DA Highlights Biotech Applications

Plant Breeding: Traditional and Modern Biotechnology Techniques

Traditional plant breeding techniques have had a long history in the Philippines. A largely agricultural country, Filipino farmers have often used this method which employs visual examination to identify crops that manifest target attributes such as resiliency to adverse weather and environment conditions, high productivity, and disease resistance. Such qualities are useful for farming production and efficiency and the best of such crops are then subjected to interbreeding until the method begins to produce a new variety of crop that contains the best qualities of its progenitors.

Such traditional techniques, however, often carry their own drawbacks. Results can take somewhere between 5 to 30 years and involve a more arduous and unpredictable process. Modern agricultural biotechnology offers a more efficient and precise breeding technique. Manipulation for gene insertion or introduction occurs at the molecular level and thereby increases the likelihood of desired trait manifestation. Production of the resultant crop, described as "genetically modified", is at 3 to 5 years.

Bt corn is one example of a genetically modified crop developed in order to counteract damage that corn borers can inflict. It takes a gene from a soil bacterium, *Bacillus thuringiensis*, which acts to protect the corn by producing a protein that kills off corn borer larvae that eat the corn. The first GM crop to be commercialized in the country, *Bt* corn is a key ingredient in poultry and livestock feeds.

Akin to the *Bt* corn are the *Bt* eggplant and *Bt* cotton, GM crops that have been similarly fortified to be proof against their pests. The long shelf-life and PRSV-tolerant papaya is another crop strengthened with virus resistance and delayed ripening characteristic. Golden rice is beta carotene-enriched in order to help correct for Vitamin A deficiency. The *Bt* eggplant, *Bt* cotton, virus-resistant papaya and golden rice are currently in the pipeline. Another rice variety known as 3-in-1 Golden Rice, which has beta carotene in addition to

resistance to tungro disease and bacterial blight, is under development.

Diagnostic Technologies

Diagnostic technologies for plant disease and pathogen detection are very important for the containment of the spread of diseases and infestation and the timely activation of a disease management system. Examples of biotechnological diagnostic technologies for the detection of diseases and/or pathogens include the LAMP technology for rice virus detection, the detection of *fusarium* species in white corn through PCR, the detection of black sigatoka in banana through PCR, and the detection of *salmonella* in vegetables.

Livestock Breeding Artificial insemination is a technique that involves the manual impregnation of the female animal in livestock. It is commonly used to avoid risks that may arise in natural mating, such as male animal aggression or failure of reproduction due to infertility. As a breeding technique, it is considered to be a safe method that mitigates the propagation of disease, enhances production efficiency, and allows for facilitated improvement of genes. In the Philippines, it has been used in swine, carabao and poultry.

Marker-assisted breeding, on the other hand, is a selective breeding strategy that utilizes gene markers to effect rapid gains in making genetic improvements appear in livestock. This technique may be quite beneficial where target genes may be low in heritability and problematic to measure. Examples of diagnostic technologies being used for livestock include *salmonella* detection in raw meat, meat products and foot and mouth disease kit for swine. The latter was developed by the Philippine Carabao Center.

Applications for Climate Change Adaption and Mitigation

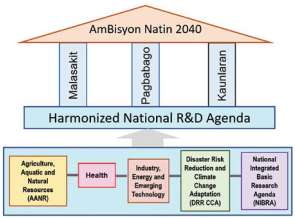
Molecular marker technology has helped develop breeding lines of drought-tolerant eggplant with the view toward establishing a breeding program. Another identified for potential is the tomato-leaf-curl-virus-resistant breeding lines of tomatoes.

DNA Fingerprinting and Barcoding

DNA fingerprinting and barcoding for gene banking have been performed on the following for gene banking, authentication and traceability and for use by regulatory agencies: the grouper, crustaceans, mollusks, and the CITES-listed and regulated Philippine aquatic species. Others include sea cucumber, tilapia, water buffaloes, etc.

Value-Adding Technologies

Value-adding technologies generated through traditional biotechnology methods add more value to traditional agricultural products. These include, for example, waste byproducts reused or recycled to create another product, generating even more income and satisfying niche market demands.Example of value-adding technologies currently in the market include microbial rennet, enzyme-extracted essential oils like citronella and turmeric, and vamrich. The ones in the pipeline include taro wine with pigmented rice and probiotic guava leaf drink.



Biotechnology in the National Harmonized R&D Agenda

The Department of Science and Technology (DOST), in consultation with government and private research and development institutions, the academe, industry, civil society, and other stakeholders, drew the Harmonized National Research and Development Agenda (HNRDA) 2017-2022 as a guide to investment in research, ensuring that science, technology and innovation are utilized for maximum economic and social benefits of the Filipinos.

Biotechnology as a research agenda is embedded across sectors, a platform technology that aims to improve human health, create better crops, assist in the manufacture of specific enzymes for cheaper and efficient drug development, among others. Some of the biotechnology researches supported by the sectoral Councils of the DOST are as follows:

The Philippine Council for Health Research (PCHRD) funded Biotek-M, a dengue diagnostic kit that uses polymerase chain reaction to provide quick and accurate diagnosis. The

researcher has put up a spinoff company which recently bagged a contract from the Department of Health to supply three regions of the country with the kits.

The Philippine Council for Industry, Energy and Emerging Technology Research and Development's (PCIEERD) supported research on colorants derived from red yeast rice to help develop a more sustainable, safer, and cheaper replacement for artificial dyes. Studies and trials are still ongoing to ensure safety in consumption of the products containing the said dyes

Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) has studies on genomics of aquaculture products such black tiger shrimps and mangrove crabs; and agriculture commodities such as rubber, cacao, and coffee which help improve quality and create better yields. The genomic studies are focused on using molecular markers toward assisted selection, molecular breeding of varieties, creating hybrids, and mapping populations.

National Research Council of the Philippines' (NRCP) actinomycetes research that look into antiobotic, antitumor, and immunosuppressive properties found in the mangrove-dwelling microbe. They are currently utilizing the study through the formulation of an antibiotic cream, ointment, or injectible that would use the bioactive compound from the actinomycetes to treat mastitis in dairy cattle.

From Brown to Green: How DENR uses biotechnology

As the research bureau of Department of Environment and Natural Resources (DENR), Ecosystems Research and Development Bureau (ERDB) conducts different research activities to help protect and preserve our environment. ERDB takes advantage of the plant-microorganism relationships in developing biofertilizer that are useful to produce quality planting materials.

Combatting deforestation

One of the problems that our country faces today is deforestation. DENR exerts an effort to raise awareness on

the importance of our forests and trees in the environment. The Department also strictly implements the policy on cutting trees and urges planting especially on degraded areas.

To support the DENR in this endeavor, ERDB developed a biofertilizer called Hi-Q VAM 1. It is a fungus that attaches to the roots and serves as extensions that help plants better absorb water and makes plants healthier and immune to diseases. Hi-Q VAM 1 is applied only once on the seedlings. Once it penetrates to the roots, this biofertilizer will continue to multiply. ERDB developed this technology to produce quality planting materials of indigenous forest trees that are being used for reforestation activities- one of these is the National Greening Program or NGP.

Hi-Q VAM 1 can also be used in agricultural crops. The Bureau conducts technology forum on this biofertilizer which is being attended by different people's organizations (PO) from different parts of the country. The members of the PO are usually farmers, which is being informed by the Bureau on the importance of planting indigenous trees aside from their crops.

Clonal Propagation for quality planting materials

It is important that the plants that we use in rehabilitation sites are good quality, thus, ERDB implements clonal propagation. Clonal propagation is being done through stem cuttings harvested from the mother trees or trees that carry good characteristics. Stem cuttings are the harvested vertically grown shoots after the mother tree was detopped. They are rooted in sterilized rooting medium for two to four weeks and applied with Hi-Q VAM 1. Clonal propagation is another effort of ERDB to produce quality planting materials for rehabilitation purposes.

DENR also faces the challenge of rehabilitating mining sites. ERDB conducted phytoremediation in Itogon, Benguet and Bagacay Mines, Hinabangan, Samar. Trees were planted to absorb heavy metals in the soil in mining areas. Indigenous trees like narra, kupang, batino, Benguet pine, and agoho that absorb heavy metals were applied with Hi-Q VAM1 and planted in mining areas in the said ERDB research sites. Today, there are now trees growing in these barren areas.

As the DENR explores biotechnology, its uses and potentials in environmental protection and conservation are being discovered. ERDB continues to engage in different research activities to promote this kind of discoveries to contribute in sustainable development of the country.

The Philippine FDA and Health Biotechnology Products

The Philippine Food and Drug Administration (FDA) is in charged with regulating health products in the country.

Biotechnology has always been at the forefront in the development of the Philippine health care delivery system, as well as the growth of the various sectors of industry it regulates, namely includes food processors, including food supplements and additives, pharmaceuticals, and cosmetics, medical devices and health-related devices, and household/urban hazardous substances, including urban pesticides.

The health and well-being of the Filipinos, as well as the quality of life, in the country is dependent on the availability and access of consumers and patients to health products manufactured in other countries, as well as locally. The pharmaceutical industry is valued at around USD 2.7 billion (2011). The processed/prepackaged food and beverage industries based on the 2012 output only is valued at USD 11 billion. The cosmetic industry is valued at USD 3.2 billion (2011). The medical device industry is valued at USD 77 million in 2012, excluding USD 24 million of exported products.

More than 50% of the family expenditure of an average Filipino family (2015) is spent on health products regulated by the FDA.

The FDA was created in 1963, and ever since it approved several life-saving health products, such as antibiotics and antimicrobials to control infectious diseases, chemotherapeutics agents against cancers and hormones to treat metabolic diseases. These health products have improved the quality of life of patients, and improved the mortality and morbidity profile of the Filipino population. It was during this era when vaccines and

biologics against highly communicable diseases were used in mass vaccination against smallpox, tuberculosis, tetanus, poliomyelitis, pertussis, mumps, and German measles. The aggressive global vaccination campaign led to the eradication of smallpox in 1980. Polio will be eradicated soon, and it survives only among the world's poorest and most marginalized communities.

The FDA Philippine is one of the first regulatory agencies to approve the first recombinant (r) DNA Human Insulin, a hormone to control blood sugar level, in mid-1980s. It also approved the first rDNA Human Erythropoietin (Hiamulin) for kidney patients to stimulate the production of red blood cells. The first anti-liver vaccine, the rDNA Hepatitis B vaccine, was approved in mid-1980s. In the mid-1990s, the FDA approved a recombinant bovine growth hormone (rBGH). FDA also approved a protein derived from botulinum toxin, Botox, which counteracts the typical effects of Bell's palsy, which may include weakness and uncoordinated movement of the face. Botox is now used for temporary smoothing of glabellar lines or wrinkles.

To ensure safe, effective and good quality health products, the DOH-FDA instituted the Pharmacovigilance Unit and Vaccine-Preventable Diseases Surveillance Unit.