Pinoy Biotech Products –

Now and in the Future

Abe Manalo
NCPAG-UP Diliman

Know the Science Webinar Series:
R&D of Pinoy Biotech Products
03 November 2022 via Zoom

ISAAA Inc.

SEAMEO SEARCA

Know the Science Webinar Series

11 OCT 2022
10-11AM (GMT+8)

Current Status of Commercialized GM Crops in the Philippines: Biotech Corn and Golden Rice

Dr. Gabriel O. Romero
Executive Director
Philippine Seed Industry Association

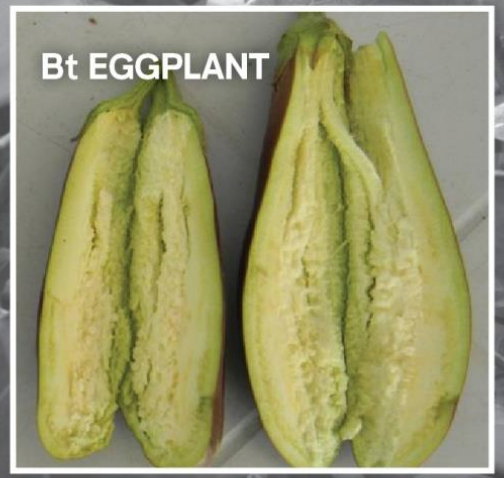
Dr. Ronan G. Zagado
Program Leader, Golden Rice
DA Philippine Rice Research Institute

03 NOV 2022
10-11AM (GMT+8)

Research and Development of Pinoy Biotech Products

Dr. Edison C. Riñen
Project Leader, Bt Cotton Project
Philippine Fiber Industry Development Authority

WHAT IS Bt EGGPLANT?

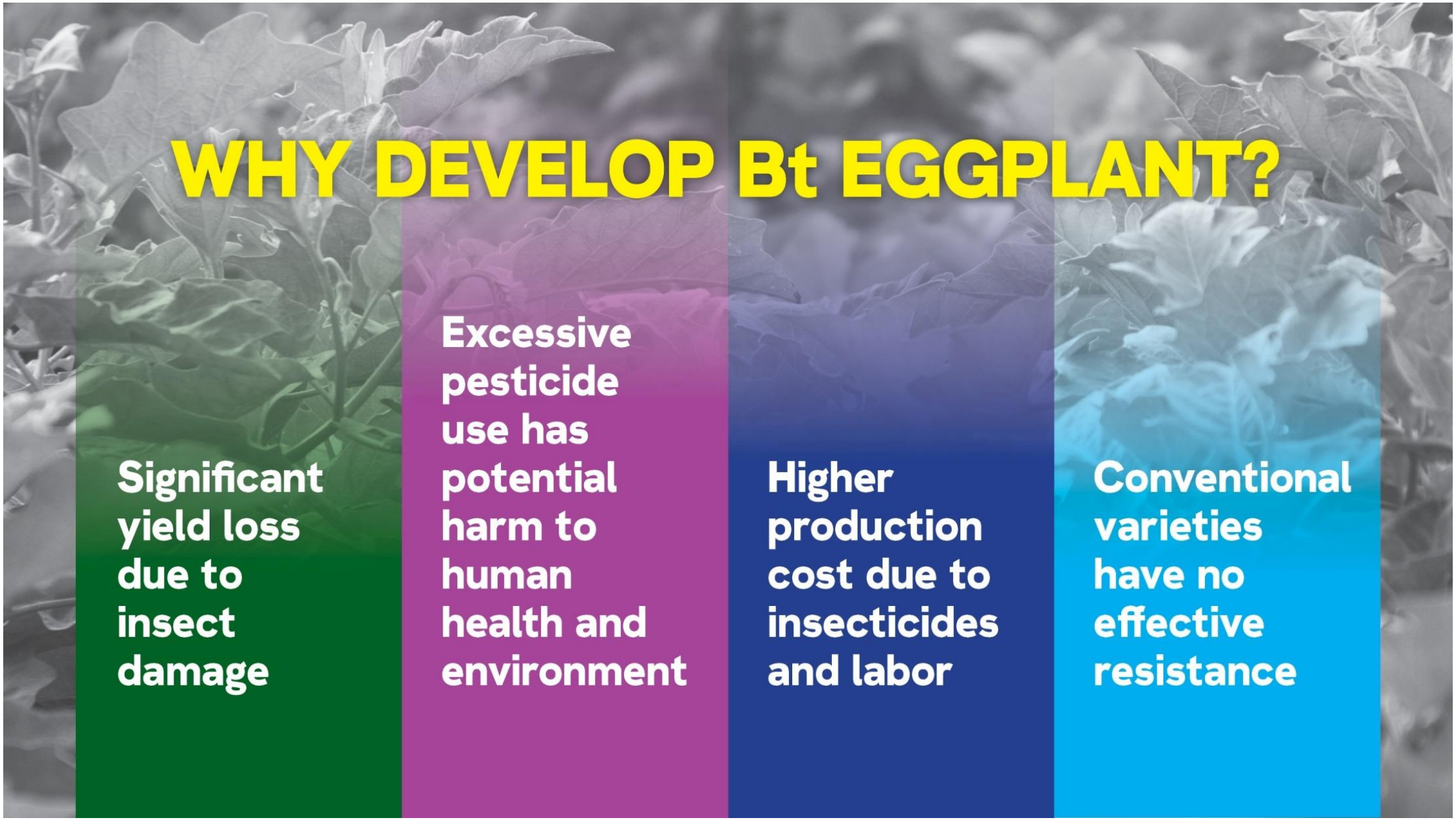


Eggplants resistant to eggplant fruit and shoot borer (EFSB) developed using modern biotechnology

Contains 2 novel genes: Bt *cry1Ac*, from *Bacillus thuringiensis* var. *kurstaki* and *nptII* from *E. coli*

Mode of action is highly specific; safe for humans and non-target organisms

Source of Slide: D.M. Hautea (2021)



Source of Slide: D.M. Hautea (2021)

MAJOR PROBLEMS IN EGGPLANT PRODUCTION

EGGPLANT FRUIT AND SHOOT BORER (EFSB)

Leucinodes orbonalis Guenee

Most destructive pest of eggplant

ADULT MOTH

DESTRUCTIVE LARVA

PHOTO SOURCE: RAO, 2010

EFSB FEEDING DAMAGE

70-80% YIELD LOSS

Source of Slide: D.M. Hautea (2021)

WHAT WILL FARMERS GET WHEN THEY PLANT BT EGGPLANT?

BETTER INCOME

Farmers net annual income
₱71,060/HECTARE
Gross annual income can reach
₱120,000 – ₱272,000/HECTARE

HIGHER YIELD

HIGH RESISTANCE TO EGGPLANT FRUIT AND SHOOT BORER

99-100% RESISTANCE TO EFSB SHOOT DAMAGE

98-100% RESISTANCE TO FRUIT DAMAGE

96-99% REDUCED EFSB LARVAL INFESTATION

REDUCED PESTICIDE USE

DOES NOT NEED PESTICIDE **TO CONTROL EFSB**

19.5% LOWER ENVIRONMENTAL FOOTPRINT

NO PESTICIDE RESIDUES LEFT IN FRUIT AND FARMERS

ISAAA

Source of Slide: D.M. Hautea (2021)

Status of Application for Commercial Propagation

Transformation Event (Application Form)	Trait	Technology Developer	Public Information Sheet	Status of Public Comment	Date Applied	Date Approved	Biosafety Permit	Date Posted
EE-1 Eggplant	Insect Resistant	University of the Philippines Los Banos	Public Information Sheet of EE-1 Eggplant	Closed	March 31,2022	October 18, 2022	Biosafety Permit of EE-1 Eggplant	October 19, 2022

Republic of the Philippines
Department of Agriculture
BUREAU OF PLANT INDUSTRY
692 San Andres St., Malate, Manila

Biosafety Permit for Commercial Propagation
Number 22-001 Propa

Eggplant transformation event EE-1 owned and licensed by the University of the Philippines Los Baños (UPLB), with office address at Office of the Chancellor, UPLB Campus College, Laguna has satisfactorily undergone biosafety assessment for commercial propagation pursuant to the DOST-DA-DENR-DOH-DILG Joint Department Circular (JDC) No. 1, Series of 2021. Further, the permittee has satisfactorily complied with all requirements for the issuance of the biosafety permit for commercial propagation. This permit is hereby issued for the commercial propagation of the said regulated article.

This Biosafety Permit for Commercial Propagation shall not excuse the permittee from complying with relevant regulations of other government agencies.

Issued on **October 18 2022** at the Bureau of Plant Industry, San Andres St., Malate, Manila subject to conditions stated at the back of this permit. This permit shall remain valid unless revoked for any reasons set forth under Section 1.J. Revocation of Biosafety Permit for Commercial Propagation.

GERALD GLENN F. PANGANIBAN, Ph.D.
Director
Bureau of Plant Industry

Global Experience in Bringing a GM Crop to the Market

Comparing Time with GM Product Commercialization

It takes longer to get a GM seed variety approved than pharmaceutical medicines!

Source: CropLife International (2018)

The Philippines as Case Study

First GM Crop Approved: Bt Corn MON810

1985 – Laboratory activities in the US

1997 – Greenhouse trial at UPLB

1999 – Confined field trial in Lagao, General Santos City

2001/2002 – Wet/Dry season multi-location field trial

Dec 2002 – Regulatory approval for commercial propagation

2003 – Commencement of IRM activities

Republic of the Philippines
DEPARTMENT OF AGRICULTURE
Bureau of Plant Industry

Permit to Propagate
Number 02-0001

Pursuant to Sections 9 and 10 of Administrative Order No. 8, Series of 2002, this permit is hereby issued to MONSANTO PHILIPPINES, INC. with office address at 7th Floor, Ayala FGU Building, Acacia Road, Corner Alabang-Zapote Road, Madrigal Business Center, Alabang, Muntinlupa to propagate the regulated article Corn Event MON 810 and all progenies from crosses of the product with any conventionally-bred corn and corn containing registered-biotechnology events.

Further, Monsanto Philippines, Inc. had satisfactorily complied with the requirements of the aforementioned administrative order.

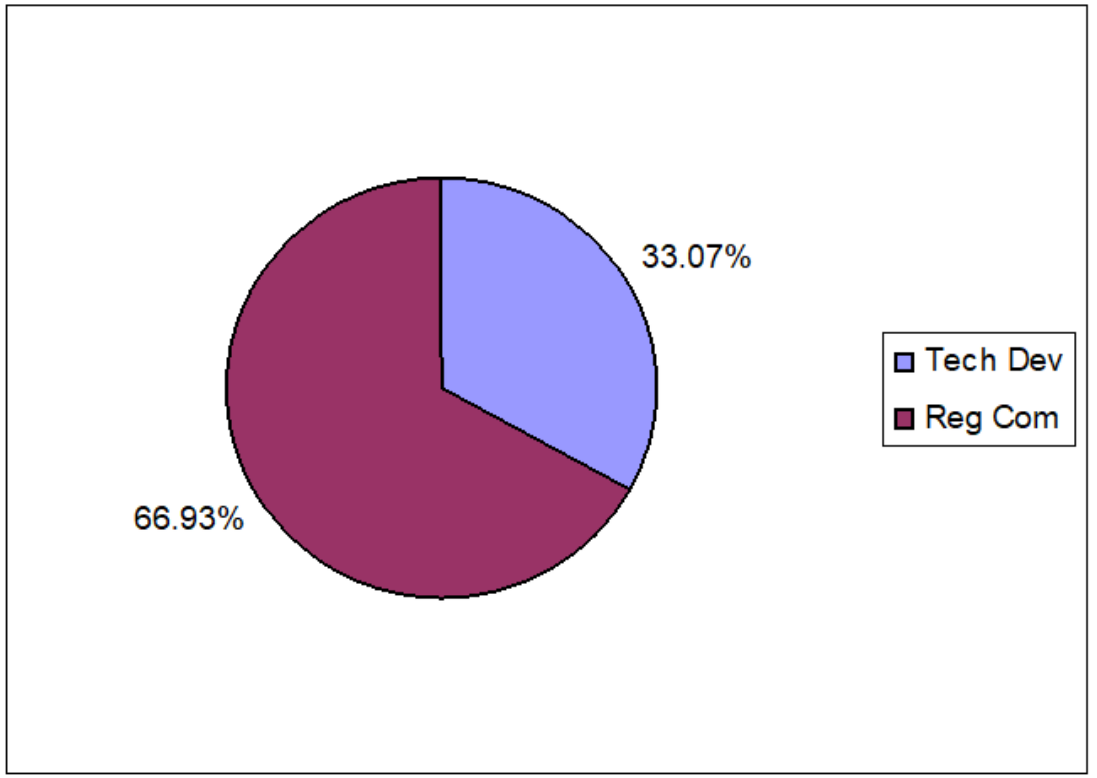
This permit is valid for five years and shall expire on ***December 3, 2007*** *subject to the terms and conditions set forth in Administrative Order No. 8, Series of 2002.*

Issued this 4th day of ***December 2002***

BLO UMPAR ADIONG
Director

Cost by Development Phase

Phase	Discounted Cost at 2004 Prices (PhP)	Percent Share (%)
Lab/Greenhouse (U.S.)	5,199,741.45	4.06
Greenhouse (Phil.)	1,988,113.36	1.55
Confined Field Trial	7,009,087.78	5.48
Multi-location Field Trials	44,379,128.09	34.68
Commercial Application	16,312,461.45	12.75
Post Commercial Activities	53,088,637.01	41.48
Total	**127,977,169.13**	100.00



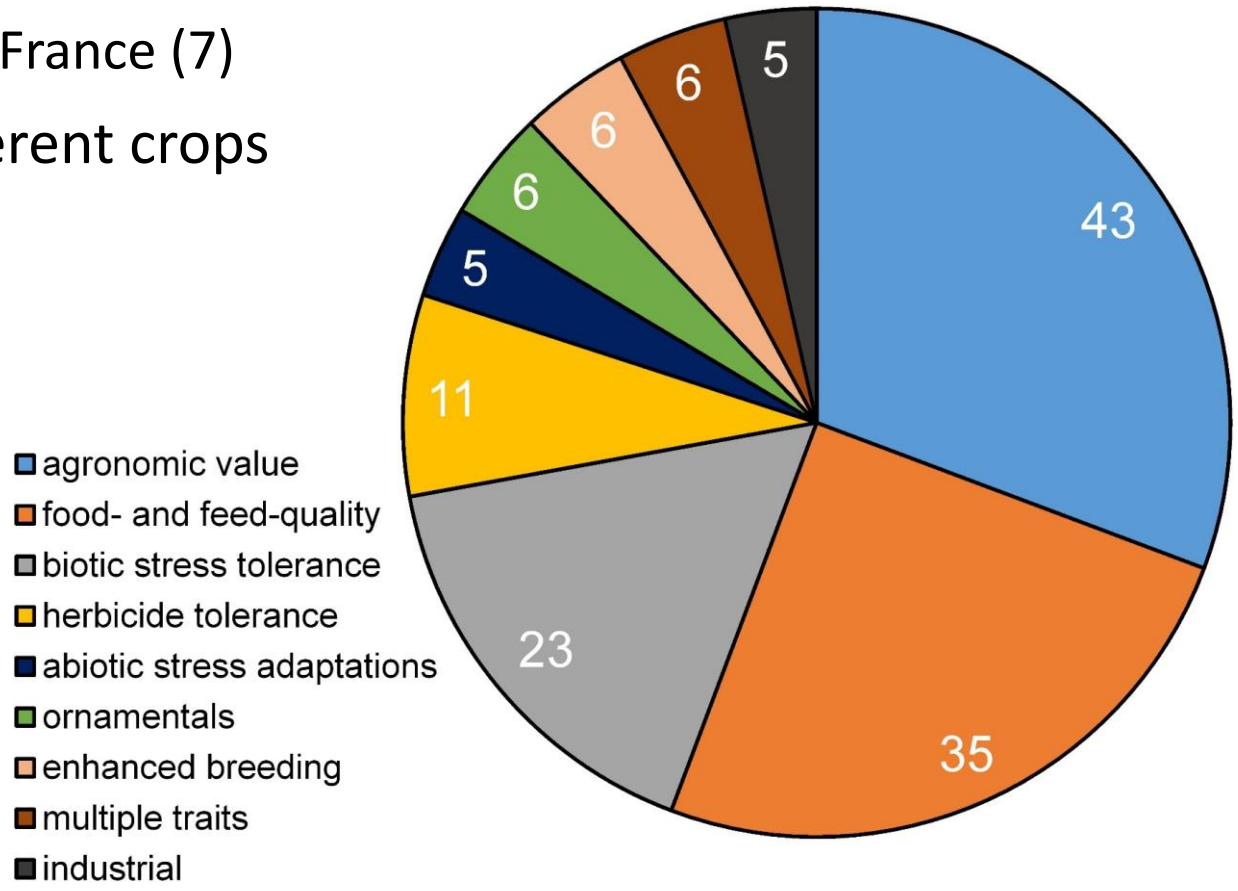
Source: Manalo & Ramon (2007)

Gene Edited Crops

Market Oriented Applications (Jan 1996 to July 2019)

- 217 publication identified with market oriented applications
- China (101), US (78), Japan (17) Germany and France (7)
- 140 different type of application in 41 different crops

  Rice (81)
  Tomato (26)
  Maize (25)
  Wheat (14)
  Potato (14)
  Soybean (12)
  Plus: peanut, kiwi, lettuce, lemon, poppy, salvia, cacao, banana, manioc, and sugar cane



Source of Slide: Ruthner (2020), data from Menz et al. (2020)

Gene Edited Crops Being Developed in the Philippines

- **Institute of Plant Breeding (UPLB-IPB)**
  - Low phytate corn
  - High lycopene tomato

- **International Rice Research Institute (IRRI)**
  - BLB resistance
  - Tungro resistance
  - Yield
  - Biofortification
  - Water efficiency

- **Philippine Rice Research Institute (PhilRice)**
  - Tungro resistance
  - BLB resistance
  - Optimal grain amylose

Source: G. Romero (2021)

Institute of Plant Breeding, UP Los Baños

Targeted Genome Editing using CRISPR-Cas9 Technology: Capacity Building and Proof-of-Concept in Rice, Corn, and Tomato

Dr. ANTONIO C. LAURENA
Project Leader

Implementing Agency: University of the Philippines Los Baños
Cooperating Agency: IRRI

Methodology

Seminars, trainings and workshops on CRISPR-Cas9 for capacity-building of University faculty, staff and students and other SUC's

Tissue culture rice, corn and tomato plants as starting material for transformation

Gene Editing using CRISPR (Cas9 and Cpf1)

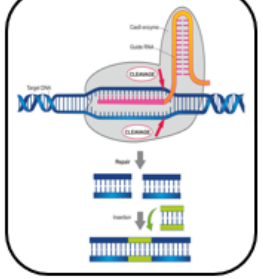
T1-T2 Generation: Phenotypic analysis and chemical characterization

YEAR 1 **YEAR 2** **YEAR 3**

EPF/EPFL for reduced stomatal density

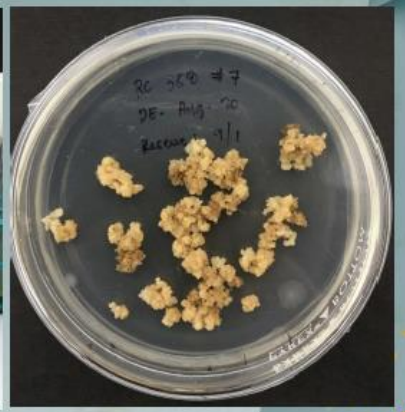
Lycopene cyclase for enhanced anti-oxidant (orange to deep-red fruit)

Phytic acid *(ZmIPK1)* change by 5-10% vs. wild type for better nutrient availability



Philippine Rice Research Institute

Improving popular released rice varieties through gene editing



Traits to be targeted

- Tungro resistance
- Bacterial leaf blight (BLB) resistance
- Optimized grain amylose content

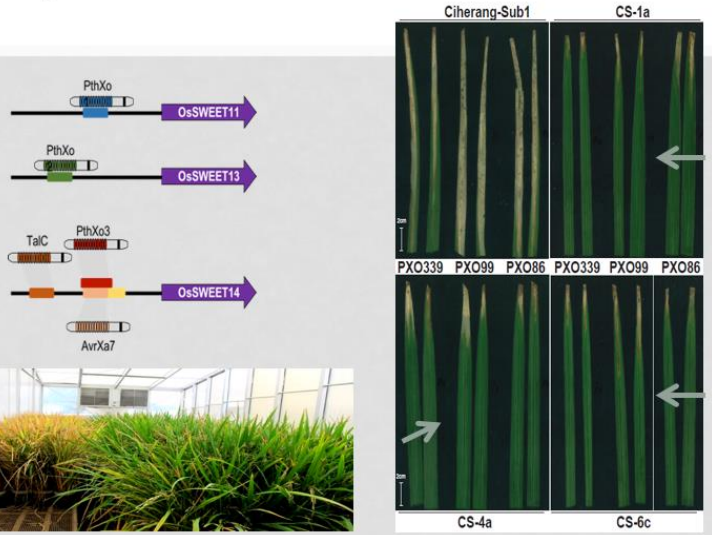
Ultimately, our outputs are expected to increase consumer preference, help secure farmers' incomes and reduce dependence on pesticides.

Quality Rice. Quality Life.

Source of Slides: R. Ordonio (2021)

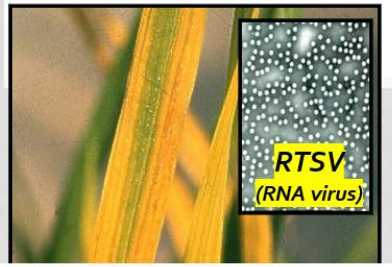
International Rice Research Institute

Quadruple SWEET variants in IR64 and Ciherang-Sub1 with broad-spectrum resistance to BLB



Oliva R, Slamet-Loedin et al. Nature Biotechnology. 2019

Rice tungro spherical virus (RTSV)



Event	eIF4G allele	eIF4G protein	Zygosity	Reaction to RTSV
1146	A	Substitutions/deletions far upstream of YVV	A/A or A/D	Inconclusive (Resistant or susceptible)
	D	Truncated		
1147	B	Substitutions/deletions immediate upstream of YVV	B/B or B/D	Resistant
	D	Truncated		

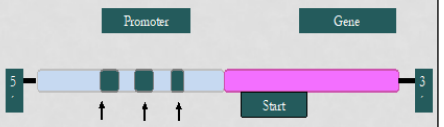
- Rice Tungro Virus Disease is a serious constraint in rice production across tropical Asia. RTD is caused by the interaction between Rice tungro spherical virus (RTSV) and Rice tungro bacilliform virus (RTBV)
- Natural variation in `Utri merah' resistant rice cultivar for RTSV Resistance is controlled by eIF4G in chr 7 (Lee et al., 2010).
- We developed novel variants by gene editing showing resistance to RTSV

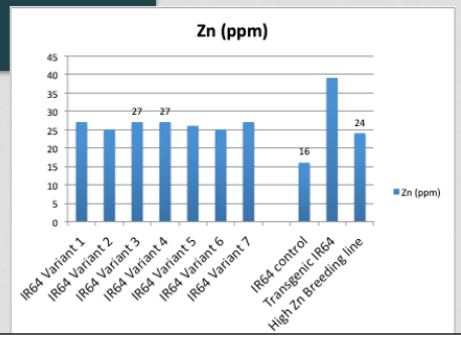
Plant Biotechnol J. 2018 Nov;16(11):1918-1927. doi: 10.1111/pbi.12927. Epub 2018 Apr 30.

Novel alleles of rice eIF4G generated by CRISPR/Cas9-targeted mutagenesis confer resistance to Rice tungro spherical virus.

Biofortification by GEd approach

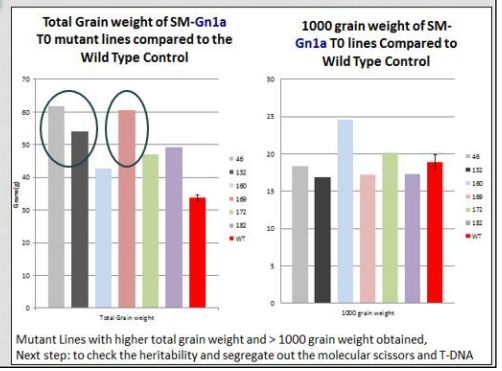
Promoter editing - by CRISPR-Cas9 and -Cpf1 to increase translocation of mineral





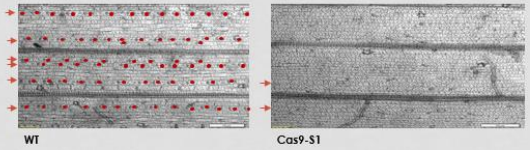
Yield trait

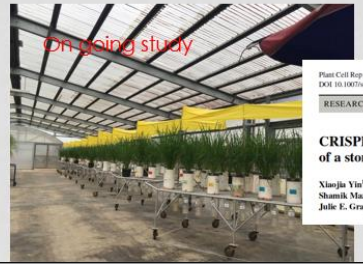
- Knockout Yield Related Genes Using CRISPR-Cpf1 System in Samba Mahsuri and IR64
- Gene : *Gn1a*



Mutant Lines with higher total grain weight and > 1000 grain weight obtained,
Next step: to check the heritability and segregate out the molecular scissors and T-DNA

OsEPFL9 Knocked-out in Rice Using CRISPR to reduce the mature stomata number for Water Use Efficiency





Plant Cell Rep
DOI 10.1007/s00299-017-2118-z

RESEARCH ARTICLE

CRISPR-Cas9 and CRISPR-Cpf1 mediated targeting of a stomatal developmental gene *EPFL9* in rice

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Sources of Slides: I. Slamet-Loedin (2020)

Status of Application for Field Trial

Transformation Event (Application Form)	Trait	Technology Developer	Public Information Sheet	Date Applied	Date Approved	Sites Approved	Biosafety Permit	Date Posted
High Iron, High Zinc Rice IRS1030-031	High Iron, High Zinc	Philippine Rice Research Institute	Public Information Sheet for High Iron, High Zinc Rice IRS1030-031	May 31, 2022	October 20, 2022	PhilRice Central Experiment Station, Brgy. Maligaya, Science City of Munoz, Nueva Ecija and PhilRice Batac Station MMSU Campus, Batac City, Ilocos Norte	Biosafety Permit of High Iron, High Zinc Rice IRS1030-031	October 20, 2022
High Iron, High Zinc Rice IRS1030-039	High Iron, High Zinc	Philippine Rice Research Institute	Public Information Sheet for High Iron, High Zinc Rice IRS1030-039	May 31, 2022	October 20, 2022	PhilRice Central Experiment Station, Brgy. Maligaya, Science City of Munoz, Nueva Ecija and PhilRice Batac Station MMSU Campus, Batac City, Ilocos Norte	Biosafety Permit of High Iron, High Zinc Rice IRS1030-039	October 20, 2022

Republic of the Philippines
Department of Agriculture
BUREAU OF PLANT INDUSTRY
692 San Andres St., Malate, Manila

Biosafety Permit for Field Trial Number 22-001b-FT

Field trial proposal entitled ***"Proposal for the Field Trial of Genetically Engineered High Iron and Zinc Rice Event IRS1030-031"*** of the Philippine Rice Research Institute (PhilRice) with office address at PhilRice Central Experiment Station, Maligaya, Science City of Muñoz, 3119 Nueva Ecija has satisfactorily completed the biosafety risk assessment for field trial pursuant to the DOST-DA-DENR-DOH-DILG Joint Department Circular No. 1, series of 2021. This permit is hereby issued for the field trial of the said regulated article.

This Biosafety Permit for Field Trial shall not excuse the permit holder from complying with relevant regulations of other government agencies.

The Bureau of Plant Industry has approved the conduct of the proposed activity in **PhilRice-Batac Station MMSU Campus, Batac City, Ilocos Norte** subject to the following conditions:

a. The proponent shall submit to the BPI the duly accomplished Oath of Undertaking before

Republic of the Philippines
Department of Agriculture
BUREAU OF PLANT INDUSTRY
692 San Andres St., Malate, Manila

Biosafety Permit for Field Trial Number 22-002b-FT

Field trial proposal entitled ***"Proposal for the Field Trial of Genetically Engineered High Iron and Zinc Rice Event IRS1030-039"*** of the Philippine Rice Research Institute (PhilRice) with office address at PhilRice Central Experiment Station, Maligaya, Science City of Muñoz, 3119 Nueva Ecija has satisfactorily completed the biosafety risk assessment for field trial pursuant to the DOST-DA-DENR-DOH-DILG Joint Department Circular No. 1, series of 2021. This permit is hereby issued for the field trial of the said regulated article.

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Salamat