N E W S L E T T E R

e-SCIENCE PUTRA

UNIVERSITI PUTRA MALAYSIA

AGRICULTURE | INNOVATION | LIFE

ISSUES 19 (SEPTEMBER - DECEMBER 2025)

Welcome to the Newsletter e-Science Putra. This issue presents the research activities from September to December 2025 which highlight the latest research findings by the selected faculty members.

HIGHLIGHTS

- Smart Agriculture and Iot Inspire Young Innovators Towards Malaysia's Sdg Goals
- A Legendre Ensemble-Based Extreme Learning Machine Neural Network Method for Time-Fractional Convection–Diffusion Equation
- When Flood Threaten the Rice Bowl: Why Malaysia Needs Flood-Resilient Rice Varieties
- Mercury Impairs Vision, Color Choice and Social Behavior in Zebrafish

SMART AGRICULTURE AND IOT INSPIRE YOUNG INNOVATORS TOWARDS MALAYSIA'S SDG GOALS

Dr. Nur Biha Mohamed Nafis
Department of Physics, Faculty of Science,
Universiti Putra Malaysia
Expertise: Metamaterials, RF and Microwaves, Microwave sensors, Selective Surface Frequencies
Email: nurbiha@upm.edu.my

In February and July 2025, the Department of Physics, Faculty of Science, Universiti Putra Malaysia, in collaboration with SK Kem Terendak 1, organised a programme aimed at strengthening students' understanding of smart agriculture, the Internet of Things (IoT) and Arduino automation. Led by Dr. Nur Biha Mohamed Nafis and funded by the Knowledge Transfer Grant Scheme @ PTJ (KTGS@PTJ), the initiative supported STEM learning while contributing to Malaysia's Sustainable Development Goals (SDGs) as outlined in the national 2030 Agenda (United Nations, 2015). Through hands-on and interactive lessons, the programme demonstrated significant gains in students' knowledge and awareness, as shown through pre- and post-programme survey data. Two main modules were implemented: agriculture module and sensors and Arduino module.

1. Agriculture: Strengthening Food Security (SDG 2)

Prior to the programme, students had limited exposure to modern agricultural systems such as aeroponics and vertical farming—both critical for future food security (FAO, 2021). Post-survey findings showed marked improvements: 97.22% identified high-quality seeds, 88.89% understood seedling preparation, 75% differentiated between sowing techniques, and 77.78% recognised the benefits of aeroponics. These gains support SDG 2 (Zero Hunger) by fostering early awareness of sustainable food production.

2. Sensors & Arduino (IoT): Developing Digital Problem-Solvers (SDG 4 & SDG 9)

Initial surveys revealed high interest in technology, with 55.10% expressing strong enthusiasm, though only 61.22% had heard of Arduino. After the module, understanding improved significantly: 94.44% grasped the use of soil moisture sensors, 94.44% understood Arduino's role in agriculture, 80.55% recognised data transmission through platforms such as ThingSpeak, and 88.89% explained LED functions in circuits. A notable 97.22% expressed motivation to explore IoT further. These outcomes align with SDG 4 (Quality Education) and SDG 9 (Industry, Innovation & Infrastructure), reinforcing Malaysia's digital transformation goals.

The KTGS@PTJ programme delivered clear improvements in agricultural literacy, digital skills, IoT knowledge, and STEM motivation. These outcomes support Malaysia's aspirations to develop an innovation-driven and resilient society aligned with the 2030 Agenda for Sustainable Development.

By integrating smart agriculture techniques and IoT applications, the programme nurtures technologically capable and environmentally responsible young learners who will contribute to Malaysia's sustainable future.

Figure 1: Smart agriculture and IoT hands-on activities.

Figure 2: Group photo with facilitators and organisers after the Projek Tanamlah@Q1.0 session.

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3)UNESCO. (2024). UNESCO and Sustainable Development Goals. Unesco.org. https://www.unesco.org/en/sdgs

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A LEGENDRE ENSEMBLE-BASED EXTREME LEARNING MACHINE NEURAL NETWORK METHOD FOR TIME-FRACTIONAL CONVECTION–DIFFUSION EQUATION

Assoc. Prof. Dr. Norazak Senu
Department of Mathematics and Statistics,
Faculty of Science,
Universiti Putra Malaysia
Expertise: Numerical Analysis
Email: norazak@upm.edu.my

The recent advancements in machine learning techniques across various domains have opened new possibilities for addressing time-fractional convection–diffusion equations, particularly using neural networks (NNs). These approaches take advantage of the universal approximation property of neural networks to efficiently represent complete solutions. This study introduces a neural network-based method that employs the ensemble extreme learning machine (EN-ELM) to effectively solve time-fractional convection–diffusion equations defined using the Caputo fractional derivative. The proposed method integrates Legendre polynomials to expand input features and uses the radial basis function as the activation function for the hidden layer neurons. By incorporating cross-validation, the EN-ELM framework achieves enhanced accuracy, improved stability, and reduced computational complexity.

The time-fractional convection–diffusion equation of order ,$0 < \zeta \leq 1$ given as the following [1]:

$$\frac{\partial^{\zeta}\Phi(x,t)}{\partial t^{\zeta}} + \frac{\partial\Phi(x,t)}{\partial x} + \frac{\partial^{2}\Phi(x,t)}{\partial t^{2}} = 2x^2 + 2t^{\zeta} + 2, \quad (x,t) \in [0,1],$$

$$\Phi(x,0) = x^2, \quad 0 < x < 1,$$

$$\Phi(0,t) = \frac{2\Gamma(\zeta+1)}{\Gamma(2\zeta+1)}t^{2\zeta}, \qquad \Phi(1,t) = 1 + \frac{2\Gamma(\zeta+1)}{\Gamma(2\zeta+1)}t^{2\zeta},$$

The exact solution is $\Phi(x,t) = x^2 + \frac{2\Gamma(\zeta+1)}{\Gamma(2\zeta+1)}t^{2\zeta}$.

A graphical representation of the approximate and exact solutions for is provided in Fig. 1, demonstrating the accuracy of the proposed method. The efficiency of the L-EN-ELM approach is further validated in Table 1, which compares its performance with the method in [2] and the single-layer Hermite Wavelet Neural Network (HWNN) method in [3].

The results clearly show that the L-EN-ELM method achieves superior accuracy and faster execution time compared to HWNN.

x	L-EN-ELM	HWNN in [3]	Method in [2] (m=64)
0.1	1.11022e−16	4.0792e−04	1.210e−03
0.2	0	6.5330e−04	1.2590e−03
0.3	1.11802e−16	8.0828e−04	1.8650e−03
0.4	4.44089e−16	8.9717e−04	7.4120e−03
0.5	0	9.3368e−04	1.0000e−06
0.6	4.44398e−16	9.1281e−04	7.4600e−03
0.7	0	8.2092e−04	1.7240e−03
0.8	2.22045e−16	6.4271e−04	4.9900e−03
0.9	2.22354e−16	3.6825e−04	1.6780e−02
Execution time: L-EN-ELM = 0.0092 s		HWNN = 0.136130 s	

Table 1 Comparison of absolute errors of L-EN-ELM and HWNN in [3], for ζ =0.5, t=0.5

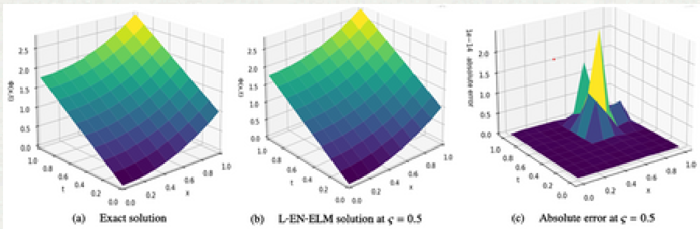

Figure 1. Plots of exact and approximate solutions.

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WHEN FLOOD THREATEN THE RICE BOWL: WHY MALAYSIA NEEDS FLOOD-RESILIENT RICE VARIETIES

Assoc. Prof. Dr. Rosimah Nulit
Department of Biology,
Faculty of Science,
Universiti Putra Malaysia
Expertise: Biotechnology and Plant Molecules
Email: rosimahn@upm.edu.my

Rice is more than just food in Malaysia. It is part of everyday life. Every plate of nasi lemak or plain white rice reflects a food system that millions of Malaysians depend on. Yet behind this staple lies a growing concern, Malaysia produces only about two-thirds of the rice it consumes. Flood have become an almost yearly event, particularly in key rice-growing states such as Kedah and Kelantan. While rice plants require water to grow, excessive flooding can be devastating-submerging fields, damaging crops, and wiping out entire harvests (Fig. 1). Past flood disasters have destroyed 18,520 ha of paddy fields and destroyed over 50,000 tonnes of paddy, costing farmers millions of ringgits and disrupting national rice supplies. Between 2017 and 2021 alone, over 40,000 ha of paddy fields were affected nationwide, with compensation exceeding RM128 millions (MAFI, 2024).

Climate change is intensifying this problem. Natural monsoon cycles play a role, but human activities such as deforestation and rapid urbanisation have made the situation worse. Malaysia has made progress i developing high-yield and disease-resistant rice varieties, but the resistance of these varieties to flooding is unknown. This gap is critical in a country where flooding occurs almost every year, driven not only by monsoon rains but also by deforestation and rapid urban development. This is where flood-tolerant rice becomes critical. Our research focuses on the identification and evaluation on Malaysian indica rice varieties that can better cope with flood stress using biomarkers approach; plant growth, biochemicals, and yield-related traits (Fig. 2).

The findings are expected to provide valuable baseline data for breeding flood-tolerant rice lines and support their deployment in flood-prone areas, thereby reducing yield losses, improving farmer livelihoods, and strengthening national food security.

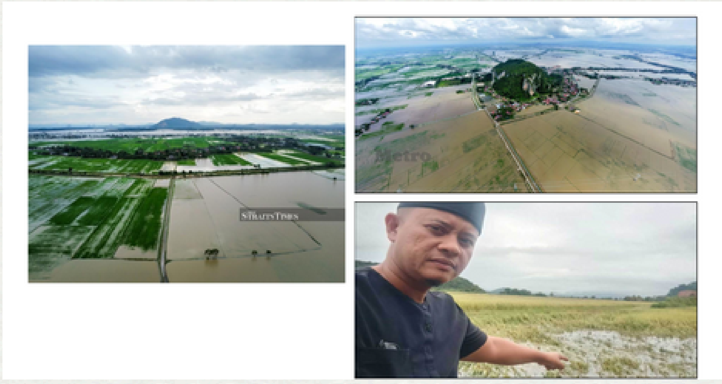

Fig. 1. Paddy fields in the Muda Agricultural Development Authority (MADA), Kedah area and Kampung Pulau Mas have been affected by the massive floods

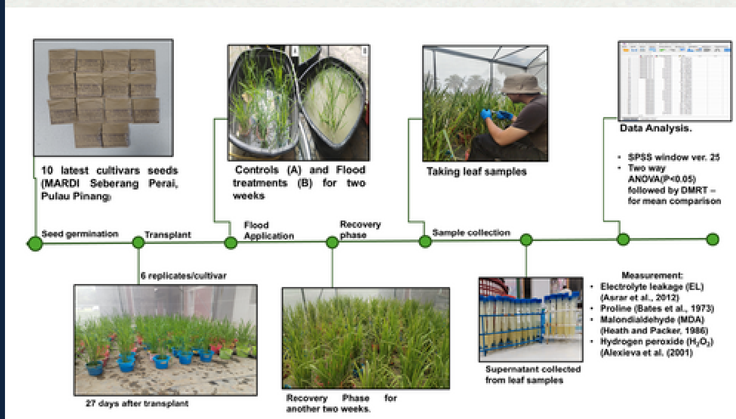

Fig. 2. Evaluating flood-tolerant Malaysia indica rice varieties

References:

Ministry of Agriculture and Food Security (MAFI) (2024). National Agrofood Policy. Retrieved from https://www2.kpkm.gov.my/en/agro-food-policy/national-agrofood-policy.

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MERCURY IMPAIRS VISION, COLOR CHOICE AND SOCIAL BEHAVIOR IN ZEBRAFISH

Dr. Noraini Abu Bakar
Department of Biology,
Faculty of Science,
Universiti Putra Malaysia
Expertise: Neuroscience, Neurotoxicology
Email: norainibakar@upm.edu.my

Mercury, a heavy metal found widely in the environment and used in many industrial and household products, is known to harm human health. Yet, its effects at low levels of exposure are often overlooked. Mercury deposition in the environment can contaminate fish, shellfish, marine mammals, and rice cultivated in highly mercury-polluted area. Of particular concern, an increasing body of evidence indicates that even low-level mercury exposure can have subtle yet detrimental health effects in developing children. Emerging evidence suggests that mercury accumulation in ocular tissues may contribute to visual impairment and a potential comorbidity between autism spectrum disorder (ASD) traits and visual deficits. However, elucidating the underlying mechanisms of mercury-related visual impairment in both humans and rodent models remains challenging. Using zebrafish as a model organism, our research trace how even "safe" mercury exposure disrupts vision, cognition, and social behavior, offering early warning signs for prevention. Zebrafish (Danio rerio) rely heavily on vision, making them a valuable model for assessing the neurotoxic effects of environmentally relevant mercury concentrations. Their retina is highly conserved with that of mammals, featuring cone-rich photoreceptors responsive to blue, UV, red, and green light, and enabling visual responses as early as 5 dpf. This cone-dominant system, unlike rodent models, allows detailed study of photoreceptor development and visual deficits. Rapid visual development, high-throughput behavioral assays, and advanced microscopy further support zebrafish as an ideal model for investigating the neurotoxicity effect of mercury at low concentration.

Our findings showed that zebrafish larvae with a cone–dominated retinal visual system exposed to 100 nM $HgCl_2$ increased dark-phase locomotion, reduced shoaling and exploration, and impaired color preference. Microridges defects, as disruptions to the eye's first protective barrier, may signal early $HgCl_2$-induced visual toxicity. LC–MS profiling revealed depletion in polyunsaturated fatty acids (PUFAs) including linoleic acid, arachidonic acid (ARA), alpha-linolenic acid, and docosahexaenoic acid (DHA) as well as changes in neurotransmitter-related metabolites such as gamma-aminobutyric acid (GABA) and sphingosine. These metabolic changes suggest potential biomarkers of retinal impairment and associated behavioral deficits. These metabolic disruptions were accompanied by suppressed expression of ASD associated genes (adsl, shank3a, tsc1b), suggesting molecular pathways through which $HgCl_2$ exposure impairs retinal function and behavior. From eye to mind, mercury leaves an enduring imprint by disrupting vision, cognition, and social behavior in zebrafish. This work reveals how low-level mercury exposure can cause lasting harm, highlighting long-term public health risks even at levels deemed safe.

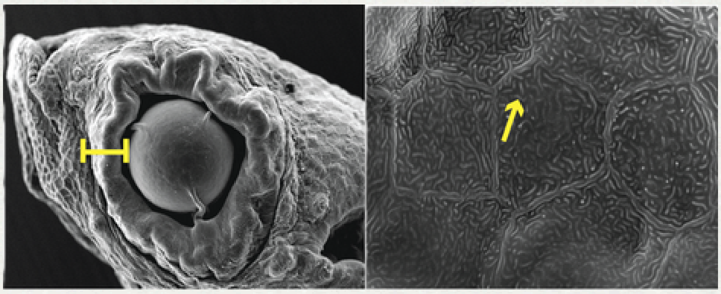

Figure 1 Microridges defect on zebrafish eyes after embryonic exposure to mercury.

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Science is much more than just a body of KNOWLEDGE.
It is a way of THINKING.

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FACULTY OF SCIENCE, UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR DARUL EHSAN, MALAYSIA
+603 97696601/6602/6603 www.science.upm.edu.my fs_tdps@upm.edu.my