of CRISPR/Cas9 technologies to generate desired mutations without introducing exogenous genetic material.

Classic enhancement techniques for obtaining TR4-resistant Cavendish Triploid Cultivar (AAA) plants are not usable as the variety is parthenocarpic, sterile and vegetatively propagated. The only chance of obtaining resistant bananas is to introduce genes into their genome that can provide that resistance. So far it has been possible to generate transgenic Cavendish plants with TR4 resistance in plantations analyzed in the field for three consecutive years (Dale *et. al.*, 2017). Two resistant lines were obtained, one expressing the *RGA2* gene and one expressing the *Ced9 gene. RGA2* is an isolated gene of a TR4-resistant diploid banana, while *Ced9* is a gene with anti-apoptotic activity isolated from the C. *elegans* nematode. Interestingly, in the Cavendish cultivar there are genes homologous to *RGA2* although they are expressed at a very low level. Dale and colleagues propose to use the CRISPR/Cas9 technology of genomic editing not to insert any gene into the banana stables but to achieve a much greater expression of RG*A2* homologues which should lead to obtaining the grow TR4-resistant non-transgenic Cavendish.

CRISPR/Cas9 technology more than a promise to improve bananas.

Banana cultivars are polyploid clones that derive from *Musa accuminata* (genome A) and/or *Balbisiana Musa* (genome B). If, instead of considering introducing resistance to diseases in a polyploid cultivar, sterile and reproduced vegetatively as is the case of Cavendish cultivation, we go to sources of diploid germplasm or triploids that may be useful in improvement programmes, we run into other kinds of problems. For example, the presence of banana streak *virus* (eBSV) in the B genome of the banana type known as plantain (AAB) is a challenge for obtaining and spreading hybrids, as under stressful conditions eBSV produces viral particles and the corresponding symptomatology. Thus, the use of the *Balbisian* Musa parents and their derivatives is excluded from improvement programmes as they have at least one genome B. Tripathi *et al.* (2019), have developed a CRISPR based editing strategy of the viral sequences that prevent the transcription of the virus into functional proteins. Thus, they obtained lines from the Plant Gonja Manjaya with mutations in the chosen locations of the eBSV sequence. Up to 75% of the edited genes produced plants that remain asymptomatic under water stress conditions reversing their ability to become infectious viral particles. It is worth to recall here that Tripathi and colleagues are doing their work at the Institute of Tropical Agriculture in Nairobi in Kenya, demonstrating that genomic editing technologies can be implemented in laboratories in developing countries to deal with food emergencies.

5. LEGAL RISKS RELATING TO THE DEFINITION, NAME AND CATEGORIZATION PROVIDED BY THE GENOMIC EDITION TECHNIQUES

The position of scientists on the genetic identity of plants produced by new genomic editing techniques in relation to their definition in categorization and labelling is explained in point 4 of this document. Although scientifically accepted the difference between the classic concept of Genetically Modified Organisms and that of “gene editing”. It is necessary to specify, given the complexity of the subject, the nuances that refer to social or economic aspects, to clarify and avoid confusion, in the errors of such categorization.

In addition to ensuring the safety and innocuousness of food, one of the fundamental principles of food legislation is the correct information to consumers. In this sense there are numerous sentences of the **Court of Justice of the European Union** (CJEU) in which not only the violation of the principle of veracity is considered illegal, in the sense of granting qualities of excellence to a product that does not have them, but on the contrary, using denominations or categorizations that suppose a lessening of the consumer's perception of the quality level, qualities or characteristics of the product [see, for example, the CJEU sentences "Chocolate substitutes" (Spain) and "Pure Chocolate" (Italy) , both of 2003].

In this same sense, the sentence "Cassis de Dijon", which enshrined the principle of mutual recognition, dealt especially with the denomination of the products, when it could be detrimental to the consumer's appreciation of the product in question.

U.S. food legislation is also based fundamentally on the same principles of veracity and protection of the authenticity of the product, **safeguarding from pejorative denominations or categorizations**; and it has been with this approach that a decision has already been made on the vegetables obtained by genomic edition (CRISPR techniques). Also, Japan as well as other countries, has aligned with this legal orientation.

It is obvious, then, that to qualify or include products in a category that could have a directly or indirectly pejorative or unjustifiably negative character to genomic edition products (CRISPR and others) would constitute a **violation of the principle of veracity and legal certainty**, insofar as It could potentially and negatively influence consumer perception. In addition, the EU Regulation on unfair commercial practices precisely prohibits such infringements, if they can influence the purchasing decision of the customer who acquires services or products, including, of course, food products.

In addition, by reducing the range of products that the **consumer** may be willing to buy, it also **influences negatively and disadvantageously** a very important principle in the food sector, which is to offer a wide range of products in all links of the food chain. The accessibility to products, so that the availability of food (Food Security) and, in a broader sense, the credibility of the scientific community and of the administrations responsible for food safety (Food Safety) is then guaranteed.

Unfortunately, in the EU, and specifically in an answer to a relevant written question on this matter, (Nov/7/2019), the acting Commissioner Mr. Andriukaitis stated: "The Commission would like to clarify that there are no plans to put forward new legislative proposals concerning the legislation on GMOs under the current College of Commissioners ".

However, it is to be hoped that this work will continue with the support of science and technology, in the challenge of offering safe food of good quality in sufficient quantity to the entire population, with the approach of a sustainable global food system, based on citizen confidence, through appropriate information.

6. CONCLUSION

Genomic editing technologies derived from CRISPR/Cas9 are demonstrating **great potential** to face challenges that question Food Security in a world whose population will continue to grow to more than 10 billion people towards the end of this century. We have taken the example of bananas as a paradigmatic by being part of the basic diet of many millions of people in developing countries. However, since 2014 numerous publications have appeared in scientific literature that make important advances in the use of genomic editing to develop tolerance to biotic and abiotic stresses in other species cultivated in tropical areas such as cassava, cocoa, cotton, rice or wheat (Haque, E., *et*al., 2018 and wheat references included). Some of these challenges need quick answers that, as we have seen, CRISPR/Cas9 technology can provide. To do this, it is necessary, as the **scientific community claims**, that plants obtained by the CRISPR/Cas9-mediated genome editing leading to the elimination of unwanted genes or DNA sequences, which in many cases are identical events to those that occur in nature**, are not considered to be transgenic plants.**

Finally, in accordance with the progress made in disciplines such as nutrigenetics or nutrigenomic, in mass sequencing techniques, and in **genome-editing techniques**, we can be optimistic about a biotechnological future to support Food and **Food Security**. For this to be possible, significant socio-economic, regulatory, political and ethical changes must occur.

The food challenges of the 21st century can only be faced with the minimum of guaranties with focus on a **sustainable global food system**, taking into consideration the availability of food, the economy, politics and the support of science, technology and responsible business activity.

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