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Reinventing the Green Revolution: How Biotech Crops Changed the Global Agriculture Landscape?

Asia's Trailblazer: The Success Stories of Biotech Crop Adoption in the Philippines

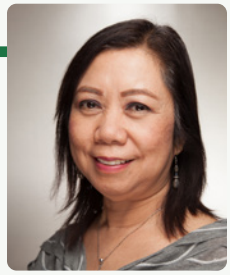
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Welcome Message



Welcome to the maiden issue of *Pinoy Biotek Magazine!*

After nearly three decades of the International Service for the Acquisition of Agri-biotech Applications Inc. (ISAAA Inc.)'s engagement with various stakeholders on global agricultural biotechnology in print, online, onsite, and social media platforms, our focus now is on homegrown biotechnologies, hence, the name, Pinoy Biotek. We, at the ISAAA Inc., consider this publication a dream come true.

Since the biotech program at the Department of Agriculture (now named DA-Philippine Agriculture and Fisheries Biotechnology Program) was established 23 years ago, various technologies and products have been developed but have not reached the target beneficiaries. Thus, the overarching objectives of this publication are to serve as a venue to bridge the knowledge gap among various stakeholders, communicate biotech products that are ripe for commercialization to attract industry takers, and disseminate information on the biosafety of conventional and modern biotechnology products in order to move approvals and adoption in the country.

In this maiden issue, which is the first of four, we are featuring the Philippines' pride as follows: (a) products of modern biotechnology (Golden Rice, Bt eggplant, and Bt cotton), and (b) conventional biotechnology (Mudfish spawning and Biomeg). The issue also highlights the scientists behind these technologies. The DA Biotech Program Office (BPO) scholars' chosen field of expertise and hopes for a biotech Philippines are also presented in this magazine.

We invite readers and other proponents to reach out to us if you wish your technologies to also be featured in our magazine. Through our concerted efforts, we hope to bring the technologies to their primary target–the Filipinos– and contribute to food security, sustainability, and climate change resiliency.

Finally, I would like to thank the ISAAA Inc. team, the invited writers, and the project leaders, for skillfully collating the excellent knowledge content of this magazine. We also express our sincerest gratitude to the DA BPO for the funding support and for believing in ISAAA, Inc.

Dr. Rhodora Romero-Aldemita
Executive Director, ISAAA, Inc.
Director, Global Knowledge Center on Biotechnology

Director's Message



The Pinoy Biotek Magazine is a joint collaboration of the Department of Agriculture (DA) Biotech Program Office and the International Service for the Acquisition of the Agri-biotech Applications (ISAAA) Inc.. Our shared vision is to develop a magazine that will feature local biotechnology research initiatives, locally-developed biotechnology products supported by the Program, and the diverse advocacy, outreach, and policy efforts that support the advancement of agricultural biotechnology in the country.

Created in 2000 through the Agriculture and Fisheries Modernization Act, the Philippine Agriculture and Fisheries Biotechnology Program or the DA Biotech Program is a special program of the Department of Agriculture.. It was formed to foster an enabling environment for the responsible utilization of biotechnology as one of the tools to improve productivity, achieve and sustain food security, and enhance resilience to climate change.

The Pinoy Biotek Magazine will underscore the remarkable strides of agricultural biotechnology, especially in its pivotal role in ensuring food affordability and availability for every Filipino. The first issue of the magazine will cover the status of biotechnology from global to local perspective, the different genetically modified (GM) crops and approvals in the Philippines, locally developed GM crops in the country and their current status, and the use of traditional biotechnology to produce and improve products for crops and fisheries. It shall also feature success stories of scholars supported through the DA Biotech Program Office.

At this point, I would like to express my gratitude to the dedicated team of writers, researchers, and editors who have worked diligently to contribute and curate the first issue of the Pinoy Biotek Magazine.

Dr. Claro Mingala
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PINOY BIOTEK MAGAZINE

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Reinventing the Green Revolution: How Biotech Crops Changed the Global Agriculture Landscape?

BY KAYMART GIMUTAO

According to the Food and Agriculture Organization (FAO), the status of food security on the planet is still a major global concern, even worsened by major challenges, such as the pandemic, dramatic land use conversions, economic shocks, and the climate crisis. The World Food Program reported that in 2023, more than 345 million people are experiencing significant levels of food insecurity in 79 countries where data are available.

The looming crisis of food insecurity is a serious global concern, yet the promises of modern techniques in plant breeding are yet to be optimized. Modern breeding techniques, or genetic engineering, involve the alteration of genetic material (DNA) of a species through a technique that primarily entails the specific modification of DNA, including the transfer of a specific gene from one organism to another.



As of 2019, biotech crops were cultivated by up to 17 million farmers in 29 countries, covering around 190.4 million hectares of agricultural land. This makes biotech crops the fastest-adopted crop technology in the history of modern agriculture since the first biotech crop's commercialization in 1996. The 24 developing countries comprised 56% of the total land area devoted to biotech crops, while the remaining five industrial countries took the 44% share.

For more than 25 years that biotech crops have been commercialized, overwhelming evidence of the benefits of this technology has been documented, such as the increase in yield and income of the farmers who adopted the technology, improved mental health of farmers, reduced carcinogenic compound within the crops, and the significant reduction of the greenhouse gasses (GHGs) emission by the agriculture sector.

The safety of biotech crops is carefully and rigorously evaluated by the countries that have adopted the technology through their national biosafety regulatory frameworks. These frameworks are also guided by multilateral policies, such as the *Cartagena Protocol on Biosafety* and the *Nagoya Protocol on Access to Genetic Resources.*

The potential of crop biotechnology is close to limitless, from varieties that can fight malnutrition to ones that can withstand the adverse impact of the climate crisis. This opens a big opportunity to combat the seemingly perennial problem of food insecurity and finally achieve the second Sustainable Development Goal (Zero Hunger) by 2030.

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Asia's Trailblazer: The Success Stories of Biotech Crop Adoption in the Philippines

BY KAYMART GIMUTAO

The Philippines is one of the pioneer countries in Asia to adopt biotech crops and the first in Southeast Asia to issue regulatory frameworks on genetically engineered (GE) crops for cultivation and consumption. Almost two decades after the commercialization of biotech corn, two new biotech crops, the Golden Rice and Bt Eggplant, were approved for commercial planting in 2021 and 2022. In total, the country has approved 64 biotech maize events for commercial planting and granted approvals for food, feed, and cultivation of 129 events for nine biotech crops in the Philippines.

In terms of the land area devoted to biotech crop cultivation, the Philippines ranked 12th among the 29 countries in the world that planted biotech crops in 2019. This is equivalent to 875,000 hectares of agricultural land that caters to biotech corn, which is an increase of 39% or roughly 245,000 hectares from the past year's farmed area. A surge of 12% in the adoption rate of biotech corn between 2018 (50%) and 2019 (62%) was also recorded, following good global prices and increasing feed demands for local consumption.

Since the first cultivation of biotech corn in the country in 2003, its farming areas and the number of farmers-adopters have increased exponentially. From 2003 to 2021, the areas devoted to biotech corn cultivation increased by an average of 31.24% annually. This has benefitted more than 673,000 smallholder farmers (with an average of 1.3 hectares farm size) and their families.

Benefits derived by the farmers from planting biotech crops include increased income, biotech corn's good physiological and physical traits, high quality and volume of harvests, and fewer expenses for labor and pesticide. On a macroeconomic level, biotech corn adopters in the Philippines earned around US$872.6 million cumulatively from 2003 to 2018.

Other biotech crops in the country that are in the pipeline include Bt cotton,



a project developed by the Philippine Fiber Development Administration through the technology provided by Nath Biogene Ltd. and Global Transgene Ltd. from India, the Biotech Papaya with delayed ripening and papaya ringspot virus (PRSV) resistance, a project aimed at providing farmers flexibility in selling their goods and ensuring consumers of "fresh-from-the-garden" produce. The Philippine Government has also started developing regulatory frameworks for GE animals and other beneficial products that can be derived through innovative biotechnologies.

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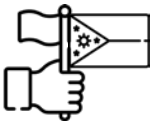
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Facts About Biotech Crops in the Philippines

The Philippines is a pioneer biotech crop-planting country in Southeast Asia.



The country was the first in Southeast Asia to approve Bt corn for commercial planting in 2002 and has become a model for science-based and thorough regulatory policy in the region. In 2019, the Philippines was one of the 14 countries in the world that planted biotech corn.

The first Bt corn that was approved for planting in the Philippines is MON810.



MON810 is resistant to the Asiatic corn borer, a pest that eats its way into a corn ear, destroys the tassels, and eats other parts of the plant as a larva. Now, there are 64 biotech corn events approved in the Philippines with resistance to insect pests and tolerance to herbicides.

Since 2003, the adoption rate of biotech corn has increased consistently year after year.

The Philippines ranked 12th among the 29 countries that planted biotech crops in 2019 with a total area of 875,000 hectares dedicated to biotech corn. It has retained the biotech mega-country status which it held since 2004 for planting 50,000 hectares or more of biotech crops.

Aside from GE regulations, the Philippines has also established regulations for plants and plant products derived from plant breeding innovations (PBIs).



The rules, marked as Memorandum Circular No. 8, Series of 2022 (MC8), provided a science-based and efficient process for the assessment and determination of gene-edited plants if they are to be considered genetically engineered (GE) or not.

Two more biotech crops were recently approved for commercial planting in the Philippines.



Golden Rice, developed by the International Rice Research Institute (IRRI) and the Department of Agriculture Philippine Rice Research Institute (DA-PhilRice) is a rice variety genetically engineered to contain additional levels of beta-carotene, which the body converts into vitamin A. Golden Rice was given approval by the DA-Bureau of Plant Industry (DA-BPI) on July 21, 2021. In early 2023, more than 100 tons of Golden Rice were harvested in 17 pioneer production sites across the country.

The other biotech crop that recently got approval for planting is the fruit and shoot borer resistant eggplant or Bt eggplant.



Developed by the Institute of Plant Breeding (IPB) at the University of Philippines Los Baños (UPLB), Bt eggplant contains a natural protein from the soil bacterium *Bacillus thuringiensis* which makes it resistant to eggplant fruit and shoot borer (EFSB), the most destructive pest of eggplant. The DA-BPI granted the biosafety permit for the commercial planting of Bt eggplant on October 18, 2022, making the Philippines the second country in the world after Bangladesh to allow the commercial propagation of Bt eggplant. Following the approval, priority activities included seed production, varietal registration, and farm demonstrations. Concurrent with these activities, an extensive growers' education program will also be launched in 2023.

A total of 9 crops and 129 events are approved for food, feed, and cultivation in the Philippines.

The crop with the most approved events is maize (64 events). The other biotech crops available in the country are soybeans (24 events), cotton (16 events), potato (11 events), Argentine canola (6 events), alfalfa (4 events), rice (2 events), eggplant (1 event), and sugar beet (1 event).

The Philippines is the first country in the world to approve Golden Rice for commercial planting.



Golden Rice, now popularly known as Malusog Rice in the country, was approved for commercialization in July 2021. Aside from the Philippines, Golden Rice has already received food safety approvals in Australia, New Zealand, Canada, and the United States of America. Golden Rice is still undergoing regulatory review in Bangladesh.

The Philippines has an up-to-date regulatory policy for importation, handling and use, transboundary movement, release into the environment, and management of genetically engineered (GE) plants and plant products derived from the use of modern biotechnology.



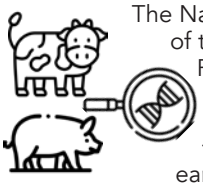
The 2016 joint department circular (JDC) was revised to improve the bureaucratic process and speed up the approval of biotech crops, which is necessary for meeting the food and feed needs of the country. After reviewing the JDC in 2021, amendments were approved and implemented in March 2022.

Filipino farmers and their families enjoy the benefits of planting biotech corn.



The immense economic gains continue to benefit more than 673,000 Filipino farmers and their families in the last 20 years of commercial planting of biotech corn in the country.

The draft policy and regulations on animal biotechnology are under review.



The National Committee of the Biosafety of the Philippines targets to release the final guidelines before the end of 2022 or early 2023.

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Unang Ani: Celebrating Malusog Rice's Journey Through Sustained Partnerships

BY DR. RONAN G. ZAGADO

In March 2023, the Malusog Rice Program visited the province of Antique for a thanksgiving celebration dubbed ***"Unang Ani ng Malusog Rice."*** The event was held to formally recognize farmer-partners and local officials who co-implemented the initial deployment activities in the province.

Partners and stakeholders instrumental to the pioneering planting season of ***Malusog Rice*** in the Western Visayas region were present at the activity, where it was announced that the Provincial Board of Antique adopted a resolution in support of ***Malusog Rice*** cultivation and consumption. Patnongon and Sibalom in Antique are among the pilot municipalities selected for deployment.

Malusog Rice is a new type of rice with a significant amount of beta-carotene in its grains, which can provide at least 30% of the estimated average daily requirement for vitamin A, with regular consumption. This beta-carotene, similar to what is found in orange-colored fruits and vegetables, is converted to vitamin A as needed by the body. Malusog Rice is intended to complement existing nutrition interventions to address vitamin A deficiency (VAD), a public health problem affecting children as well as pregnant and lactating women.

Following commercial propagation approval in July 2021, DA-PhilRice, in collaboration with IRRI, DA regional attached offices, and local government partners, commenced pilot-scale deployment. In April 2022, Golden Rice in the background of PSB Rc 82 was registered with the National Seed Industry Council (NSIC) as NSIC 2022 Rc 682GR2E or Malusog 1. This varietal registration cemented the branding shift from Golden Rice to ***Malusog Rice***.



More than 100 tons of Malusog Rice were harvested in 17 pioneer production sites across the country in December 2022. (Photo Source: IRRI)

The name ***Malusog Rice*** emphasizes its nutritional benefit and the health outcome that Filipino families are envisioned to achieve. The program hopes to reach this goal through sustained support from policymakers and government officials at the national level down to the barangay; from the hardworking frontline workers in the agriculture and nutrition sectors; to farmers, millers, retailers, and all members of the rice value chain, all working together to make ***Malusog Rice*** accessible, available, and affordable to Filipino families.

The ***Unang Ani*** event was meant to celebrate the first harvest of ***Malusog Rice*** not just in Antique, but for the rest of its pilot deployment areas. Sustained partnerships enable the program to continue the journey with stakeholder engagements, policy advocacy, and securing buy-in for the program. These strategies are crucial in ensuring that there will always be a successful ***Malusog Rice*** harvest that can be brought to the tables of households that need it the most in the years to come.



Golden Rice grains compared to white rice. {Photo Source: IRRI)

Bt Talong: An Important Crop in PH Agriculture

BY DR. LOURDES D. TAYLO, DR. DESIREE M. HAUTEA, AND DR. ANTHONY M. SHELTON

Eggplant, also known as brinjal in other countries, is a widely cultivated vegetable in the Philippines. It is grown commercially in farmers' fields and in home gardens. In 2022, eggplant was planted on 21,000 hectares, producing 214,000MT valued at Php 6.04B.

Among the insect pests of eggplant, the Eggplant Fruit and Shoot Borer (EFSB) is the most chronic and damaging, with losses reaching up to 80%. The larval stage of the FSB is the most damaging because the borer burrows inside the stem or fruit, where it is protected from most insecticides. Borers can also feed on eggplant flowers, but the most severe damage is on fruits rendering them unmarketable.

Farmers can practice Integrated Pest Management which includes a combination of non-pesticide-based control strategies. However, farmers have been overly dependent on insecticides, using various mixes of insecticides which account for 40% of eggplant production costs.

Because of the severe negative effects of insecticides on human health and the environment, as well as their ineffectiveness, and high cost, alternatives are needed. Traditional breeding efforts have not produced eggplant lines resistant to EFSB so collaborative efforts between Maharastra Hybrid Seeds Co. Pvt. Ltd (Mahyco) and partner state universities and research institutions in India, the Philippines, and Bangladesh were established to develop their own Bt eggplant lines using Mahyco's Event EE-1 through a royalty-free sublicensing agreement. The agreement was brokered by the Sathguru Management Consultants Pvt. Ltd. through USAID-funded projects based at Cornell University-The Agriculture Biotechnology Support Project II, Feed the Future Eggplant Improvement Project, and the Feed the Future-Insect Resistant Eggplant Partnership. The local funding agency, the Department of Agriculture-Biotechnology Program Office, also provided significant research funds for the project's continuity.

As a genetically engineered crop, Bt eggplant was required to undergo rigid risk assessments by the mandated national regulatory agencies during each stage. The Bt eggplant project went through several regulatory stages, including a contained trial (2007-2008) and a limited confined field trial (2008-2009), both closely monitored by the Department of Science and Technology (DOST)-Biosafety Committee. From 2010-2012, multi-location field trials in Pangasinan, Laguna, Camarines Sur, and North Cotabato, were monitored by the Department of Agriculture-Bureau of Plant Industry (DA-BPI), with the DA Administrative Order No. 8, s. 2002 as the regulatory system.



Bt eggplant fruits. The Philippines is only the second country in the world to plant Bt eggplant. (Photo Source: UPLB-IPB Bt Eggplant Project)

The Application for Food, Feed Processing with the Joint Department Circular (JDC) 1, s. 2016 followed. The biosafety (food safety) permit was obtained on July 21, 2021, confirming that Bt eggplant is as safe as its non-Bt counterpart. It took almost two decades before the Bt eggplant project was granted approval for commercial cultivation on October 18, 2022. Parallel with the biosafety permit for cultivation, an Insect Resistance Management plan was submitted aimed at delaying the development of resistance by EFSB to the Bt protein expressed in the plants and prolonging the durability of the Bt technology. Event EE-1 was also registered as a Plant Incorporated Protectant-Insecticide to the DA-Fertilizer and Pesticide Authority and UPLB as a licensed pesticide handler.

Currently, the Philippines is only the second country in the world to approve the cultivation of Bt eggplant (Bangladesh allowed cultivation in 2014). With the granting of the biosafety permit for cultivation of UPLB Bt eggplant, UPLB established the first field planting (farm scale size) of Bt eggplant from February to May 2023 to assess the field performance (effectiveness against the EFSB and the fruit quality) of the Bt eggplant hybrids. The trials demonstrated there was no shoot borer infestation in the crop and the quality of the crop is good. Different stakeholders (students, faculty members, farmers, science communicators, and journalists) visited the fields, and they were unanimous in saying that farmers should be given access to Bt eggplant seeds as soon as possible so that they can confirm for themselves the benefits of Bt eggplant.

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The Philippine Regulatory Framework on Genetically Engineered Crops

The Philippines is the leader in biotechnology adoption in Southeast Asia, being the first country in the region to implement a regulatory framework on genetically engineered (GE) crops and approve cultivation for food and feed.

The biotechnology regulatory system in the country is governed by five departments, namely the Departments of Science and Technology (DOST), Agriculture (DA), Environment and Natural Resources (DENR), Health (DOH), and Interior and Local Government (DILG), through a Joint Department Circular (JDC). The JDC sets out the rules and regulations for research and development, handling and use, transboundary movement, release into the environment, and management of genetically modified (GM) plant and plant products derived from the use of modern biotechnology.



First issued in 2016, the JDC is a response to the ruling of the Philippines' Supreme Court, declaring the DA Administrative Order (AO) No. 8, Series of 2002 (Rules and Regulations for the Importation and Release into the Environment of Plants and Plant Products Derived from the Use of Modern Biotechnology) null and void on December 8, 2015, temporarily halting GE crop field testing and application "until a new administrative order is promulgated in accordance with the law."

Consistent with the National Biosafety Framework (NBF) and the principles of the Cartagena Protocol on Biosafety (CPB), the 2016 JDC dictates that risk assessment is mandatory and central in making biosafety decisions for the importation and release into the environment of GE plants in all stages of development. It identifies and evaluates the perceived risks to the environment and human and animal health. The Circular also outlines the approval process and requirements for field testing.

Three years after its implementation, the Competent National Authorities (CNAs) from the five government departments recommended reviewing the 2016 JDC to address the challenges of its implementation and to take into consideration the coming into force of Republic Act No. 11032 (Ease of Doing Business Law), which prescribes specific timeframes for all government transactions, including the process of securing a biosafety permit under the said Circular. The revised version of the Circular came into force on March 23, 2022, 15 days after its publication in two newspapers of general circulation.

The revised JDC aims to align and harmonize government regulations, address gaps, and clarify certain provisions. Thus, the 2021 JDC remains to be science-based, risk-proportionate, time-bound, and consistent with international guidelines.

The following changes were the salient revisions in the 2021 JDC:

- Shortened approval process. A biosafety permit for field trial, commercial propagation, and direct use as food and feed or for processing will be covered within 40 working days pursuant to the Ease of Doing Business Law.
- Creation of JAG. A JAG will be established for every application and makes recommendations to the Bureau of Plant Industry (BPI) director on the approval of biosafety permit applications.
- Policy on field trial of regulated articles. Permit applications for regulated articles developed in other economies may be filed directly for a Biosafety Permit for Field Trial.
- Social, economic, ethical, and cultural considerations. The revised JDC shifts the language of SEC inclusion from "shall take into account" to "may take into account," suggesting that SECs will now be optional and not mandatory.
- Validity of biosafety permits. Biosafety approvals for direct use and commercial propagation will no longer require renewals after five years of safe use and will remain valid unless revoked.
- No deregulation. There will be no deregulation, but greater emphasis is directed to revocation grounds so permits can be invalidated at any time.
- GM plants and plant products with stacked events. Plants with stacked traits produced through conventional breeding of approved GM parental lines and their derived products are not considered novel and, therefore, need not be assessed.
- Petition for reconsideration. The aggrieved party for decisions made on applications for field trial, commercial propagation, and direct use may file for reconsideration to the DA Secretary within 15 working days from the announcement of the decision.

Source

Accelerating Impact Through a Responsive Regulatory Framework: The DOST-DA-DENR-DOH-DILG Joint Department Circular No.1, Series of 2021 (https://www.isaaa.org/resources/publications/policybriefs/2022/pb1/2022-Policy-Brief-JDC1.pdf)

SIMPLE TECHNIQUES WITH OUTSTANDING RESULTS

Empowering Filipino Fishers Through Aquaculture Innovation

BY ZABRINA J. BUGNOSEN

The Department of Agriculture (DA) is at the forefront of promoting the country's agricultural development. It aims to collectively empower farmers, fisherfolk, and other key sector players to increase agricultural productivity and profitability while promoting sustainable, competitive, and resilient technologies and practices. The fisheries sector is vital in fulfilling this mandate as one of the major sources of livelihood in the country. Thus, DA saw the need to nurture Filipino innovations that can support aquaculture while ensuring food security and economic growth.

The fisheries and aquaculture sectors of the Philippines provide livelihood and resources to many Filipinos. In 2019, the Southeast Asia Fisheries Development Center reported that the fisheries sector comprised of about 1.99 million fishers and 0.35 million farmers. They also stated that each Filipino consumed an average of 34.27 kg of fish and fishery produce every year. During the first quarter of 2023, the Philippine Statistics Authority documented that the Philippines' annual volume of fisheries production increased by 2% from the previous year, having reached 991.14 thousand metric tons in total. About half of these, or 545.64 thousand metric tons, was attributed to aquaculture production. Sensing the need to improve and promote fisheries and aquaculture activities in the country, DA through the Philippine Agriculture and Fisheries Biotechnology Program (DA Biotech Program) assisted the innovative aquaculture tools and techniques developed by the National Fisheries Research Development Institute (NFRDI) and the Bureau of Fisheries and Aquatic Resources (BFAR).

In 2020, Dr. Casiano H. Choresca Jr. led a team of NFRDI researchers from the Fisheries Biotechnology Center to develop techniques that can induce spawning and improve nursery-rearing protocols for *dalag* (mudfish) and *hito* (catfish). The goal was to address the decline of fish catch in Philippine waters, the decreasing presence of fingerlings from the wild, and the lack of knowledge in the cultivation of certain fish species. The team chose to focus on *dalag* because it is palatable, highly nutritional, and has medical value. Its appeal to consumers made the fish economically important to the country.



Dr. Casiano Choresca Jr. (center) briefs a group of Southeast Asian scientists about the fish spawning technique that they developed and shows the different stages of mudfish that they are maintaining in their fish rearing facility in DA-NFRDI, Science City of Muñoz, Nueva Ecija. (Photo by EJ Azucena, ISAAA Inc.)

Induced fish-spawning is meant to bypass the natural biological processes to speed up the spawning process. The new method begins with identifying good quality and mature fish broodstock from fish pens. The selected fish's flesh is exposed to anesthesia for a few minutes, then hormones are injected into its reproductive area. The area is then massaged to evenly distribute the hormone suspension. Afterwards, the fish are placed in pens that are divided into sections using mesh nets as separators, with a 1:1 ratio of male and female per section. The spawning process takes place in these pens and lasts for 24 to 32 hours after injection. Once spawning is completed, fertilized fish eggs start to float. These are collected and incubated in a facility that controls the temperature of the water to stimulate hatching.

The eggs are expected to hatch between 24 and 30 hours after fertilization, and the fry are placed in rearing facilities. They are kept until their desired stage of adulthood.

The technique developed by Dr. Choresca's team is simple and does not require technical knowledge to be successfully implemented. The approach is also proven to remove uncertainties in breeder spawning, produce fry for hatchery and grow-out even outside the spawning season, provide pure spawn or fish under cultivation, and offer a more controlled hatchery or aquaculture operations.

Developing aquaculture techniques that can be easily adopted by Filipinos not only aids DA's vision to ensure food security for the Philippines, but also encourages fishers to engage in mudfish farming while increasing awareness about the government's initiatives to foster local innovations that empower both Filipino researchers and fishers. It is through modern techniques like this that DA is proudly able to show tangible results of *"Masaganang Ani at Mataas na Kita."*

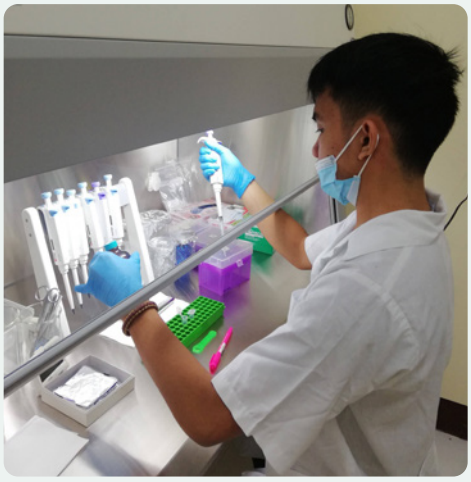
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PINOY BIOTEK ON SPOTLIGHT

KARL ANGELO TENIZO





(Top photo) Graduation picture taken in May 2019. Laboratory apprenticeship in the National Institute of Molecular Biology and Biotechnology, UPV (Bottom photo).

What happens when passion turns into purpose?

You can find the answer to this question from the story of Karl Angelo Tenizo, a young boy who wanted to know more about Philippine fishery. His passion led him to be one of the biotech scholars of the Department of Agriculture. Through his journey as a scholar, he found his purpose in the world of biotechnology.

STARTING THE JOURNEY

The field of molecular biotechnology and its applications in studying aquatic resources have always captivated me. Being surrounded by seas in the Philippines and the vast untapped resources waiting to be explored for the prosperity of our economy has fueled my curiosity for years. However, this fascination did not just develop overnight. It resulted from years of education and training that led me to my chosen career path.

My journey began as a regular fisheries student with limited knowledge of biotech studies and their applications. However, everything changed when I became a scholar in the biotech scholarship program of the Department of Agriculture. As part of the program, I was assigned to various laboratories, where I had the opportunity to experience a wide range of techniques, such as microbial isolation, identification, nucleic acid extraction, polymerase chain reaction (PCR), and bioinformatics. It was a humbling experience for me as a regular student as I faced the vastness and challenges of the field. Looking back, I can proudly say that I have come a long way, though I acknowledge that there is still much more to learn and achieve.

Currently, I am working as a Science Research Associate at the Philippine Genome Center Visayas, University of the Philippines Visayas. I focus on conducting multi-omics research on seaweeds and contributing to COVID-19 biosurveillance efforts. It is a fulfilling role that allows me to combine my passion for marine biotechnology with an urge to aid in pandemic response.

DRIVE TO ACHIEVE GOALS

I have chosen to pursue a career in bioinformatics because I am captivated by the stories hidden within vast sequencing data sets. Each data has a unique tale, offering valuable insights and discoveries. In today's digital age, where next-generation sequencing is becoming increasingly important, the demand for bioinformaticians and data science experts is soaring. This need is especially critical in the Philippines, where the field is still undervalued and needs to be further developed.

What drives me the most is my desire to create a significant impact in the field of fisheries and contribute to my country's development. Fisheries research compels me. I want to push the boundaries of knowledge and technology and find ways to benefit farmers and fisherfolk. The untapped wealth of data on our natural resources presents an exciting opportunity. With my expertise, I aim to tackle the challenges faced in overlooked areas of study.

CONTRIBUTING TO SCIENCE

While I may not have any published works yet, my focus and dedication lie in a crucial area of research–understanding the diseases in seaweeds, specifically the ice-ice disease in Eucheumatoids. I am trying to understand the mechanism of disease development by looking into disease-associated pathways involved for defense mechanisms and metabolic processes. Additionally, I am also trying to investigate the host-pathogen interactions by analyzing the microbial shifts in response to temperature changes to understand its impact on the host species. These macroalgae have a significant impact on the economy and the lives of seaweed farmers as the ice-ice disease poses a serious threat to the sustainability of seaweed farming. While my contributions may not be in the form of published research just yet, I firmly believe that my efforts hold huge potential to make a tangible difference in addressing the challenges faced by the seaweed industry.



Seaweed affected by *ice-ice* disease.

DREAM FOR PINOY BIOTEK

My primary goal is to promote biotechnology among the younger generation. Considering the Philippines' significant role as a global seaweed producer, addressing challenges related to diseases and rising temperatures is necessary. Biotechnology offers a promising solution to tackle these issues head on. By nurturing expertise in this field, we can foster innovative approaches to improve seaweed farming, combat diseases, and ensure sustainable growth. This endeavor has great potential to positively impact the economy and the lives of farmers, ultimately advancing agriculture and aquaculture in our country.

BioMeg: The Tool for Crop Success

BY LUCILLE GRACE PUNZALAN

If you are given a biotechnology that will boost the yield and nutritional quality of your crops, would you take it? That is what BioMeg is for.



BACKGROUND

There are soils that cannot be used for agricultural purposes. These soils have immobilized elements that are not utilized by plants. Bacteria can be used to release these micronutrients from the soil, so the plants can absorb them.

An example of a bacteria that can help with this process is *Bacillus megaterium*. It is a naturally occurring organism that was isolated from soil in some areas of Leyte and was used to produce BioMeg, a microbial inoculant for crops. BioMeg was innovated by researchers from the Visayas State University led by its project leader, Dr. Edgardo Tulin. The project is currently being funded by the biotechnology office of the Department of Agriculture.

COMPONENTS OF THE PROJECT

The researchers chose sweet potato and purple yam as test crops because they are resilient to different types of soils and conditions. These are also high value crops and have high demand locally and abroad. For the micronutrients, the researchers focused on copper, iron, and zinc because they are needed by the human body. Zinc is important for brain growth, while copper and iron are used for human metabolism.

Bacillus megaterium was chosen for BioMeg because it was suitable for the three criteria that were considered. It is fast-growing and sporulating, so it can be stored in a solid medium for a period of time and revived when it is needed to be used. It can also solubilize copper, iron, and zinc in the soil, so the plants can utilize them. When the micronutrients are absorbed, it will spur growth and development in the plants and will increase the nutritional content, which is translocated into the plants and then stored in the roots.

FEATURES OF BIOMEG

BioMeg only costs about 218 pesos per kilo. It is low-cost because indigenous and locally sourced materials are used in its production. Farmers only need to apply a small amount of BioMeg to the crops a few days after planting, and it will already increase the yield and enhance the nutritional quality of the plants.

The expected increase in crop yield will produce a corresponding increase in income and offer a sustainable livelihood for the farmers. The net income from crops that used BioMeg is about three to four times higher than the normal yield.

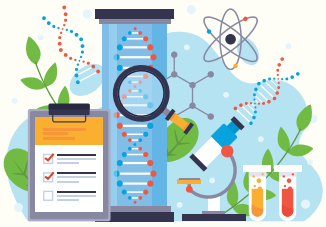
This biotechnology is also organic-based and environment-friendly as no chemicals were used in production. The culture and production of BioMeg are being improved so that it would not need a lot of facilities for reproduction and so it could be produced at a lower price.

BIOMEG'S IMPACT

BioMeg is significant in helping farmers face issues, such as food production security and global competitiveness. This biotechnology helps with environmental protection because it does not utilize chemicals, but only organic waste. It also aims to address micronutrient deficiency in infants and growing children.

Even though BioMeg was only tested in sweet potato and purple yam, the researchers recommend using it for other types of crops as well. This biotechnology will significantly increase the yield, nutritional content, and income from crops, so people can have a more sustainable livelihood.

Biotech Crops in the Philippines



REGIONAL BIOTECHNOLOGY LEADER IN SOUTHEAST ASIA

1st COUNTRY IN THE REGION TO HAVE A REGULATORY FRAMEWORK ON BIOTECH CROPS

1 OF THE 14 COUNTRIES PLANTING BIOTECH CORN IN THE WORLD



PHILIPPINES



FAST TRACK TO COMMERCIAL PLANTING

1st COUNTRY IN THE WORLD TO APPROVE **GOLDEN RICE/ MALUSOG RICE**

2nd COUNTRY IN THE WORLD TO APPROVE **BT EGGPLANT/ BT TALONG**

2002

BT CORN WAS APPROVED FOR COMMERCIAL PLANTING IN 2002

2003

1st COUNTRY IN SOUTHEAST ASIA TO PLANT A BIOTECH CROP AFTER BT CORN WAS APPROVED FOR COMMERCIAL PLANTING IN 2002

2019

875k HECTARES OF BIOTECH CORN PLANTED

12th LARGEST PRODUCER OF BIOTECH CROPS IN THE WORLD

2022

64 BIOTECH CORN EVENTS APPROVED

SOME HAVE "STACKED EVENTS" TRAITS
- 2 traits occurring at the same time

9 BIOTECH CROPS APPROVED FOR FOOD, FEED, AND CULTIVATION

CORN, RICE, EGGPLANT, SOYBEANS, COTTON, POTATO, ARGENTINE CANOLA, ALFALFA, AND SUGAR BEET

MON 810 THE FIRST BT CORN PLANTED. IT IS GENETICALLY MODIFIED TO BE RESISTANT TO THE ASIATIC CORN BORER THAT CAUSES 80% YIELD LOSS

673k FARMER FAMILIES HAVE ENJOYED THE IMMENSE ECONOMIC BENEFITS IN THE LAST 16 YEARS OF BIOTECH CORN COMMERCIALIZATION



Golden Rice is a rice variety genetically engineered to contain additional levels of beta-carotene, which the body converts into vitamin A.



Bt eggplant is a genetically engineered insect resistant eggplant that contains a natural protein that makes it resistant to eggplant fruit and shoot borer, the most destructive pest of eggplant.

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PINOY BIOTEK MAGAZINE

Pinoy Biotek Magazine aims to raise the Filipinos' awareness, understanding, and acceptance of Pinoy biotech products derived from conventional and modern biotechnology. It is published in print and distributed for free to selected schools and institutions. This magazine is also available for free download in the ISAAA Inc. website.

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