FREQUENTLY ASKED QUESTIONS

BIOTECHNOLOGY

AND ITS APPLICATIONS
WHAT IS BIOTECHNOLOGY?
Biotechnology is a modern technology that makes use of organisms (or parts thereof) to make or modify products; improve and develop microorganisms, plants or animals; or develop organisms for specific purposes in a more precise manner.

Tools of biotechnology can be used to make products for agricultural, industrial, medical, and environmental applications.

HOW IS BIOTECHNOLOGY DIFFERENT FROM THE TRADITIONAL WAY OF IMPROVING CROPS?
Biotechnology allows scientists to precisely introduce a desired character by being able to insert only specific genes into a plant. Traditional crop improvement entails a long process of hybridization and selection. It involves numerous combinations of traits that require a large population to be able to select a plant with the desired trait.

WHAT IS THE SCIENTIFIC BASIS OF BIOTECHNOLOGY?
All plants, animals, and living organisms have cells, the basic unit of life. Within cells are hereditary materials generally composed of deoxyribonucleic acids (DNA). These hereditary materials (that determine a trait) are called genes. Through biotechnology, the gene fragments can be inserted from one organism to another, within related and unrelated species, to improve specific traits.

WHAT ARE THE TOOLS USED IN BIOTECHNOLOGY?
- **Gene Cloning** - identification and isolation of specific DNA fragments that are introduced into a self-replicating genetic element so that the fragment can be reproduced and expressed in the target organism.
- **Tissue Culture** - a technique that involves culturing plant parts and animal cells under laboratory conditions.
- **Microbial culture** - a method of multiplying microbial organisms.
- **DNA-marker technology** - involves the identification of DNA fragments associated with a certain desired trait and its utilization.
- **Genetic Engineering** - the manipulation, introduction, and expression of specific genes or DNA in the target organisms. This is the method used in developing genetically modified organisms (GMOs).

WHY DO WE NEED CROP BIOTECHNOLOGY?
To be able to develop crops with increased yield; improved food, nutrient and other agronomic qualities; multiple disease and insect resistance; and tolerance to abiotic stresses in a short and precise manner.

BIOTECHNOLOGY
is a modern technology that makes use of organisms (or parts thereof) to make or modify products; improve and develop microorganisms, plants or animals; or develop organisms for specific purposes in a more precise manner.
WHAT IS A GM/BIOTECH CROP?
A GM/biotech or transgenic crop is a plant that has a novel combination of genetic material obtained through the use of modern biotechnology.

HOW ARE NOVEL GENES INSERTED INTO PLANTS?
Several methods currently exist for introducing transgenes into plant genomes. The most commonly used involves a device called biolistic or gene gun. The DNA to be introduced into the plant cells is coated on to tiny gold or tungsten particles. These particles are then physically shot into plant cells. Some of the DNA comes off and is incorporated into the DNA of the recipient plant.

Another method uses the bacterium Agrobacterium tumefaciens to introduce the gene(s) of interest into the plant DNA through transfection. The cells are screened to identify which successfully took up the desired gene and are then evaluated for the expression of the new trait. When crops reach the field stage, the seeds are sown in the field and grown the same way as any other crop. These plants just have the new and desired trait.

WHY MAKE GM/BIOTECH CROPS?
GM technology can address problems that cannot be solved through conventional crop improvement methods. It enables plant breeders to bring together in one plant useful genes from a wide range of sources, not just from within the crop species or closely related plants.

This powerful tool allows plant breeders to attain a desired trait combination faster and address urgent concerns like the development of crops that are resistant to biotic (diseases and pests) or abiotic stresses (drought and waterlogging), and with increased yield and improved food and nutrient quality.

HOW DO YOU SELECT THE VARIETY OF CROP TO BE IMPROVED?
Popular varieties are selected to be the target of crop improvement through genetic engineering. These varieties are already being widely planted and accepted by the farmers but needs improvement in one or more characters.

WHO PRODUCES GM CROPS?
Early generations of GM crops were developed in industrialized countries mainly in North America and Western Europe. Recently, many research and development on GM crops are being done in developing countries, like the Philippines, which have established the capacity for genetic engineering.
WHAT WERE THE FIRST GM/BIOTECH PLANTS?
GM petunia and GM tobacco were produced in 1983 in laboratories in the USA and Belgium.

WHEN WAS THE FIRST GM/BIOTECH CROP COMMERCIALIZED?
In 1994, Calgene’s delayed-ripening tomato (Flavr-Savr™) became the first genetically modified food crop to be produced and consumed in an industrialized country. In 1995, GM cotton with resistance to herbicide and GM corn with insect resistance were subsequently commercialized. GM corn is now planted in developing countries like the Philippines.

WHAT ARE THE GM/BIOTECH CROPS AVAILABLE IN THE MARKET?
Most of the GM crops currently in the market have an increased level of crop protection through the introduction of resistance against plant pests and diseases caused by insects, viruses, or other pathogens. Others have an increased tolerance towards herbicides.

Insect resistance is achieved by incorporating the gene for toxin production from the bacterium *Bacillus thuringiensis* (*Bt*) into the crop. This bacterium has been widely used as conventional microbial insecticide in agriculture since the 1930s.

GM crops that permanently produce this toxin have been shown to require lower quantities of insecticides in specific situations, e.g. where pest pressure is high. Several Bt corn varieties are already propagated and marketed in the Philippines.

Virus resistance is achieved through the introduction of a gene from certain disease-causing viruses. Virus resistance makes plants less susceptible to these viral diseases, minimizing damage to the plant and resulting in higher crop yields. Papaya ringspot virus resistant papayas are already being cultivated and consumed in the USA and China.

Herbicide tolerance is achieved through the introduction of a gene from a bacterium conveying resistance to some herbicides. This allows herbicides to be used to control weeds without harming the crop. Herbicide tolerant soybean is the most planted GM crop in the world. Around 75% of the global area devoted to soybean is planted to GM soybean.

WHERE ARE GM/BIOTECH CROPS GROWN?
The area planted to GM crops increased from 1.7 million hectares in 1996 to over 185.1 million hectares in 2016, making biotech crops the fastest adopted crop technology in recent times.
In 2016, there were 26 countries planting biotech crops, comprised of 19 developing countries and 7 industrial countries. They were, in order of hectareage, USA, Brazil, Argentina, India, Paraguay, Pakistan, China, South Africa, Uruguay, Bolivia, Australia, Philippines, Myanmar, Spain, Sudan, Mexico, Colombia, Vietnam, Honduras, Chile, Portugal, Bangladesh, Costa Rica, Slovakia, Czech Republic (ISAAA, 2016).

In the Philippines, the genetically engineered corn resistant to borer insects was first commercially planted in 2003. In 2016, the area planted to biotech maize in the Philippines increased to 812,000 hectares from 702,000 hectares in 2015 (ISAAA, 2016).

WHY ARE GM/BIOTECH CROPS NOT GROWN IN SOME PARTS OF THE WORLD?
Reasons why some countries do not grow GM crops may be as follows: the absence of a biosafety regulatory framework, public non-acceptance of GM products, and trade issues relating to organic farming.

WHAT ARE THE BENEFITS OF GM/BIOTECH CROPS?
Among the documented benefits of GM crops include:
- Higher crop yields
- Reduced farm costs
- Increased farm profit
- Improved health, and cleaner and safer environment
- Improved soil quality

ARE GM/BIOTECH CROPS APPROPRIATE FOR DEVELOPING COUNTRIES?
Developing countries can benefit from GM crops by being able to increase food production, lower production cost and food prices, improve food quality and preserve the environment. The new generation of nutritionally enhanced GM crops could also play a key role in helping alleviate micronutrient malnutrition and generate affordable and accessible pharmaceuticals and vaccines for many developing countries.

WHAT ARE THE OTHER POTENTIAL BENEFITS/USES OF GM/BIOTECH CROPS?
Food production - this is an area where biotechnology plays a significant role in the production of ingredients, vitamins, starter cultures and enzymes for food processing.

Agriculture - fruits and vegetables can be improved in appearance, taste, nutrient content, storage life, resistance to certain pests and even stability under unfavorable climatic conditions.
Environmental management - biotechnology offers new opportunities for the protection of the environment. For example, genetically modified bacteria may one day be used to convert organic wastes to useful products or clean up oil spills.

Medicine - some types of insulin are examples of biotechnology products. Biotechnology also offers new methods for producing critical vaccines at a lower cost.

WILL GM/BIOTECH CROPS WIPE OUT AND REPLACE VARIETIES FROM TRADITIONAL BREEDING?
No, GM crops will not replace varieties from traditional breeding because genetic modification is only conducted to introduce important genes to the already established and bred varieties.

Genetic modification, therefore, is conducted to further improve the already existing popular and high-yielding varieties.

Likewise, a transgenic variety can be used in crop improvement and breeding programs.

WHY ARE GM/BIOTECH FOODS ASSESSED DIFFERENTLY FROM TRADITIONAL FOODS?
With GM foods, most national authorities consider that specific assessments are necessary. Similar evaluations are generally not performed for traditional foods. Hence, there is a significant difference in the evaluation process prior to marketing for these two groups of food.

Generally, consumers consider that traditional foods (that have often been eaten for thousands of years) are safe. When new foods are developed by natural methods, some of the existing characteristics of foods can be altered, either in a positive or a negative way.

National food authorities may be called upon to examine traditional foods, but this is not always the case. Indeed, new plants developed through traditional breeding techniques may not be evaluated rigorously using risk assessment techniques.

Reference:

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Updated June 2017