

Biotechnology in the Philippines: Prospects for the New Decade

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scope

- ▶ The past 40 years in a nutshell
- ▶ What are in store for PHL Biotech in the new decade 2011-2020
- ▶ Challenges

Protein & DNA markers for disease diagnosis; crop varietal identity & diversity; marker-assisted breeding

Markers

1990s
 Recombinant DNA technology 2000s

Biofertilizers

1980s

Tissue culture

1960s

Fermentation

Gene discovery; genetic engineering of crops for improved traits; protein engineering

BS, MS, PhD MBB Programs, UP Diliman (late 1980s); MS, PhD UPLB (late 1990s); BS Ag Biotech UPLB (2010)

Some homegrown biotech products

Tissue culture technologies

- Embryo rescue of makapuno
- Micropropagation of orchids

Dr. Emerita V. de Guzman

Dr. Ramon C. Barba

Pioneered the induction of mango flowering using KNO_3 ; Developed micropropagation techniques for banana and abaca.

Dr. Helen Valmayor

At UPLB

Tissue culture

- ❖ Somatic embryogenesis of mango, banana
- ❖ cassava
- ❖ Garlic and shallot
- ❖ Indigenous orchids

Gene discovery

- ❖ ACC synthase of papaya, mango
- ❖ Resveratrol synthase, chitinase genes
- ❖ Coconut genes involved in fatty acid metabolism
- ❖ Storage proteins and genes of coconut

Markers

- ❖ Hybridity test of coconut hybrids
- ❖ DNA fingerprints of papaya, abaca, mangosteen
- ❖ Genetic diversity analyses of papaya, abaca, mangosteen
- ❖ QTL mapping maize, tomato, mungbean

Disease diagnostic kits

- ❖ Ratoon stunting disease
- ❖ TYLC virus of tomato
- ❖ Papaya ringspot virus disease

Bacterial Blight Resistant Varieties Developed through MAS

IR64
 IR64

NSIC Rc142 (Tubigan 7)

- ✓ IR64 background
- ✓ Resistant to BLB
- ✓ 7.4 t/ha yield; 113 days to maturity; 95 cm tall

NSIC Rc154 (Tubigan 11)

- ✓ PSB Rc14 background
- ✓ 9.2 t/ha yield; 111 days to maturity; 110 cm tall
- ✓ Intermediate amylose content, good milling and head rice

Courtesy of PhilRice Dr. AA Alfonso

Animal Biotechnology

- Artificial insemination; vaccines
- Sex reversal technology
- In vitro fertilization; embryo transfer
- Nutritional biotech; diagnostics;
- Marker technologies

Philippine Carabao Center

Home grown biotech products

Reproductive Biotechnology; MOET

Multiple Ovulation Embryo Transfer

Dr. Rafael D. Guerrero III

Initially studied sex reversal of tilapia for his PhD in Auburn Univ; continued work at CLSU and tried it on commercial scale in the early 1980s. in triggered the growth of the tilapia industry!

In vitro fertilization done in India; frozen embryos transported to the Philippines; transferred to surrogate carabao mothers. Twin calves shown.

DA Philippine Carabao Center, Nueva Ecija

Home grown biotech products

St. Luke's Medical Center
One of the world's best

- Dengue
 - Serum Bank
 - Dengue serological detection kit
 - Conducted basic, animal and clinical studies
- Molecular diagnostics
 - Chromosomal analyses for various diseases, cancers, disorders
- DNA-based tests
 - Monitor disease gene markers
 - Detect infectious diseases

St. Luke's Medical Center
Research Biotechnology Division
Started 1995

Foreign biotech products tested and adopted in the Philippines

- For propagation
 - ▶ Single transformation events
 - MON 810
 - Corn NK603
 - Corn GA21
 - Corn Bt11
 - MON 89034
 - ▶ Stacked traits
 - Corn MON810xNK603
 - Bt11xGA21
- For direct use as food, feed or for processing events
 - As of 2009
 - ▶ 29 transformation events
 - ▶ 18 stacked genes

More than 400,000 ha of GM corn planted in PHL


These are the waves or generations of biotechnology processes or products

Most of the current commercial products belong to the first wave.

Biotechnology generations

- First wave: Agronomic traits biotic or abiotic stress yield
- Second wave: Quality traits improved nutrition, functional properties
- Third wave: Recombinant health products produced by microorganisms
- Fourth wave: biofuels, Renewable resources, Factories pharmaceuticals, industrials

What's store for this new decade 2011-2020?



Animal biotechnology at UPLB

Applied Animal Biotechnology for the Improvement of Philippine Mallard Ducks

Dr. AL Lambio, Dr. RSA Vega, Dr. SS Capitan, & Mr. MGN Yebron


- Analyze genetic diversity via SSR markers
- Assess vitellogenin levels in blood & liver

Optimizing Rumen Ecology of Indigenous Ruminants for Efficient Production

Dr. CC Sevilla, Dr. AC Laurena, & Mr. MGN Yebron

- Identify dominant rumen bacteria & protozoa
- Determine changes in rumen microbial ecology due to nutritional interventions.

Animal and Dairy Sciences Cluster, College of Agriculture, UPLB



Animal biotechnology at UPLB



The UPLB-DA DNA Barcoding Project: Agricultural Sub-sector on Animal Production and Health (ASAPH)

- The UPLB-DA DNA barcode library (including photo documentation) started in September 2010 uses a segment of the mitochondrial gene (cytochrome c oxidase subunit 1) in discriminating closely allied (commercial and indigenous/native) breed groups.

Dr. Orville L. Bondoc, Project Leader, Animal & Dairy Sciences Cluster, CA, UPLB


Crop Biotechnology at UPLB

- Transgenic papaya with delayed ripening trait and PRSV resistance is awaiting field trial. [EM Tecson-Mendoza, Project Leader]

Fruit and shoot borer resistant Bt eggplant is being field tested. [DM Hautea, Project Leader]


Sweet potato with resistance to sweet potato feathery mottle virus is in contained facility testing. [LM Dolores, Project Leader]



Philippine Genome Program

- UP Diliman
 - NIMBB
- UP Manila
 - IMBB
 - National Institutes of Health (NIH) UP Manila
 - Genome sequence & diagnostics for TB, malaria
- UP Los Baños
 - IBS, CAS
 - IPB-CSC, CA

Genome Program of UPLB: building on the previous decade's outputs



ENHANCING AGRICULTURAL PRODUCTIVITY THROUGH GENOMICS

- Genomics of Abaca Towards Improving Its Productivity
 - Marker-Assisted Breeding of Abaca (*Musa textilis* Nee) for the Development of High Fiber Quality and Virus Resistant Cultivars
 - Construction and Analysis of Abaca Expressed Sequence Tags (EST) Library and Functional Analysis of Selected Traits
- Genomics of High Value Crop Banana 'Saba' (*Musa balbisiana*) Towards Improving Its Productivity
 - ESTs, DNA Markers, MADS-Box genes

Drs. RP Landa, EM Tecson-Mendoza, AC Laurena, MS Mendioro, ETM Ocampo, MGQ Dizon, RN Garcia.


ENHANCING AGRICULTURAL PRODUCTIVITY THROUGH GENOMICS

- Development of DNA Markers for Genetic Diversity Analysis, Fingerprinting and Sex Determination of Pili (*Canarium ovatum*)

Roberta N. Garcia, Evelyn Mae Tecson-Mendoza and Leon O. Namuco

Crop Science Cluster, CA UPLB

Funded by the Department of Agriculture Philippine Agriculture Fisheries Biotechnology Program 2011



BIOTECH Institute at UPLB



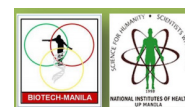
Selected projects

- ▶ Fuel Ethanol Production from Lignocellulosic Feedstocks–(PCASTRD–DOST), FR Nayve
- ▶ Biotechnology for the Production of Clinically–Important Alkaloids in *Catharanthus roseus* Cell Culture (PCASTRD–DOST), EC Marfori
- ▶ Bioinformatics and Drug Discovery Program
 - Bioactive Compounds from Philippine Streptomyces Collections, T.O. Zulaybar
 - Animal Vaccine Production, H. Molina

Dr. Reynaldo V. Ebor, Director

Biotech at UP Manila

Institute of Biotechnology and Molecular Biology



- ▶ Molecular Diagnosis of Infectious Diseases: The Biotek–M Projects;
 - Diagnostics for early detection of TB; ...dengue virus; molecular characterization & detection of flu virus infection
- ▶ Human Microbiome and Chronic Diseases
 - Metagenomic study of human microbiome & nutrition status
- ▶ Biosurveillance of emerging infectious diseases;
- ▶ Biobanking Program of microbial, tissue, cellular assembly and genetic resources.

Dr. Raul V. Destura, Director

Biotech at UP Mindanao



UP Mindanao Biotech focuses on conservation and utilization of sago palm

- ▶ Micropropagation of sago
- ▶ Molecular characterization
- ▶ Extraction, functional characterization and food applications of sago starch
- ▶ Biodegradable plastics from sago starch
- ▶ Direct lactic acid fermentation using novel amyolytic lactic acid bacteria
- ▶ Obtained PhP1 8 M grant from UP System

Dr. Dulce M. Flores, Project Leader

Biotech at UP Diliman

The National Institute of Molecular Biology and Biotechnology (NIMBB)



- ▶ Vision—**genome–based research** in different aspects of molecular biology and biotechnology
 - Antibody and molecular oncology
 - Fluorescent proteins from marine invertebrates
 - Microbial enzymes for industrial use and bioremediation
 - Molecular studies on *Vibrio harveyi* and *Vibrio campbellii*
 - Fatty acid synthesis and expressed genes in algae

Dr. Cynthia Hedreya, Director

Biotech at Diliman, NSRI



- Service
- Mitochondrial DNA Heteroplasmy in a Filipino population
- The Peopling of the Philippines: Molecular Variation among Human Populations in the Philippine Archipelago
- Research, Training and Extension Services in Forensic DNA Analysis in the Philippines

Dr. Maria Corazon Ungria, Head

Biotech at PhilRice



- ▶PhilRice is field testing Golden Rice with IRRI.




From beyond Philippine shores: Traits of Products in the Pipeline

- ▶ Better pest resistance and weed control
- ▶ Water usage efficiency
- ▶ Nitrogen use efficiency
- ▶ Intrinsic yield
- ▶ Quality traits


Better pest resistance and herbicide tolerance

- ▶ Rootworm resistance
- ▶ Corn borer III
- ▶ Multistacked traits such as Agrisure-Viptera of Syngenta which controls as many as 12 above and below ground insect pests including corn borer, rootworm and multipest complex plus herbicide tolerance flexibility using either glyphosate or glufosinate applications.
- ▶ Sugarcane with insect resistance & herbicide tolerance

control



With gene




2007 FIELD TESTING SHOWS VISUAL PROOF OF YIELD IMPROVEMENT

Water stress exposure during different stages of development can have significant effect on corn yield. Monsanto's lead drought-tolerance trait shows a significant yield advantage compared with controls under drought stress

Drought tolerant corn

<http://www.monsanto.com/droughttolerantcorn/default.asp>

DO NOT WATER



Monsanto and BASF used a gene from *Bacillus subtilis* called *cspB*, which helps the bacteria cope with cold temperature.

7 to 16% yield advantage

Photo from Gilbert--
<http://www.nature.com/news/2010/100728/full/466548a.html>

Water efficiency use technology

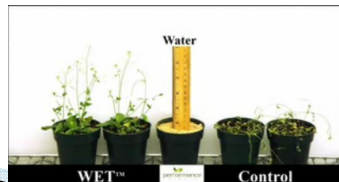
- ▶ Performance Plants Inc of Canada has WET™ technology
- ▶ allows plants to grow normally and produce excellent seed yields with significantly less water.
- ▶ Greenhouse experiments have shown that WET® plants produce 22% more growth with limited water.
- ▶ Demonstrated in canola and other crops

WET™

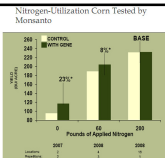
Water efficiency use technology



Performance Plants Inc of Canada
<http://www.performancplants.com/>



Nitrogen use efficiency



- ▶ Companies/institutions involve
 - Monsanto, Syngenta, Pioneer, Limagrain, Vilmorin, small start-ups (Arcadia, Evogene, Performance Plants Inc.)
 - Public research (several research institutes and universities)
 - Others have discontinued (eg, CIMMYT)
- ▶ All at proof-of-concept stage
- ▶ Main targets—corn primarily; rapeseed, wheat, rice

Increasing biomass

- ▶ Suited for large biomass applications such as feedstock for cellulosic ethanol and for fiber and forage
- ▶ Two times more biomass by enhancing vegetative plant growth
- ▶ Is now being introduced to crops and is at greenhouse testing

BET™



Transgenic animals

- ▶ Improved traits for production
 - Transgenic fish (salmon, trout) (Aqua Bounty)
 - Disease resistance
- ▶ For better environment
 - Environment friendly pig has phytase in saliva which releases phytate from phosphorus
- ▶ Gene Pharming
 - Atryn (Anti-thrombin) production in goats, GTC, released 2006 in Europe and 2009 in the US.
 - Human polyclonal antibodies production in cows, Hematech
 - α -antitrypsin production in sheep, PPL Therapeutics



DNA-marker technologies can help identify genetically superior animals

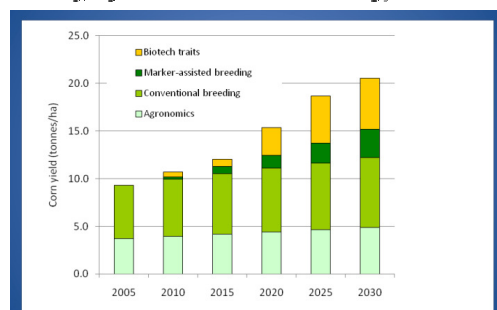
- ▶ HD 50K for Angus
- ▶ GeneStar® MVP® feed efficiency, marbling, tenderness, as well a meat quality palatability index and homozygous black.
- ▶ GeneStar® Black homozygous black
- ▶ GeneStar® EliteTender® guaranteed tender!
- ▶ SireTRACE® DNA fingerprint
- ▶ SureTRAK® Product verification
- ▶ Genetic Conditions Testing



Pfizer Animal Health
<http://www.pfizeranimalgenetics.com/>

Other animal health companies involved

Significant yield increases due to advanced plant breeding, agronomics and biotechnology



Anticipated impact of improvements in agronomics, breeding and biotechnology on average corn yields in the United States. Edgerton (2009).

Our strengths

- ▶ Our academic programs
 - BS MBB, BS Agricultural Biotechnology, BS Bioengineering
 - MS, PhD programs in Molecular Biology and Biotechnology
 - Allied programs
- ▶ Our present (tenacious) researchers
- ▶ Our basic facilities
- ▶ Our rich genetic resources

Challenges



- ▶ DOST Secretary Mario Montejo has expressed support to biotechnology.
- ▶ Biotech continues as one of DOST's key programs
- ▶ Secretary Montejo has challenged us: where will Philippine biotechnology be in 5 years? In ten years?

Challenges

Regulation of GM R & D and products

- ▶ The biosafety regulatory system of the Philippines is operational; it is strict but it works. It is a model for many countries.

Challenges

- ▶ “Agricultural biotechnology is a tale of great achievement & constant controversy.” *Christopher Leaver, Emeritus Professor, Oxford University*
- ▶ It has given activism big success stories.
Activism has frozen policy and regulatory attitudes.
- ▶ We need more responsible activism!

Challenges

- ▶ Research Budget, do we have enough?

DOST GIA budget for R & D in 2010
~PhP638 M; Malaysia provides each of its four research universities \$50 M per year.

- ▶ Researchers, do we have enough?

Targets: TO INCREASE

- ▶ Research budget
- ▶ Number of high caliber scientists
- ▶ Number of commercializable biotech products
- ▶ PhP generated by biotech products annually
- ▶ Number of biotech companies in the Philippines
- ▶ Number of people (from our graduates!) employed directly by biotech industries

**Salamat po at
Mabuhay!**

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