Genetic biofortification and dissemination of Indian maize hybrids for enhanced nutritional security

Dr. Vignesh MUTHUSAMY
Senior Scientist
Indian Agricultural Research Institute

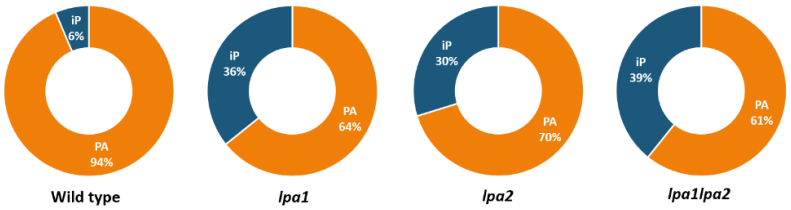
Reason for the Award

The awardee developed a total of 18 nutritionally rich maize hybrids and others, including India's first provitamin A-rich maize hybrid, through marker-assisted backcross breeding and other breeding approaches. In addition to the development of such biofortified varieties, the achievement was recognized for its strong record of dissemination and practical application, as eight of these varieties have been officially registered and commercialized through licensing agreements with seed companies.

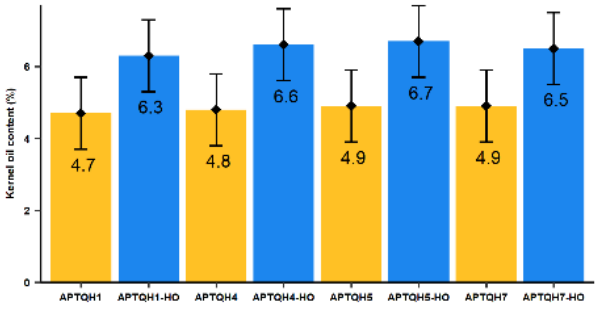
Outline of Research Achievement

Addressing the concerns of micronutrient malnutrition, Dr. Vignesh Muthusamy has significantly contributed to the development of 18 nutritionally rich maize hybrids and 9 specialty corn hybrids through an integrated approach combining traditional and molecular breeding techniques. Nutritionally rich hybrids combine QPM, provitamin A, vitamin E, low phytate, and waxy traits, while specialty hybrids include popcorn, shrunken2-based sweet corn, male sterile baby corn, and forage maize. He pioneered the development of provitamin A-rich maize genotypes through marker-assisted backcross breeding, leading to India's first provitamin A-rich maize hybrid 'Pusa Vivek QPM-9 Improved', also the world's first multi-nutrient-rich maize hybrid with elevated provitamin A, lysine, and tryptophan.

Low-phytic acid maize was advanced by pyramiding the *lpa1* and *lpa2* genes to develop double mutants (*lpa1lpa2*). The role of *CCD1* and *lox3* was determined for provitamin A retention and tocopherol stability, respectively, to address post-harvest storage concerns in maize. To further enhance the bioavailability of vitamin A and E, high-oil multivitamin maize hybrids have been developed. Also, efforts on biofortification of popcorn led to the development of quality protein popcorn hybrids.



Proportion of phytic acid (PA) and inorganic phosphorus (iP) in *lpa*-based wild, single, and double mutants



Enhancement of kernel oil content in the multi-vitamin maize hybrids

Main Publications:

(1) Enrichment of kernel oil and fatty acid composition through genomics-assisted breeding for *dgat1-2* and *fatb* genes in multi-nutrient rich maize. *The Plant Journal*, 119, 2402–2422 (2024).
(2) Development and characterization of *lpa1* and *lpa2*-based low phytate double mutants in maize for enhancing the nutritional quality of food and feed. *Journal of Food Composition and Analysis*, 136, 106771 (2024).
(3) Genetic dissection of embryo size and weight related traits for enhancement of kernel oil in maize. *Plant Physiology and Biochemistry*, 197, 107668 (2023).

Research on Artificial Intelligence in agriculture, aquaculture and livestock production and its international application and deployment

Dr. Ivan Eduardo RAMIREZ MORALES

Professor-Director of the Research, Development and Innovation Department

Technological University of Machala

Reason for the Award

The awardee conducted research applying artificial intelligence across diverse fields such as agriculture, aquaculture, and livestock farming. In particular, technologies on computer vision for shrimp biometric measurement via mobile phones have been put into practical use, with a related startup established and its services expanded to 18 countries. The achievement was recognized for both its successful commercialization and its promising potential as a model case for technological deployment in developing regions where advanced technology-driven agriculture is gradually spreading.

Outline of Research Achievement

Dr. Ivan Eduardo Ramirez Morales has pioneered the application of artificial intelligence (AI) in agriculture, aquaculture, and livestock, developing low-cost, scalable solutions to improve productivity and sustainability. In poultry farming, he implemented early warning systems using Support Vector Machine (SVM) and neural networks to predict drops in egg production, enabling timely interventions. In the food industry, he combined Near Infrared Reflectance (NIR) spectrometry with AI algorithms for quality control in sugar, milk, and eggs, creating fast and accessible tools for producers.

In 2020, he founded Larvia.ai, a startup that applies computer vision for shrimp biometric measurement via mobile phones. The tool is now used in more than 18 countries and has been globally recognized as a leading aquaculture innovation providing real-time diagnostics for one of Ecuador's most strategic exports. These contributions have effectively translated academic research into practical solutions with productive, environmental, and social impact, positioning Ecuador as a regional reference in the use of AI for sustainable agricultural development.

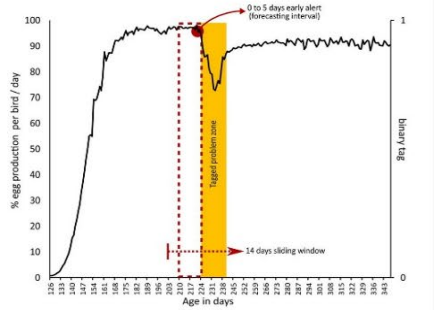


Fig 1. Early warning of egg production drop using SVM

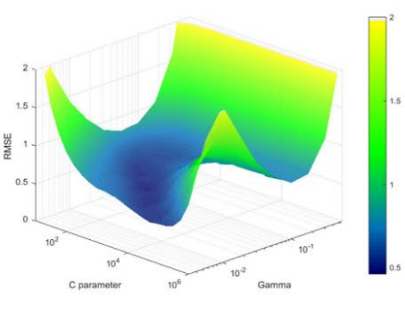


Fig 2. Surface plot of RMSE across C and γ parameters

Fig 3. Mobile-based shrimp biometric analysis using Larvia.ai

Main Patent and Publications:

(1) Method for estimating morphophysiological variables of interest in aquaculture organisms. World Patent (No. 2022172051:A1). Ecuador Patent (No. SP202248353A).
(2) Early warning in egg production curves from commercial hens: A SVM approach, *Computers and Electronics in Agriculture*, 121, 169–179 (2016).
(3) Determination of egg storage time at room temperature using a low-cost NIR spectrometer and machine learning techniques. *Computers and Electronics in Agriculture,* 145, 1–10 (2018).

Research on Innovative Enset Processing and Fermentation Technologies and its Deployment in Five Regions of Ethiopia

Dr. Addisu Fekadu ANDETA
Associate Professor of Food Technology
Arba Minch University

Reason for the Award

The awardee conducted research to innovate processing and fermentation techniques for enset, a staple crop in certain regions of Ethiopia. The developed technologies have been put into practical use, contributing to reduced labor burdens in processing and enhancing the safety of fermented foods. The achievement was also recognized for its significance in preserving traditional crops from a food security perspective, as well as its potential for entry into gluten-free and low-glycemic index (GI) markets in Europe and the United States.

Outline of Research Achievement

Enset (*Ensete ventricosum*), a climate-resilient crop, sustains more than 25 million Ethiopians. Despite its high yield and nutrient density, its contribution to food security has been limited by labor-intensive processing, long fermentation periods, and inconsistent product quality. Traditional processing requires up to eight hours of work, while fermentation lasts 2–3 months, favoring undesirable microbes and causing post-harvest losses of up to 34%. The microbial ecology of enset fermentation has been mapped, with *Leuconostoc*, *Lactobacillus*, and *Weissella* identified as dominant lactic acid bacteria (LAB) (Andeta et al., 2025). From these, *Lactobacillus plantarum* (FX15, SAM6) and *Leuconostoc mesenteroides* (HM53) were validated as starter cultures, reducing fermentation time from 60 days to just 7 days. In parallel, user-friendly, cost-effective processing machines (designed by Dr. Addisu) cut women's workload from 10 hours to under 1 hour and reduced food loss from 34% to 2%. Together, these innovations have transformed enset into safe, diverse value-added products that are gluten-free, low glycemic, organic, and nutrient-dense, positioning it as a potential superfood. Deployment across five Ethiopian regions demonstrates enset's transition into a modern, climate-smart food system that strengthens women's livelihoods, enhances food security, and creates new market opportunities.

Enset processing and fermentation: (A) Traditional processing, (B) Improved processing with machines, (C) Kocho without starter (60 days), and (D) Kocho with starter culture (7 days)

Main Publications and Patent:

(1) Evaluating food safety of traditionally fermented kocho: microbial profiling through classical methods and PacBio SMRT sequencing technology. *Antonie van Leeuwenhoek*, 118, 127 (2025).
(2) Development and validation of lactic acid starter cultures for enset (*Ensete ventricosum*) fermentation. *Lebensmittel-Wissenschaft + Technologie*, 115,108462 (2019).
(3) Kocho Flour and Enset-Based Foods Preparation from Fermented Enset (Patent No.: ET/U/2021/3772).