# BOOK OF ABSTRACTS

15th ICERD

BCG

## The 15th International Conference on Environmental and Rural Development

**8-10 March, 2024**
**Khon Kaen, Thailand**


### Organized by

International Society of Environmental and Rural Development
Khon Kaen University, Thailand
Institute of Environmental Rehabilitation and Conservation, Japan

### Collaborated with

United Nations University Institute for the Advanced study of Sustainability
University of Queensland, Australia
The University of East Sarajevo, Bosnia and Herzegovina
Tokyo University of Agriculture, Japan
Yezin Agricultural University, Myanmar
Bohol Island State University, Philippines
Association of Environmental and Rural Development, Thailand
Kasetsart University, Thailand
Royal University of Agriculture, Cambodia
Rajamangala University of Technology Thanyaburi, Thailand
Sukhothai Thammathirat Open University, Thailand
Can Tho University, Vietnam
National University of Laos, Lao PDR

60 ปี แห่งการสร้างสรรค์และพัฒนาเพื่อสังคม

# 15th ICERD

## The 15th International Conference on Environmental and Rural Development

# BOOK OF ABSTRACTS

8-10 March, 2024

Khon Kaen, Thailand

Organized by

Supported by

Collaborated with

## Table of Contents

***Education for Sustainable Development (ESD)***



***Rural Development (RD)***

## Managing Committee and Chairmanship

| | |
|---|---|
| Managing Committee | |
| President of ISERD | Prof. Dr. Mario T. Tabucanon |
| Deputy Presidents of ISERD | Prof. Dr. Bunthan Ngo, Prof. Dr. Anan Polthanee, Prof. Dr. Eiji Yamaji |
| Chair of Organizing and Steering Committee | Assoc. Prof. Dr. Chuleemas Boonthai Iwai |
| Chair of Scientific Committee | Prof. Dr. Machito Mihara |
| Chair of Awarding Committee | Prof. Dr. Eiji Yamaji |

**ORAL PRESENTATION**

| **Session 1** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Room 1** | | **Room 2** | | **Room 3** | | **Room 4** | |
| Chair | **Dr. Rika Terano** | Chair | **Prof. Dr. Barry Noller** | Chair | **Dr.Christian Hartmann** | Chair | **Dr. Lalita Siriwattananon** |
| Co-chair | **Dr. Supaporn Poungchompu** | Co-chair | **Dr. Adcharaporn Pakdee** | Co-chair | **Dr. Kewaree Pholkern** | Co-chair | **Dr. Koki Homma** |
| **Session 2** | | | | | | | |
| **Room 1** | | **Room 2** | | **Room 3** | | **Room 4** | |
| Chair | **Prof. Dr. Fumkazu Ubukata** | Chair | **Prof. Dr. Anan Polthanee** | Chair | **Dr. Narong Touch** | Chair | **Dr. Takashi Kume** |
| Co-chair | **Dr. Kasumi Ito** | Co-chair | **Dr. Hor Sanara** | Co-chair | **Dr. Santi Kongmany** | Co-chair | **Dr. Naoko Oka** |
| **Session 3** | | | | | | | |
| **Room 1** | | **Room 2** | | **Room 3** | | **Room 4** | |
| Chair | **Dr. Borarin Buntong** | Chair | **Dr. Sarvesh Maskey** | Chair | **Dr.Tarek Ben Hassen** | Chair | **Dr. Anucha Wittayakorn-Puripunpinyoo** |
| Co-chair | **Dr. Raj Chongtham** | Co-chair | **Dr. Jeeranuch Sakdaduang** | Co-chair | **Prof. Dr. Ping Li** | Co-chair | **Prof. Dr. Choichi Sasaki** |

## POSTER PRESENTATION

| AGRICULTURE AND FOOD SYSTEMS 1 | |
|---|---|
| Co-Chairs | Dr. Yoshimi Osawa |
| Co-Chairs | Dr. Panupon Hongpakdee |
| Co-Chairs | Dr. Riskina Juwita |

| AGRICULTURE AND FOOD SYSTEMS 2 | |
|---|---|
| Co-Chairs | Prof. Dr. Koshi Yoshida |
| Co-Chairs | Prof. Dr. Kazuo Oki |
| Co-Chairs | Dr. Tetsuya Shimamura<br>Dr.Thammared Chuasavathi |

| ENVIRONMENTAL MANAGEMENT 1 | |
|---|---|
| Co-Chairs | Dr. Tadao Yamamoto |
| Co-Chairs | Dr. Ivana Angelova |
| Co-Chairs | Dr.Sunny Eng Giap Goh |

| ENVIRONMENTAL MANAGEMENT 2 | |
|---|---|
| Co-Chairs | Dr.Bernard Mijares |
| Co-Chairs | Dr. Natsima Tokhun |
| Co-Chairs | Dr. Somara Oum |

| ESD and RURAL DEVELOPMENT | |
|---|---|
| Co-Chairs | Prof. Dr. Mario T. Tabucanon |
| Co-Chairs | Dr. Kailert Taweekul |
| Co-Chairs | Dr. Thanaporn Athipanyaku |

# 15th ICERD General Program

## 8th March 2024, Friday (at Bayasita KKU Hotel)

**Bayasita KKU Hotel**
Address: 123 Mu 16 Thanon Mittraphap, Nai Mueang, Mueang Khon Kaen District, Khon Kaen 40002, Thailand ⟶ **[Google maps link]**

| | |
|---|---|
| 15:00 - 18:00 | Registration of the conference at **Bayasita KKU Hotel** in Khon Kaen |
| 15:00 – 16:30 | The 15th ISERD Council Meeting at Choem Khwan Room of Bayasita KKU Hotel |
| 16:30 – 17:00 | Steering Committee Meeting of 15th ICERD with ISERD Councilors |
| 17:00 - 19:00 | Welcome Reception at Khoom Khwan courtyard of Bayasita KKU Hotel |

## 9th March 2024, Saturday (at Avani Khon Kaen Hotel & Convention Centre)

**Avani Khon Kaen Hotel & Convention Centre**
Address: Mu 4 999 Thanon Prachasamoson, Mueang Khon Kaen District, Khon Kaen 40000, Thailand ⟶ **[Google maps link]**

| | |
|---|---|
| 08:00 – 16:30 | Registration of Participants at **Avani Khon Kaen Hotel & Convention Centre** |
| 08:30 – 10:00 | Opening Ceremony |
| 10:00 - 10:30 | Poster Presentation and Coffee-Tea Break |
| 10:30 - 12:00 | Scientific Program - Session 1 |
| 12:00 - 13:00 | Lunch Time |
| 13:00 - 14:30 | Scientific Program - Session 2 |
| 14:30 - 15:00 | Poster Presentation and Coffee-Tea Break |
| 15:00 - 16:30 | Scientific Program - Session 3 |
| 17:00 - 20:00 | Banquet and Awarding Ceremony |

## 10th March 2024, Sunday (from Avani Khon Kaen Hotel & Convention Centre)

**Avani Khon Kaen Hotel & Convention Centre**
Address: Mu 4 999 Thanon Prachasamoson, Mueang Khon Kaen District, Khon Kaen 40000, Thailand ⟶ **[Google maps link]**

| | |
|---|---|
| 08:00 – 16:00 | Excursion Option 1 (Gathering in front of **Avani Hotel at 7:30** ) |

# 15th ICERD Scientific Program

## Opening Ceremony

**Master of Ceremony: Associate Professor Dr. Adcharaporn Pagdee.** Head of Department of Environmental Science. Faculty of Science Khon Kaen University

| | | | |
|---|---|---|---|
| 8:30-10:00 | 8:30 - 8:35 | Welcome Remarks from Khon Kaen University | **Associate Professor Dr.Darunee Jothityangkoon**<br>Dean of the Faculty of Agriculture, Khon Kaen University |
| | 8:35 - 8:50 | Welcome Remarks from ISERD | **Professor Dr. Mario T. Tabucanon**<br>ISERD President / Professor Emeritus at Asian Institute of Technology /<br>Senior Visiting Professor at the United Nations University Institute for the Advanced Study of Sustainability |
| | 8:50 - 8.55 | Reports from the Chair of the 15th ICERD Organizing Committee | **Assoc. Professor Dr. Chuleemas Boonthai Iwai**<br>ISERD Deputy President / Associate Professor at Khon Kaen University /<br>Director at Integrated Land and Water Resource Management Research and Development Center in Northeast Thailand, Khon Kaen University, Thailand |
| | 8:55 - 9.00 | Opening Remarks | **Assoc. Prof. Charnchai Panthongviriyakul, M.D.**<br>President of Khon Kaen University |
| | 9:00 - 9:15 | Introduction about ISERD Awards | **Professor Dr. Eiji Yamaji**<br>ISERD Deputy President / Professor Emeritus at the University of Tokyo /<br>Director (Research) at the Institute of Environmental Rehabilitation and Conservation, Japan |
| | 9:15 - 9:30 | Messages from ISERD Councilors | **Professor Dr. Machito Mihara**<br>ISERD Executive Secretary / Director, Professor at the Center for Global Initiatives, Tokyo University of Agriculture /<br>President at the Institute of Environmental Rehabilitation and Conservation, Japan |
| | 9:30 - 9:45 | Keynote presentation | **Associate Professor Dr.Darunee Jothityangkoon**<br>Dean of the Faculty of Agriculture, Khon Kaen University<br>Presentation title **: Bio-Circrlar-Green(BCG) Economy (BCG in action at KKU) : Pathways to a Sustainable Future** |
| | 9:45 - 10:00 | Keynote presentation | **Professor Yoshiko Tanahashi**<br>ISERD Managing Editor (Advisor) / Professor at Tokyo University of Agriculture, Japan<br>Presentation title: **Citation Analysis on International Journal of Environmental and Rural Development 2010-2023** |

## Scientific Session

| | | | |
|---|---|---|---|
| 10:00-16:30 | 10:00-16:30 | Poster Presentations | All posters are exhibited in the conference hall (10:00-10:30, 14:30-15:00 Poster Presentation time) |
| | 10:30-12:00 | Oral presentations - Session 1 | Please see following pages for Oral Presentation Program |
| | 13:00-15:00 | Oral presentations - Session 2 | Please see following pages for Oral Presentation Program |
| | 15:30-16:30 | Oral presentations - Session 3 | Please see following pages for Oral Presentation Program |

## Banquet and Awarding Ceremony

| | | | |
|---|---|---|---|
| 17:00-20:00 | 17:00 | Dinner | |
| | 18:45-19:00 | Awarding Ceremony for ERECON Awards with the acknowledgement of ISERD | **For Scientific Award of Environmental Agriculture:** Assoc. Prof. Dr. Kasumi Ito<br>**For Award of Global Greening:** Assoc. Prof. Dr. Kasumi Ito |
| | 19:00-19:45 | Awarding ceremony for ISERD Awards | **For Award of Excellent Paper:** Prof. Dr. Eiji Yamaji<br>**For Award of Excellent Poster Presentation:** Prof. Dr. Dieter Trautz<br>**For Award of Sustainability Promotion:** Prof.Dr.Barry Noller<br>**For Award of Outstanding Scientific Achievement:** Assoc. Prof. Dr. Chuleemas Boonthai Iwai |
| | 19:45-20:00 | Invitation to NEXT ICERD | |

# Oral Presentations : Session 1

| | Room 1 | | Room 2 | | Room 3 | | Room 4 | |
|---|---|---|---|---|---|---|---|---|
| | Chair | **Dr. Rika Terano** | Chair | **Prof. Dr. Barry Noller** | Chair | **Dr. Christian Hartmann** | Chair | **Dr. Lalita Siriwattananon** |
| | Co-chair | **Dr. Supaporn Poungchompu** | Co-chair | **Dr. Adcharaporn Pagdee** | Co-chair | **Dr. Kewaree Pholkern** | Co-chair | **Dr. Koki Homma** |
| | Code | Title | Code | Title | Code | Title | Code | Title |
| **10:30-10:45** | **EM-15-17** | Ecotourism in Southeast Asia: A Systematic Review of Ecotourism Activities and Factors Determining Tourists' Willingness to Pay for Ecosystem and Biodiversity Protection<br>**Desvia Norita Angelina and Adcharaporn Pagdee** | **AG-15-19** | Sustainability Transition to Organic Agriculture in Kosovo: A Case Study of Organic Beekeeping<br>**Arnita Veliu, Ekrem Gjokaj, Hamid El Bilali and Tarek Ben Hassen** | **RD-15-15** | Living with Salt: A Social History of Salt-affected Area in Khon Kaen, Thailand<br>**Fumikazu Ubukata, Hirotaka Matsuda, Chuleemas Boonthai Iwai, Takashi Kume and Tadao Yamamoto** | **RD-15-10** | Prospects of Nutmeg Industry Development in North Maluku, Indonesia<br>**Riskina Juwita and Siti Jahroh** |
| **10:45-11:00** | **ESD-15-03** | Factors Influencing the Accounting for Biological Assets: The Case of Selected Agritourism Farms in the Philippines<br>**Hanna D.Miranda-Quibot and Yasuo Ohe** | **EM-15-14** | The Bio Circular Dairy Farming Model of Thai-Danish Dairy Cooperatives Lam Phaya Klang Limited, Saraburi Province, Thailand<br>**Anucha Wittayakorn-Puripunpinyoo** | **EM-15-44** | Evaluation of Salt-affected Farmland by Different Sensing Methods<br>**Tadao Yamamoto, Takashi Kume, Katsuyuki Shimizu and Chuleemas Boonthai Iwai** | **AG-15-48** | Recent Trends in Consumption of Traditional Fermented Foods in Cambodia<br>**Sothea Kong, Hisako Nomura, Tamon Baba, Hiroyuki Hattori, Samnang Nguon and Kasumi Ito** |
| **11:00-11:15** | **RD-15-07** | Assessing Locals' Perceptions on the Environmental, Economic, and Socio-Cultural Impacts of Agritourism Versus Conventional Farming in Tanzania<br>**Issa Abrahaman Kachenje and Yasuo Ohe** | **AG-15-24** | Agroecological Performance of Market Gardens Located in Southern Sweden<br>**Iman Raj Chongtham and Mathilda Hakansson** | **AG-15-26** | Development of the Biological Salt Utilization System for Management of Saline Agricultural Field in Khon Kaen, Thailand<br>**Takashi Kume, Chuleemas Boonthai Iwai, Tadao Yamamoto, Katsuyuki Shimizu, Fumikazu Ubukata and Hirotaka Matsuda** | **RD-15-02** | Costs and Returns from Black Soldier Fly Farming as an Alternative Protein Source in Animal Feed for Small-scale Farmers in Thailand<br>**Yardroong Mawongwai, Yupa Hanboonsong and Yaowarat Sriwaranun** |
| **11:15-11:30** | **EM-15-01** | People - Peatland Interconnections: Socio-economic Determinants of Local Livelihoods Underlying Effective Peatland Protection in Riau, Indonesia<br>**Mohammad Yunus and Adcharaporn Pagdee** | **AG-15-17** | Evaluation of Agroecological Performance Under Geographical Aspect and Agroecology Transition Levels in Battambang Province, Northwest of Cambodia<br>**Theara Mao, Sorith Hou, Samnang Ngoun, Lucie Reynaud, Sovann Pat, Rada Kong, Veng Sar, Guillemette Arminjon and Agnès Colbe** | **AG-15-10** | Complementarity of Physical and Biological Analyses to Qualify Soils in a Gradient of Use in a Tropical Context<br>**Emilie Peiffer, Yarapon Puttakot, Sébastien Franceschini, Chuleemas Boonthai Iwai and Aurore Degré** | **AG-15-49** | Elucidation of the Chemical Structures and Antioxidant Property of Cambodian *Melaleuca* Extract<br>**Ravor Seng, Akane Kuroki, Masashi Kawaguchi, Fumie Nakashima, Takahiro Shibata and Hiroyuki Hattori** |
| **11:30-11:45** | **AG-15-04** | Factors Influencing Adoption of Ecosystem - based Adaptation Practices: The Case of Small-Scale Maize Farming in Morogoro Region, Tanzania<br>**Upendo Saitabaua Mollel, Katsumori Hatanakaa, Ramadhona Savillea, and Nina Shimoguchia** | **RD-15-19** | Herder's Willingness to Inherit Grassland Animal Husbandry Production and Its Influencing Factors<br>**Ping Li and Ruiyao Zhang** | **AG-15-06** | Assessment of Irrigated Soil Quality in Paddy Fields at Dakawa Irrigation Scheme in Morogoro, Tanzania<br>**Jimmy Felix Macha and Machito Mihara** | **ESD-15-05** | Characterization of Liming Materials Derived from Apple Snail Shell Biochar<br>**Kasamaporn Kaewprom, Pancheewan Pongpang-Nga and Praphat Kawicha** |
| **11:45-12:00** | **RD-15-06** | Farmers' Perspectives on Ecosystem Services Provided by Tree Windbreak System in Ovche Pole Region, Macedonia<br>**Ognen Onchevski and Mihara Machito** | | | **RD-15-26** | The Consumption Smoothing of Rural Households in Developing Country Under the Threaten of Climate Change and Salt Damage: A Case in North-Eastern Part of Thailand<br>**Hirotaka Matsuda, Fumikazu Ubukata, Chuleemas Boonthai Iwai, Takashi Kume and Tadao Yamamoto** | **AG-15-14** | Comparison on Mechanical Properties of PCL-Based Fiber Composites Fabricated by Fused Deposition Modeling and Injection Molding<br>**Chhengven Chhoem, Dyna Theng, Chim Chay, Mouylin Chem, Inés Ferrer and Marc Delgado-Aguila** |
| **12:00-13:00** | **Lunch Break** | | | | | | | |

## Oral Presentations : Session 2

| | Room 1 | | Room 2 | | Room 3 | | Room 4 | |
|---|---|---|---|---|---|---|---|---|
| | Chair | **Prof. Dr. Fumkazu Ubukata** | Chair | **Prof. Dr. Anan Polthanee** | Chair | **Dr. Narong Touch** | Chair | **Dr. Takashi Kume** |
| | Co-chair | **Dr. Kasumi Ito** | Co-chair | **Dr. Hor Sanara** | Co-chair | **Dr. Santi Kongmany** | Co-chair | **Dr. Naoko Oka** |
| | Code | Title | Code | | Code | Title | Code | Title |
| **13:00-13:15** | **RD-15-04** | Innovative Shareholding Arrangements for Producer Groups Providing Machinery or Marketing Services to Smallholders<br>**Randel Esnard, Michael Charles Lyne, Kevin Old and Ani Kartikasari** | **EM-15-29** | Study on Local Awareness and Perception of Fertilizer Application: A Case Study in Anuradhapura District, Sri Lanka<br>**Arachchillage Buddhika Priyadarshani Bandara and Machito Mihara** | **EM-15-37** | Potential of Waste Bank Establishment for Waste Management at the Faculty of Science, Khon Kaen University<br>**Takdanai Phansawat, Jinnatam Suebpheng and Adcharaporn Pagdee** | **AG-15-34** | Effects of Different Agricultural System Practices on Soil Erosion Using RUSLE Model in Ratanak Mondul District, Battambang Province, Cambodia<br>**Sarey Rim, Nareth Nut, Lyhour Hin, Sophoanrith Ro, Lytour Lor, Sakdanupol Chan and Machito Mihara** |
| **13:15-13:30** | **AG-15-18** | Entrepreneurial Innovation for Climate Resilience: Enhancing Food and Water Security in the MENA Region<br>**Tarek Ben Hassen, Chedli Baya Chatti, Mahmoud Abdulwahed and Allan Villegas** | **AG-15-16** | Effect of Using Wastewater from Cassava Starch Industry for Long-term Napier Grass Cultivation on Soil Organic Matter and Soil Fertility<br>**Seksan Kamlamoon and Chuleemas Boonthai Iwai** | **EM-15-12** | Performance of a Cover Lagoon Digester in Wastewater Treatments from Mango Processing<br>**Chan Makara Mean, Lyhour Hin, Meng Chhay Kim, Buntha Kun, Dyna Theng, Nareth Nut and Lytour Lor** | **AG-15-33** | Impact of Irrigation Methods on Water Delivery Performance in Large-scale Irrigation Scheme in Morocco<br>**Dayyabu Muhammad Zaharaddeen, Katsuyuki Shimizu, Yuri Yamazaki, Vinay Nangia, Anas Mansouril, Mohamed Belaarabi and Lahcen Ousstous** |
| **13:30-13:45** | **AG-15-37** | Production and Marketing Systems of Crops Replacing Rubber of Farmers Under the Production Volume Control Project in Kalasin Province<br>**Walaipan Preepradit and Arunee Promkhambut** | **EM-15-03** | Application of Soil Amendments as a Strategy for Water Holding Capacity in Sandy Loam Soil and Grapevine Performance<br>**Mohammad Mirwais Yusufi and Machito Mihara** | **EM-15-30** | Assessing the Efficiency of Different Biogas Generators in Energy Production and Greenhouse Gas Emissions for Commercial Pig Farms in Cambodia<br>**Meng Chhay Kim, Lyhour Hin, Chan Makara Mean, Dyna Theng, Sovanndy Yut, Nareth Nut, Lytour Lor and Gerald Hitzler** | **EM-15-18** | Long-Term Hydrologic Trend Analysis of Diamphwe River Basin in Central Malawi<br>**Kenford A. B. Luweya, Lameck Fiwa, Ke Zhang, Sarvesh Maskey, Hiroko Gono and Hiromu Okazawa** |
| **13:45-14:00** | **RD-15-08** | Economic Analysis of Rice Yield: Insights from IADA Barat Laut Selangor, Malaysia<br>**Rika Terano, Nurul Nadia Ramli, Juwaidah Sharifuddin and Ali Fazlin** | **AG-15-21** | Suitability of Using Swine Wastewater for Generating Biomass of *Azolla microphylla* and Application in Vermiculture Enhancing the BCG Model<br>**Phearun Lay, Chuleemas Boonthai Iwai and Sophea Nhean** | **EM-15-28** | Evaluation of Chemical Contaminants in Recycled Water for Firefighting Purposes<br>**Barry Neil Noller** | **IS-15-01** | Evaluation of Flood Peak Cut Effect Through Paddy Field Dam as Green Infrastructure in Toyama Prefecture in Japan<br>**Koshi Yoshida, Keigo Noda and Taichi Tebakari** |
| **14:00-14:15** | **AG-15-12** | Application of Multiple Correspondence and k-Means Cluster Analyses for Tomato Consumer Behavior<br>**Hettige Samitha Lakshan Gunasekara, Nina Shimoguchi, Ramadhona Saville, Rika Terano and Katsumori Hatanaka** | **AG-15-22** | A Multispecies Growth and Yield Performance Comparison of Vegetables Cultivated Under Hydroponics Using Sewerage Wastewater<br>**Dickson M. Mazibuko, Antonio Perez Fuentes, Kazuha Wakasugi, Sarvesh Maskey, Takahiko Nakamura and Hiromu Okazawa** | **EM-15-13** | Recycling of Nitrogen and Phosphorus from Urban Wastewater Using Calcium-Silicate-Hydrate (CSH): Case Study in Cambodia<br>**Somara Oum, Narong Touch and Machito Mihara** | **RD-15-16** | The Impact of Adopting the Alternate Wetting and Drying Technology on the Technical Efficiency of Rice Production in Suphan Buri Province<br>**Benjamas Jangjaidee and Thanaporn Athipanyakul** |
| **14:15-14:30** | **ESD-15-01** | High Entrepreneurial Intention Among Agricultural Students in Adverse Business Environment: Findings from a Cross-sectional Study in Haiti<br>**Rival Valcin, Tomohiro Uchiyama, Absalon Pierre and Bénédique Paul** | **ESD-15-10** | Geographic Features, Ecosystems Quality and Human Well-being as Indicators of Sustainability of the Island-Barangays of Bohol<br>**Bernabe M. Mijares Jr.** | | | **EM-15-47** | Predicting the Water Vapor Movement in Unsaturated Soil<br>**Sunny Eng Giap Goh, Khairul Ikhwan Mohd Jamalludin and Mohammad Fadhli Ahmad** |
| **14:30-15:00** | **Coffe-Tea Break** | | | | | | | |

## Oral Presentations : Session 3

| | Room 1 | | Room 2 | | Room 3 | | Room 4 | |
|---|---|---|---|---|---|---|---|---|
| | Chair | **Dr. Borarin Buntong** | Chair | **Dr. Sarvesh Maskey** | Chair | **Dr.Tarek Ben Hassen** | Chair | **Dr. Anucha Wittayakorn-Puripunpinyoo** |
| | Co-chair | **Dr. Raj Chongtham** | Co-chair | **Dr. Jeeranuch Sakdaduang** | Co-chair | **Prof. Dr. Ping Li** | Co-chair | **Prof. Dr. Choichi Sasaki** |
| | Code | Title | Code | Title | Code | Title | Code | Title |
| **15:00-15:15** | **AG-15-01** | A New Cultivation Method for Speeding up the Fruiting Body Formation of Oyster Mushroom (P*leurotus pulmonarius* (Fr.) Quél)<br>**Orlavanh Xayavong, Worawoot Aiduang, Kritsana Jatueong and Saisamorn Lumyong** | **EM-15-31** | Detecting and Tracking the Positions of Deer Using Sound Recordings at Ozegahara Wetland in 2023<br>**Kazuo Oki, Masayasu Maki, Tadanobu Okumura, Masahiro Onishi, Salem Ibrahim Salem and Sakae Shirayama** | **ESD-15-02** | Land Use Changes and Deforestation Causes in the Last 30 Years using Satellite Images in the Municipality of Cobija, Province of Pando, Bolivian Amazonia<br>**Uego Perez Juan and Machito Mihara** | **ESD-15-06** | Effects of Forest Environmental Education on Awareness and Attitudes of Local Students in Relation to Tree Survival Rate - Case of School Greening Activity in Cambodia<br>**Keiko Aoki, Kumiko Kawabe, Santa Pandit and Machito Mihara** |
| **15:15-15:30** | **AG-15-03** | Enhancing Plant Growth Using a 6 V Solar Cell–Powered Electrokinetic Treatment<br>**Narong Touch and Takahiko Nakamura** | **EM-15-41** | Environmental Factors Relating to Tree Selection for Nesting of Green Tree Ants (*Oecophylla smaragdina* ) on Khon Kaen University Campus<br>**Patompong Singtong and Adcharaporn Pagdee** | **EM-15-39** | Economic Value of Carbon Storage in Forest Trees: An Ecosystem Service from Dry Dipterocarp Forest at Khon Kaen University, Thailand<br>**Narongchai Namkort, Natchanon Thiratanaboon and Adcharaporn Pagdee** | **EM-15-40** | Factors Relating to the Ecological Footprint of Students at Khon Kaen University, Thailand<br>**Chonrada Koonsrimak, Kanphitcha Janphitcha, and Adcharaporn Pagdee** |
| **15:30-15:45** | **AG-15-27** | Plant Growth and Fruit Quality of Tomato (*Solanum lycopersicum* ) Using Advanced Treated Water in Hydroponics<br>**Antonio Perez Fuentes, Kazuha Wakasugi, Sarvesh Maskey, Dickson M. Mazibuko, Takahiko Nakamura, Hiroyuki Oshima, Taku Kato, Ayako Sekiayma and Hiromu Okazawa** | **EM-15-36** | Environmental Factors Relating to Termite Mound Distribution in Dry Dipterocarp Forest on the Khon Kaen University Campus<br>**Phoorit Leelam, Araya Panomkhet and Adcharaporn Pagdee** | **EM-15-21** | Population Assessment of Agarwood (*Aquilaria* sp.) on Leyte Island<br>**Lorraine Cristy E. Ceniza, Jimmy O. Pogosa, Marlito M. Bande and Suzette B. Lina** | **EM-15-25** | Preliminary Survey on Farmers' Perceptions of Environmental Protection in Okinawa Prefecture, Japan<br>**Naoko Oka and Toshihiko Anzai** |
| **15:45-16:00** | **AG-15-36** | Recent Expansion and Future Perspectives of Direct Seeding in Miyagi Prefecture in Japan<br>**Hiroei Kanno and Koki Homma** | **AG-15-44** | Seroprevalence of Brucellosis Disease and Lumpy Skin Disease on Cattles at Svay Rieng and Prey Veng Province, Cambodia<br>**Khoeun Sokun, Kong Saroeun, Bun Chan, Ren Theary, Ith Manay, Chan Bunyeth, Lay Hort, Hin Lyhour and Theng Kouch** | **EM-15-38** | Relationships Between Undergrowth Flora and Canopy Gap at Dry Dipterocarp Forest in Khon Kaen University<br>**Kanchana Chaengphai, Maengpor Sonmanee, and Adcharaporn Pagdee** | **RD-15-18** | Changes in the Evaluation of Rural Landscape Before and After Farmland Improvement<br>**Eiji Yamaji and Shoko Nishiwaki** |
| **16:00-16:15** | **RD-15-22** | Factors Affecting the Use of *Trichoderma* spp. in Rice Fields of Farmers in Phitsanulok Province<br>**Seerasarn Nareerut and Parichad Tarbud** | | | | | | |

## Poster Preseantations

**Chair: Prof. Dr. Dieter Trautz**

## AGRICULTURE AND FOOD SYSTEMS 1

| | |
|---|---|
| **Co-Chairs** | Dr. Yoshimi Osawa, Dr. Panupon Hongpakdee and Dr. Riskina Juwita |
| **AG-15-02** | Determine and Assess the Organic Fertilizer Production in Xiengkhouang Province, Lao PDR<br>**Sisavath Phimmasone, Chuleemas Boonthai Iwai , Hoa Tran Quoc and Pascal Lienhard** |
| **AG-15-05** | Decadal Change of the Planting Date and Planted Area of Rainfed Rice Cultivation in Northeast Thailand<br>**Hiroki Oda and Koshi Yoshida** |
| **AG-15-07** | The Value Addition of Thai Traditional Food and Beverage for Healthy from Sacred Lotus towards Green Products<br>**Natsima Tokhun, Weerawat Ounsaneha, Kanokwan Punaaterkoon, Phatsara Wongsudee, Rattanapon Puttaponthip and Chuleemas Boonthai Iwai** |
| **AG-15-08** | The Effect of Different Levels of Potassium on Nutrient Content in Cherry Tomato Fruit Grows Under Hydroponic System<br>**Kanokporn Manantapong, Anongnat Sriprachote, Rattaphol Kraiklang, Sirirat Anutrakulchai and Pornthiwa Kanyawongha** |
| **AG-15-09** | Relationships Between Soil Characteristics and Brewing Grape Quality in Katsunuma, Yamanashi Prefecture, Japan<br>**Ai Kurihara and Machito Mihara** |
| **AG-15-11** | Comparison of Useful Components of Red Swamp Crayfish (*Procambarus clarkii* ) and Signal Crayfish (*Pacifastacus leniusculus* )<br>**Saki Higuchi, Akira Kurosawa, Toshihiro Suzuki, Keiko Tanahashi and Kouji Takeda** |
| **AG-15-13** | The Green Infrastructure Supporting Circular Economy in Semi-urban Tokyo: A Holistic Analysis<br>**Ivana Angelova** |
| **AG-15-23** | Effect of Alternate Wetting and Drying Irrigation on Nitrogen Uptake and Water Consumption in Rice Paddy Farming<br>**Kiseki Kurashina, Maskey Sarvesh, Takahiko Nakamura and Hiromu Okazawa** |
| **AG-15-25** | Method Validation for Determination of Cadmium and Lead Content in Herbs (Plai and Turmeric) by Using a Simple Sample Extraction Method<br>**Nattira Kleawklaharn and Chuleemas Boonthai Iwai** |
| **AG-15-28** | Evaluation Value of Soil Ecosystem Services in Terms of Water Storage and Soil Fertility in Different Land Use Northeast Thailand<br>**Jutatad Rattanapong and Chuleemas Boonthai Iwai** |

## AGRICULTURE AND FOOD SYSTEMS 2

| | |
|---|---|
| **Co-Chairs** | Prof. Dr. Koshi Yoshida, Prof. Dr. Kazuo Oki, Dr.Thammared Chuasavathi and Dr. Tetsuya Shimamura |
| **AG-15-30** | Accessibility to Small Credit Amongst Small Scale Farmers: A Case Study in Morogoro Region, Tanzania<br>**Sabra Yusuf Abdallah, Machito Mihara and Rika Terano** |

| | |
|---|---|
| **AG-15-31** | Guidelines for Pesticide Risk Management at the Community Level in Northeast Thailand<br>**Jarupong Prasopsuk, Watcharaporn Srisawangwong, Papatsorn Seelarak, Natchayathon Khattiyaphutthimet and Malisa Wetchayanon** |
| **AG-15-32** | Estimating Leaf Area Index of Cassava Plantation Using UAV Imagery<br>**Pengkheang Mol, Sanara Hor, Sophak Pok and Chetha Chea** |
| **AG-15-35** | Effect of LED Lighting on Vitamin C and Phenols in Ethiopian Kale Microgreens<br>**Ruth Nyambura Maru, John Wesonga, Dickson Mazibuko, Satoko Akiyama, Ayako Sekiyama, Shotaro Kawakami, Sarvesh Maskey, Agnes Kavoo, Johnstone Neondo and Hiromu Okazawa** |
| **AG-15-42** | Transfer of Producing Fermented Bio-Extract Method from Fermented Fish by Product for Using in Organic Vegetables Cultivation to Smallholder Farmers in Northeastern Thailand<br>**Supaporn Poungchompu, Keattichai Montreewong and Anan Polthanee** |
| **AG-15-43** | Transfer Optimizing Use of Nutrients for Increasing Cassava Yield and Net Income to Smallholder Farmers in Northeastern Thailand<br>**Supaporn Poungchompu, Keattichai Montreewong and Anan Polthanee** |
| **AG-15-45** | Diversity of Insect Pollinators at the Conservation area of Chaiyaphum Province in the **Northeastern Thailand**<br>**Duangrat Thongphak and Ubon Tangkawanit** |
| **AG-15-46** | The Influence of Copper and Cadmium Combined Pollution in Soil on Growth, Yield, and Copper and Cadmium Uptake of Soybean<br>**Choichi Sasaki, Chihiro Kato, Nobuhiko Matsuyama, Takeyuki Annaka and Kiichi Sasaki** |
| **AG-15-47** | Functional Ingredients and Antioxidant Effect of *Planchonella Obovata* Products in Cambodia<br>**Sothea Kong, Chim Chay, Hiroyuki Hattori, Samnang Nguon and Kasumi Ito** |
| **AG-15-51** | Designing the Future: How Business Model Innovations Drive Sustainable Food Systems<br>**Islam Mohamed Kamel, Fadi Abdelradi, Victor Shaker, Hamid El Bilali and Sinisa Berjan** |

## ENVIRONMENTAL MANAGEMENT 1

| | |
|---|---|
| **Co-Chairs** | Dr. Tadao Yamamoto, Dr. Ivana Angelova and Dr. Sunny Eng Giap Goh |
| **EM-15-02** | Impact of Ruzi Dissemination Characteristic on Land Use Change in Xiengkhoung Province, Lao PDR<br>**Soulikone Chaivanhna, Chuleemas Boonthai Iwai and Pascal Lienhard** |
| **EM-15-04** | Soil Biota, Soil Biological Activity and Soil Carbon Storage in Different Land Uses in Northeast Thailand<br>**Yarapon Puttakot, Chuleemas Boonthai Iwai and Anan Wongcharoen** |
| **EM-15-05** | Investigating the Potential of *Azolla microphylla* on Wastewater Treatment from Different Wastewater Sources<br>**Nyein Nyein and Chuleemas Boonthai Iwai** |
| **EM-15-06** | Determination of the Factors Affecting the Performances of Sediment Microbial Fuel Cells by Long-term Electricity Generation Using Lactic Acid Bacteria-attached Electrodes<br>**Narong Touch and Tadashi Hibino** |

| | |
|---|---|
| **EM-15-07** | Design of a Two-chamber Microbial Fuel Cell Without a Proton Exchange Membrane for Electricity Generation from Food Wastes<br>**Narong Touch and Xiao Xiao** |
| **EM-15-08** | Impact of Street Tree Management on the Plants Colonizing Street Tree Bases in an Urban Environment<br>**Masaaki Furuno, Taizo Uchida, Xue Jun Huan, Daisuke Hayasaka and Teruo Arase** |
| **EM-15-09** | Ecotoxicology of Microplastics Low-Density Polyethylene (LDPE) in Soil on Earthworms (*Eisenia foetida* and *Eudrilus eugeniae* )<br>**Laddawan Upakhot and Chuleemas Boonthai Iwai** |
| **EM-15-10** | Sustainability Initiatives in the Wood Processing Industry: Studying the Possibility of Utilizing Sawdust in the Production of Mycelium-Based Biocomposites to Develop Circular Material<br>**Thana Teeraphantuvat , Kritsana Jatuwong, Saisamorn Lumyong and Worawoot Aiduang** |
| **EM-15-11** | Co-digestion of Ensiled Napier Grass and Commercial Bakery Wastewater for Bioenergy Production<br>**Natagarn Tongphanpharn, Montip Jankaew and Natsima Tokhun** |

## ENVIRONMENTAL MANAGEMENT 2

| | |
|---|---|
| **Co-Chairs** | Dr. Bernabe M. Mijares Jr., Dr. Natsima Tokhun and Dr. Somara Oum |
| **EM-15-19** | Evaluation of Soil Micronutrient Status Across Selected Land use Types in Chembe Enclaved Village of Lake Malawi National Park<br>**Placid Mpeketula, Dickson Mazibuko, Sarvesh Maskey, Hiroko Gono and Hiromu Okazawa** |
| **EM-15-20** | Soil Carbon Sequestration and Soil Chemical Properties in Different Land Uses in Northeast Thailand<br>**Saharatkarin Namse , Chuleemas Boonthai Iwai and Thammared Chuasavathi** |
| **EM-15-22** | Effect of Tannery Sludge on Plants Germination<br>**Yoseph Junedi Nuwa Dhuge Poa and Chuleemas Boonthai Iwai** |
| **EM-15-26** | Comparison of Macroinvertebrate Assemblages Between Mountain Strem Constructions and Natural Streams<br>**Tetsuya Shimamura, Ryosuke Tsuji, Masaki Hamaguchi, Kyosuke Ino and Eri Nabeshima** |
| **EM-15-27** | Evaluation of the Effect of Wood Chips and Green Manure as an Amendment for Improvement of Soil Physical Characteristics<br>**Takanori Kaneko, Yuka Oguma and Tomonori Fujikawa** |
| **EM-15-32** | Density Estimation of Deer Population using Random Encounter Model (REM) at Oze Wetland in Japan<br>**Tadanobu Okumura, Kazuo Oki and Masayasu Maki** |
| **EM-15-33** | Detecting the Impact of Water Resource Development on Flow Regime in the Mekong River Basin<br>**Takumi Shimura and Taichi Tebakari** |
| **EM-15-35** | Evaluating the Performance of Managed Aquifer Recharge for Sustainable Shallow Groundwater Resources in Prachinburi Province, Thailand<br>**Kewaree Pholkern, Phayom Saraphirom, Thanyaporn Prommarach, Rattaweep Aksornklang and Arunya Luepradit** |

| | |
|---|---|
| **EM-15-42** | Development of ICP-MS Methodology for the Direct Strontium Isotope Ratio Analysis in Water and its Application in Water Resource Management<br>**Madeleine Farrell and Tatiana Komarova** |
| **EM-15-45** | Characteristics of Wastewater from Some Pig Farms in Laos<br>**Kengkham Sandkhamlue and Santi Kongmany** |
| **EM-15-48** | Urban Green Development in Siem Reap Town, Siem Reap Province: Case Study on Public Space<br>**Sokhieng Chee, Yin Chan Eng, Sophak Pok, Thapkonin Chhoengsan and Sanara Hor** |

## ESD and RURAL DEVELOPMENT

| | |
|---|---|
| **Co-Chairs** | Prof. Dr. Mario T. Tabucanon, Dr. Kailert Taweekul and Dr. Thanaporn Athipanyaku |
| **ESD-15-04** | Effectiveness of Hygiene Educational Training for Pre-School Students in Phnom Penh, Cambodia<br>**Sophorlkun Yim, Salyta Chamruen, Phanna Ly, Rathna Hor, Sunduk Cho and Eunjin Kang** |
| **ESD-15-07** | Organic Farmers Adopt Bio-Circular-Green Economy (BCG) in Agriculture for Food Safety and Environmental Sustainability<br>**Jiraphon Choeichit, Waraporn Wongsiriwon and Chuleemas Boonthai Iwai** |
| **ESD-15-08** | The Characteristics of Young Smart Farmer in Agricultural Development of Northeast Thailand<br>**Supaporn Poungchompu, Supawadee Chantanop and Keattichai Montreewong** |
| **ESD-15-09** | Determinants of Reluctance: An In-Depth Analysis of Factors Influencing Cold Water Fish Farmers' Unwillingness to Adopt Agricultural Product Insurance in Guilan Province in Iran<br>**Mohammadali Ghazi, Mohammad S. Allahyari, Sinisa Berjan and Tarek Ben Hassan** |
| **RD-15-03** | Dispersion Approach to Make Matrix of Nanocellulose-Reinforced Polylactic Acid Biocomposites for Food Packaging Materials<br>**Yut Sovanndy, Theng Dyna, Chay Chim, Chem Mouylin, Chhoem Chhengven and Marc Delgado-Aguilar** |
| **RD-15-09** | Development Directions and Challenges of Climate Change Measures in Paddy Agriculture in Southeast Asia<br>**Hiromichi Kitada, Taro Izumi, Sarvesh Maskey and Hiromu Okazawa** |
| **RD-15-11** | Changes of Local Government Expectations for Local Vitalization Cooperators in Japan<br>**Tomoyuki Ohashi, Yoshiki Kuwabara and Masahide Hayashi** |
| **RD-15-12** | Implications of the Transition from Subsistence to Cash Crops on the Livelihood of Soliga Tribe in India<br>**Iman Raj Chongtham, Sneha Shahi, Madegowda Chikkananjegouda, Obaiah Boraiah and Shrinivas M. Badiger** |
| **RD-15-14** | Determinants Influencing Technology Adoption among Vegetable Producers in Svay Rieng Province, Cambodia<br>**Chhun Hong, Buntong Borarin, Serey Mardy, Sao Vibol, Chan Bunyeth, Tum Saravuth and Chun Nimul** |
| **RD-15-25** | Evaluate the Local Livelihood of Upland Farmers in Northwestern Cambodia Through the Livelihood Asset Approach<br>**Dyna Chin, Hitoshi Shinjo, Soksan Seng, Sophak Pok, Lyhour Hin, Nuch Sek and Sanara Hor** |

**Special Paper Abstract**

# Citation Analysis on International Journal of Environmental and Rural Development 2010-2023

**Yoshiko TANAHASHI[a]***

*[a]Tokyo University of Agriculture, Tokyo, Japan*
**Corresponding email: yt208220@nodai.ac.jp*

**Abstract**
The purpose of this paper is to gain an overview of the current status quo of bibliometric performance on International Journal of Environmental and Rural Development (IJERD), using citation analysis as an indicator of scientific impact. To identify citation performance, citing papers to IJERD are analyzed by journals, research fields, author affiliations and countries. Most cited articles in IJERD are identified, but those cited articles are not cited by IJERD itself. To see other journal citation performance, compared to its IJERD, research papers on "rural development" are analyzed, and most highly journals and contributing journals to impact factor are identified. To enhance IJERD power of publication performance, selection criteria of journal impact factor is referred to discuss.

**Keywords** impact factor, citation analysis, self-citation, journal evaluation, scientific quality

**AG-15-01**

# A New Cultivation Method for Speeding up the Fruiting Body Formation of Oyster Mushroom (*Pleurotus pulmonarius* (Fr.) Quél)

**Orlavanh XAYYAVONG[abc], Worawoot AIDUANG[bcd], Kritsana JATUWONG[bcd], and Saisamorn LUMYONG[bce]***

*[a]Applied Microbiology (International Program), Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand*
*[b]Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand*
*[c]Research Center of Microbial Diversity and Sustainable Utilization, Chiang Mai University, Chiang Mai 50200, Thailand*
*[d]Office of Research Administration, Chiang Mai University, Chiang Mai 50200, Thailand*
*[e]Academy of Science, The Royal Society of Thailand, Bangkok 10300, Thailand*
** Corresponding email: scboi009@gmail.com*

**Abstract**

The Oyster mushroom (*Pleurotus* species) is one of the most economically important and edible mushrooms in the world, ranking third in the global market for commercial mushroom production. *Pleurotus pulmonarius* is the second most cultivated oyster mushroom species. This edible species is cultured mainly in Asia and North America utilizing locally available organic materials used in industrial-scale production. Traditionally, the cultivation methods of *P. pulmonarius* involve the use of plant-based solid substrates. Because the development of fruiting bodies on solid substrates typically takes more than a month, the possibility of infection by non-stable harvesting materials, potential pathogenic fungi, or bacterial contamination is increased. We therefore established an efficient and inexpensive method for growing *P. pulmonarius* by using the adaptive method of placing the inoculum vertically in the center of the mushroom bag, instead of on top, to shorten the time required for the fruiting body formation and first harvest period. Two types of mushroom spawns prepared from sorghum-based solid medium (SSM) and potato dextrose broth (PDB) were used for the inoculum experiment. Our results demonstrated that the vertical inoculation method can shorten the spawn running time by about 10 days compared with the conventional method, which is only 18.35 ± 0.87 and 19.04 ± 1.29 days for SSM- and PDB-derived spawns, respectively. In addition, the vertical inoculation method reduced the average time of first harvest by about 10 days compared with the conventional method, i.e., 25.30 ± 1.83 and 26.15 ± 0.75 days for SSM- and PDB-derived spawn, respectively. This new inoculation method could be useful for the commercial cultivation of oyster mushroom species.

**Keywords:** edible mushroom, mushroom cultivation, spawning technique, Oyster mushroom

**AG-15-03**

# Enhancing Plant Growth Using a 6V Solar Cell–Powered Electrokinetic Treatment

**Narong TOUCH[a]* and Takahiko NAKAMURA[a]**

*[a]Tokyo University of Agricultural, Tokyo, Japan*
**Corresponding email: nt207118@nodai.ac.jp*

**Abstract**

Applying electrokinetic treatment powered by a 6V solar cell (SC-6V) has been found to release essential nutrients (N, P, and K) from saturated organic soil. Additionally, this treatment accelerates the growth of Japanese mustard spinach near the anode due to oxidation reactions. However, growth inhibition occurs near the cathode due to reduction reactions. These effects may vary in unsaturated soils with irrigation water. Therefore, this study aimed to determine the effects of SC-6V on plant growth in unsaturated soils through laboratory experiments. Specifically, we examined changes in electrode potential and the growth rate of Japanese mustard spinach after applying SC-6V to andosol mixed with cow manure compost. Although reduction reactions occurred at the cathode, facilitating irrigation (water flow through the soil layer) maintained a stable cathode potential exceeding 0V. Growth rate measurements revealed a 1.2–1.8-fold increase in wet weight near both the anode and cathode. Notably, the growth rate of spinach was higher in the soil located 5–20 cm from both electrodes. Surprisingly, reduction reactions did not negatively affect the growth rate but instead contributed to increased growth in unsaturated soil. The enhancement of soil potential through irrigation water is a key driver underlying this growth. Therefore, SC-6V should be applied to upper-land soils to boost crop productivity.

**Keywords:** 6V solar cell, electrokinetic treatment, unsaturated soil, growth rate, Japanese mustard spinach

**AG-15-04**

# Factors Influencing Adoption of Ecosystem-based Adaptation Practices The Case of Small-Scale Maize Farming in Morogoro Region, Tanzania

**Upendo Saitabau MOLLEL[a]*, Katsumori HATANAKA[a], Ramadhona SAVILLE[a], and Nina SHIMOGUCHI[a]**

*[a]Department of International Agribusiness Management, Tokyo University of Agriculture, 1-1-1, Sakuragaoka, Setagaya-Ku, Tokyo 156-8502*
**Corresponding email: 13722007@nodai.ac.jp*

**Abstract**

Maize is the main staple crop cultivated in all agro-ecological zones of Tanzania dominated by smallholder farmers, whereby a large portion of the production is used for household consumption. Most of the smallholder farmers over-rely on rain-fed farming, which is hampered by climate change impacts such as a change in rainfall patterns, rise in temperature, frequent and prolonged droughts, floods, and increase in pest, disease, and destructive weeds which affect the yield of agricultural crops such as maize. Despite the impacts of climate change on maize farming, farmers still employ unsustainable farm practices such as monoculture, intensive tillage, burning of crop residues, and use of chemical fertilizers which damage the health of agroecosystem and increase the vulnerability of the farmers to climate change impacts. There is a need for the farmers to adopt Ecosystem-based Adaptation (EbA) practices which ensure the protection and functioning of agroecosystems and biodiversity and increase agricultural productivity and resilience towards climate change impacts. This study analyzed the factors influencing the adoption of EbA practices in small-scale maize farming using the Morogoro region in Tanzania as a case study. The paper used both qualitative and quantitative techniques. Data was collected through key informant interviews and a semi-structured questionnaire administered to 350 farmers. The results of the Tobit regression model show that the adoption of EbA practices on maize farming is significantly influenced by farm size, household income, land tenure system, access to climate information, access to labor, knowledge of the usefulness of EbA practices, and membership of farmer field school. Whereas age, gender, and household size revealed a negative influence. This study concluded that to scale up EbA practices adoption, farmers should be encouraged to share EbA practices information with fellow farmers, practice income diversification, and policies should focus on increasing EbA practices knowledge dissemination to the farmers through improving agricultural extension services.

**Keywords:** maize farming, climate change, ecosystem-based adaptation, Tobit model

**AG-15-06**

# Assessment of Irrigated Soil Quality in Paddy Fields at Dakawa Irrigation Scheme in Morogoro, Tanzania

**Jimmy Felix MACHA[a]* and Machito MIHARA[b]**

*[a]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
**Corresponding email: jifema86@gmail.com*

**Abstract**

Soil quality, as a measure of the soil's capacity to function, can be assessed using indicators based on physical, chemical, and biological properties. The soil assessment for rice production was conducted at Dakawa Irrigation Scheme, located in Mvomero District, Morogoro, Tanzania. The study focuses on evaluating soil quality indicators, including chemical, physical, and biological properties. The soil was excavated and described based on the FAO (2006) Guideline. Eight disturbed samples, together with twenty-four undisturbed core samples, were taken from two blocks (blocks 18 and 23) for laboratory analysis. The soil texture was identified as sandy clay loam, and the pH levels in all layers of all blocks were rated as medium (5.7-7.0) to very high (7.0-8.6). The levels of organic carbon (OC) and organic matter (OM) were found to be very low, especially in the first layer at OM was 0.8% and OC was 1.49%. The cation exchange capacity (CEC) and exchangeable bases were rated as low to medium for all blocks. The study on moisture content revealed that the moisture content at a depth of 0-50cm was very low at 1.5% for block 23 and 1.8 for block 18 which is very low compared to other layers in all blocks, this indicates that layers 2, 3, and 4 retain much more water than layer one. According to Soil Taxonomy and the World Reference Base for Soil Resources, the soil at Dakawa Irrigation Scheme is classified as Vertic Calciusteps and Haplic Vertic combisols, respectively. This classification reflects properties that may require the use and management of the soil, including the selection of crops and fertilizers, as well as the recommended rates to use. It is recommended to increase the organic matter in the soil by using organic matter. Additionally, the use of acidifying inorganic fertilizer and gypsum as soil amendments should also be taken into consideration to avoid the emergence of sodicity.

**Keywords:** soil quality, assessment, soil properties, irrigated paddy fields, Tanzania

**AG-15-10**

# Complementarity of Physical and Biological Analyses to Qualify Soils in a Gradient of Use in a Tropical Context

**Emilie PEIFFER[a]*, Yarapon PUTTAKOT[b], Sébastien FRANCESCHINI[a], Chuleemas Boonthai IWAI[bc], and Aurore DEGRÉ[a]**

*[a]University of Liège – Gembloux Agro-Bio Tech, TERRA Teaching and Research Centre, Passage des Déportés 2, 5030 Gembloux, Belgium*
*[b]Khon Kaen University – Department of Soil Science and Environment, Faculty of Agriculture, 123 Moo 16, Khon Kaen 40002, Thailand*
*[c]Integrated Land and Water Resource Management Research and Development Center in Northeast Thailand, Khon Kaen University, 123 Moo 16, Khon Kaen 40002, Thailand*
**Corresponding email: emilie.peiffer@uliege.be*

**Abstract**
Soil degradation becomes a pressing issue to ensure food supply. Intensive agricultural practices have reduced soil quality through their influence on soil parameters. This study aims to assess the soil physical and biological parameters for conventional rice, cassava, sugar cane, and forest in Northeast Thailand. An additional plot of cassava organically managed was investigated since it is suggested that organic inputs enhance soil structure which helps resist soil compaction. Each land use was analyzed at 10 and 40 cm depth. Regarding the hydro physical parameters, bulk density, water retention, pore size distribution, and hydraulic conductivity were assessed. For biological parameters, earthworms and cast densities represented soil macrofauna of the soil whereas soil respiration evaluated the microfauna. Results highlight significant differences among parameters and overall high bulk densities, especially in the subsoil. Forests display high hydraulic conductivity, low bulk density, and the highest faunal activity. For rice, high bulk density, low saturated hydraulic conductivity, and retention curves with a low slope are presented. This land-use displays a low earthworm presence. Conventional sugar cane and cassava are grouped together for most of the parameters. They feature high bulk densities coupled with high hydraulic conductivity and low water retention. No biological activity was found for those land-uses. Organic cassava presents high density in the topsoil but low density in the subsoil. Saturated hydraulic conductivity is low, and the presence of soil fauna is noted. Overall, the results indicate the impact of both land-use and management on the soil. Regarding the hydro physical analysis of conventional sugar cane and cassava, a contradictory relationship between hydraulic conductivity and bulk density is displayed. Although the high percentage of sand in those soils could explain the relation, the absence of soil fauna implies poor soil health. This underscores the need for a global approach to soil quality.

**Keywords:** agricultural management, soil physics, soil biology, soil modeling, cassava, organic farming

**AG-15-12**

# Application of Multiple Correspondence and k-Means Cluster Analyses for Tomato Consumer Behavior

**Hettige Samitha Lakshan GUNASEKARA[a]*, Nina SHIMOGUCHI[b], Ramadhona SAVILLE[b], Rika TERANO[b], and Katsumori HATANAKA[b]**

*[a]Graduate School of International Food and Agricultural Studies,*
*Tokyo University of Agriculture, Tokyo, Japan*
*[b]Faculty of International Agriculture and Food Studies,*
*Tokyo University of Agriculture, Tokyo, Japan*
**Corresponding email: 13823001@nodai.ac.jp*

## Abstract

Japan faces a pressing issue of an aging society, leading to a labor shortage in various sectors, particularly agriculture. Young farmers in Japan who joined recently struggle to discern market trends and consumer behaviors despite government support due to less experience, changing consumer behaviors, and seasonal changes. This research aims to provide actionable insights that will help young tomato producers make informed and strategic decisions by utilizing data science techniques to identify consumer behavior in the local market unique to their business. A questionnaire survey was prepared to identify tomato consumer behavior based on demographic characteristics, buying behaviors, consumption behaviors, purchasing channels, spending price per tomato purchase, and consumer preferences. In this study, 316 valid datasets were collected through a questionnaire survey from face-to-face interactions in multiple places (direct farmers' shops, direct-vegetable-vending shops), and employing online methods (QR-codes, SNS with URL links and NFC tags connected to Google Forms) in the period between 1st May 2022 to 30th June. This study used Multiple Correspondence Analysis (MCA) and the k-means cluster analysis. Results from this study revealed six consumer segments while determining the unique characteristics of tomato buying and consumption behavior based on the tomato type and seasons, consumer characteristics and preferences based on the tomato purchasing channel, and consumer preferences for tomato purchases. This study provides a consumer segmentation based on consumer behaviors and integrates data-driven decision-making principles by exploring factors influencing tomato purchasing decisions within each segment, where young new tomato farmers allow for actionable insights for data-driven decision-making by understanding the local consumers.

**Keywords:** agribusiness, agriculture, consumer segmentation, data science, data-driven decision making, questionnaire survey

**AG-15-14**

# Comparison on Mechanical Properties of PCL-Based Fiber Composites Fabricated by Fused Deposition Modeling and Injection Molding

**Chhengven CHHOEM[abe]*, Dyna THENG[a], Chim CHAY[c], Mouylin CHEM[b], Inés FERRER[d], and Marc DELGADO-AGUILA[e]**

*[a]Faculty of Agricultural Biosystems Engineering, Royal University of Agriculture, Cambodia*
*[b]Faculty of Agro-Industry, Royal University of Agriculture, Cambodia*
*[c]Department of Agro-Industry, Ministry of Agriculture, Forestry and Fisheries, Cambodia*
*[d]GREP Research Group, University of Girona, Spain*
*[e]LEPAMAP-PRODIS Research Group, University of Girona, Spain*
**Corresponding email: chhoemchhengven.ch@gmail.com*

## Abstract

Polycaprolactone (PCL), a synthetic aliphatic polyester, has gained prominence in the realm of biocomposites due to its biodegradability, biocompatibility, and relatively low melting point. To further enhance the mechanical properties of PCL, natural fibers like bleached kraft eucalyptus pulp (BKEP) have been incorporated. This study delves into a comparative analysis of the mechanical properties of PCL/BKEP biocomposites fabricated via fused deposition modeling (FDM) and injection molding (IM). Commercial BKEP was compounded with PCL at varying fiber contents ranging from 0 to 30 wt%. The resulting composites were characterized in terms of tensile strength, elongation at break, and Young's modulus using both FDM and IM techniques. The findings revealed that IM yielded superior tensile strength values for PCL/BKEP biocomposites with fiber contents exceeding 20 wt%. At 30 wt% fiber content, IM-fabricated biocomposites exhibited a 17% and 50% increase in tensile strength compared to their FDM counterparts. Conversely, FDM outperformed IM in terms of tensile strength and Young's modulus for biocomposites with fiber contents up to 10 wt%. At 10 wt% fiber content, FDM-fabricated biocomposites demonstrated a 21% and 9% enhancement in tensile strength and Young's modulus, respectively, compared to IM samples. The choice between FDM and IM for fabricating PCL/BKEP biocomposites depends on the desired fiber content and mechanical properties. IM is more suitable for producing high-fiber-content composites with enhanced tensile strength, while FDM excels for low-fiber-content composites with improved tensile strength and Young's modulus.

**Keywords:** tensile, elongation, modulus, biodegradability, biocompatibility

**AG-15-16**

# Effect of Using Wastewater from Cassava Starch Industry for Long-Term Napier Grass Cultivation on Soil Organic Matter and Soil Fertility

**Seksan KAMLAMOON[a] and Chuleemas Boonthai IWAI[ab]***

*[a]Department of Soil Sciences and Environment, Faculty of Agriculture,*
*Khon Kaen University, Thailand*
*[b]Integrated Land and Water Resource Management Research*
*and Development Center in Northeast Thailand,*
*Khon Kaen University, Thailand*
**Corresponding email: chuleemas1@gmail.com*

**Abstract**

Reusing wastewater for agriculture irrigation and renewable energy is an opportunity to alleviate the strain on freshwater resources. For many years, the reuse of wastewater from cassava starch industry for agricultural irrigation on Napier grass has increased. However, the study on the effect of wastewater irrigation on soil organic matter and soil fertility is limited. Therefore, this study aimed to investigate the effect of long-term wastewater irrigation for Napier grass cultivation on soil organic matter and soil fertility. The study was conducted by collected 4 treatments of soil samples between the depths of 0-15, 15-30 and 30-50 cm in the areas that irrigated wastewater for Napier grass cultivation over 10 years. The results showed that wastewater irrigation areas have higher organic matter and fertility (total Nitrogen, available Phosphorus and exchangeable Potassium) than the area that didn't use wastewater significantly. The irrigated wastewater areas without Napier grass cultivation have the highest organic matter followed by the areas that use a siphon system with Napier grass cultivation, pump system with Napier grass cultivation and the areas that were not influenced by wastewater and Napier grass respectively. Similarly, the areas that influenced by wastewater without Napier grass cultivation have the highest soil fertility followed by the areas that use a siphon system with Napier grass cultivation, pump system with Napier grass cultivation and the areas that were not influenced by wastewater and Napier grass respectively. Conversely, the areas that use a siphon system with Napier grass cultivation have the lowest soil compaction followed by the areas that influenced by wastewater without Napier grass cultivation, pump system with Napier grass cultivation and the areas that were not influenced by wastewater and Napier grass respectively. Therefore, wastewater irrigation on Napier grass cultivation can improve soil organic matter, reduce soil compaction and increase soil fertility.

**Keywords:** cassava wastewater, Napier grass, soil organic matter, soil compaction, soil fertility

**AG-15-17**

# Evaluation of Agroecological Performance Under Geographical Aspect and Agroecology Transition Levels in Battambang Province, Northwest of Cambodia

**Theara MAO[a]*, Sorith HOU[a], Samnang NGOUN[a], Lucie REYNAUD[b], Sovann PAT[c], Rada KONG[d], Veng SAR[d], Agnès COLBE[e], and Guillemette ARMINJON[e]**

*[a]Ecosystem Services and Land Uses Research Center (ECOLAND), Graduate School, Royal University, P.O. Box 2696, 12401-Dangkor, Phnom Penh, Cambodia*
*[b]Group for Research and Technology Exchanges (GRET) Campus du jardin d'agronomie tropicale de Paris, 94736 Nogent-sur-Marne Cedex, France*
*[c]Group for Research and Technology Exchanges (GRET), P.O. Box 57, 12304-Chamkar Morn, Phnom Penh, Cambodia*
*[d]Dept. Agricultural Land Resources Management, General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, 12158-Toul Kork, Phnom Penh, Cambodia*
*[e]L'Institut Agro Montpellier, 2 place Pierre Viala, 34060 Montpellier, France*
**Corresponding email: mtheara@rua.edu.kh*

**Abstract**

Agroecology (AE) is the application of ecological concepts and principles to agricultural systems to increase their sustainability. This study aimed to conduct a multidimensional evidence-based evaluation of AE in Battambang province in northwest Cambodia, using the Tool for Agroecology Performance Evaluation (TAPE) tool. The study investigated two main criteria: geographical aspects in Sangkae (lowland) and Rotonak Mondol (upland) districts and AE transition levels. We predefined 120 farms into two AE farms (high-AE and low-AE) and non-project. Results indicated that the mean characterization of agroecological transitions (CAET) score was low (37.42%). There was a difference in mean CAET score between geographical aspects, but it was not statistically significant. Predefined high-AE farms in lowland and upland areas obtained better CAET scores compared to low-AE and non-project farms. Most farmers (both men and women) had either ownership or perception of their land security for farming practices. Most farms received an unstainable level of pesticide exposure meaning that farmers used highly hazardous pesticides (Class I) with less than 4 of the listed mitigation techniques and applied 6 applications with 5.4 types of pesticide. Lowland and high-AE farms received acceptable levels that farmers accessed more dietary diversified with 5-7 out of 10 food groups. Women's Empowerment in Agriculture Index (WEAI) was acceptable for both criteria. For soil health, upland and high-AE farms were at acceptable levels while other farms received unstainable levels. Lowland, high-AE, and low-AE farms obtained positive agricultural income, whereas upland and non-project farms received negative agricultural income due to climate change (drought and flood), pests causing yield loss, rising agricultural input costs, loss prices of production, difficulty in selling products. The participatory analysis revealed that farmers could save their seeds and minimize waste of inputs, promote AE practices at the national level by lowering the use of chemicals as well as promote new technological techniques including cover crop, no-till, and resistant seeds to adapt to climate change, disease, and pest tolerant.

**Keywords:** agroecology, sustainability, TAPE, multi-dimensional, evaluation

**AG-15-18**

# Entrepreneurial Innovation for Climate Resilience: Enhancing Food and Water Security in the MENA Region

**Tarek BEN HASSEN[a]*, Chedli Baya CHATTI[b], Mahmoud ABDULWAHED[c], and Allan VILLEGAS[d]**

*[a]Program of Policy, Planning, and Development, Department of International Affairs, College of Arts and Sciences, Qatar University, Doha, Qatar*
*[b]Department of Social Sciences, College of Arts and Sciences, Qatar University, Doha, Qatar*
*[c]Strategic Innovation, Entrepreneurship & Economic Development Office (SIEED), Qatar University, Doha, Qatar*
*[d]HEC Qatar, Doha, Qatar*
**Corresponding email: thassen@qu.edu.qa*

**Abstract**

The Middle East and North Africa (MENA) rechange 'suffers interlinked food and water security challenges, which are worsened by climate change consequences. Rising temperatures, unpredictable rainfall patterns, and rising water shortages jeopardize the region's agricultural production systems and access to clean water. Entrepreneurship can help the MENA region develop creative solutions that boost climate resilience and promote sustainable food and water security. The paper investigates how entrepreneurship may drive technical, business model, and social innovations to promote agricultural climate change adaptation, improve water usage efficiency, minimize food loss and waste, and enhance sustainable value chains. Examples of cleantech, agtech, and social entrepreneurship initiatives that are creating climate resilience are examined. According to the research, fostering entrepreneurship, including access to funding, talents, and collaborations, is critical to sparking locally suitable solutions. Youth and female entrepreneurs, in particular, may be enabled to create context-specific, long-term innovations. Targeted entrepreneurial support may increase climate resilience and progress toward sustainable food and water security in the MENA region.

**Keywords:** entrepreneurship, innovation, food security, water security, climate resilience, sustainability, MENA region

**AG-15-19**

# Sustainability Transition to Organic Agriculture in Kosovo: A Case Study of Organic Beekeeping

**Arnita VELIU[a], Ekrem GJOKAJ[b], Hamid EL BILALI[a], and Tarek BEN HASSEN[c]***

*[a]International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM-Bari), Valenzano (Bari), Italy*
*[b]Department of Environmental and Agricultural Management, International Business College Mitrovice, Mitrovica, Kosovo*
*[c]Program of Policy, Planning, and Development, Department of International Affairs, College of Arts and Sciences, Qatar University, Doha, Qatar*
**Corresponding email: thassen@qu.edu.qa*

## Abstract

Agriculture in Kosovo has a significant impact on improving the balance of trade, reducing unemployment, and fostering economic growth. Several programs, led by national institutions and associations and international organizations, contribute to the development of sustainable agriculture, including organic farming, which is steadily gaining ground, albeit at a gradual pace. In this paper, we describe the transition process to organic agriculture in Kosovo, taking into account the case of organic beekeeping. The analysis is based on the Multi-Level Perspective (MLP) framework. Secondary data were gathered from existing literature, whereas primary data were obtained through semi-structured interviews and focus group discussions with the key players in the country's organic agriculture and organic beekeeping sectors. The data show that beekeeping in Kosovo has been a source of household livelihood for decades. Government support and subsidies appear to be the primary drivers for the transition to organic farming. On the other hand, the high certification costs, the administrative paperwork, and the need for new knowledge and improved disease management are some of the barriers that still must be overcome in the transition to organic farming. Organic beekeeping is still new in Kosovo, as there is a lack of education/training and information about the sector, as well as a lack of inputs for organic beekeeping. Findings indicate that there is only one certified beekeeper in the country. However, the situation is expected to change soon, as numerous institutions and associations are working to support the development of this sector. Hence, further research and exploration of the drivers and barriers to the development of organic beekeeping in Kosovo are still needed.

**Keywords:** sustainability transition, organic agriculture, organic beekeeping, multi-level perspective, sustainable agriculture, Balkans

**AG-15-21**

# Suitability of Using Swine Wastewater for Generating Biomass of *Azolla microphylla* and Application in Vermiculture Enhancing the BCG Model

**Phearun LAY[a], Chuleemas Boonthai IWAI[a]*, and Sophea NHEAN[b]**

*[a]Department of Soil Sciences and Environment, Faculty of Agriculture, Khon Kaen University, and Integrated Land and Water Resource Management Research and Development Center in Northeast Thailand, Khon Kaen University, Khon Kaen, 40002, Thailand.*
*[b]Division of Research and Extention, Royal University of Agriculture, Phnom Penh, 12400, Cambodia*
**Corresponding email: chuleemas1@gmail.com*

**Abstract**
Vermiculture is biotechnology in improving nutrient quality and producing earthworms. Whereas *Azolla microphylla* (an aquatic plant) is a major source of nutrients and has been applied effectively in recycling swine wastewater. The concentration of 5% of piggery wastewater demonstrated a better level for producing high biomass of *Azolla* within 14 days. Meanwhile, the results of vermiculture revealed that the parameters including (total Kjeldahl nitrogen, TKN), (total phosphorous, TP), and (total potassium, TK) in vermicompost (decomposed by earthworm, *Eudrillus ugeniae*) were significantly better than the compost (without earthworm) after the experiment. The TKN and TP proved high in vermicompost of cow dung with *Azolla* deriving from piggery wastewater (CDA) around (1.03%) and (0.4%) in comparison to compost less than (0.97%) and (0.36%), respectively. The TK was increased highly in vermicompost of CDA by (0.65%). Interestingly, the cocoons were higher in the CDA (21), while the CD was only (12). This result illustrated that the CDA was a convenient mixed material for earthworm production. Hence, the *Azolla microphylla* was a good supplemental material in improving the quality of vermicompost and good for producing earthworms driving the BCG model.

**Keywords:** wastewater, *Azolla*, vermiculture, nutrients

**AG-15-22**

# A Multispecies Growth and Yield Performance Comparison of Vegetables Cultivated Under Hydroponics Using Sewerage Wastewater

**Dickson M. MAZIBUKO[ab], Antonio Perez FUENTES[a], Kazuha WAKASUGI[a], Sarvesh MASKEY[c], Takahiko NAKAMURA[c], and Hiromu OKAZAWA[c]***

*[a]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]School of Natural and Applied Sciences University of Malawi, Malawi*
*[c]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
**Corresponding email: h1okazaw@nodai.ac.jp*

**Abstract**

The reuse of sewerage wastewater is becoming a solution to sustainable water utilization particularly in water-scarce regions. Using Biologically Treated Water (BTW), Chlorine Disinfected Water (CDW), and tap water, this study aimed at understanding the yield performance and chlorophyll content in three vegetables *Phaseolus vulgaris* (beans), *Brassica rapa var. perviridis* (tomatsuna), and *Solanum lycopersicum* (tomato) grown under hydroponics. We used a Nutrient Film Technique (NFT) hydroponic system supplied with tap water treated wastewater and reclaimed wastewater. Those plants were grown to maturity at controlled water temperature. Chlorophyll data was collected throughout while yield data was collected at harvest. Results show that vegetative growth was high in BTW and CDW compared with tap water. An ANOVA test revealed significant differences in terms of chlorophyll in tomatoes. A Welch ANOVA test showed significant differences in terms of chlorophyll in beans and komatsuna. For yield, an ANOVA test showed significant differences among the treatments for bean, komatsuna, and tomato. The Post hoc test showed significantly high chlorophyll for beans and tomatoes in tap water, compared to BTW and CDW. In terms of yield, only beans performed best in the tap water hydroponic system while tomato and komatsuna performed best in BTW and CDW compared to tap water. The results indicate a vegetable differential preference for the three water types used. These three vegetables can thus be cultivated concurrently. Research on the safety of vegetables grown in sewerage wastewater, and the economic feasibility of using reclaimed water for vegetable production with the observed lack of significant difference between the sewerage wastewaters, is urged before upscaling this technology.

**Keywords:** hydroponics, sewerage resources, vegetables, wastewater, advanced treated water

**AG-15-24**

# Agroecological Performance of Market Gardens Located in Southern Sweden

**Iman Raj CHONGTHAM[a]* and Mathilda HÅKANSSON[a]**

*[a]Department of Biosystems and Technology,*
*Swedish University of Agricultural Sciences*
*P.O Box 190, 234 22 Lomma, Sweden*
**Corresponding email: raj.chongtham@slu.se*

**Abstract**

Since the end of the Second World War and the start of the Green Revolution, there has been a rapid increase in specialization and industrialization of agriculture. Farms are growing in size with heavy reliance on external inputs such as agrochemicals and most of the inputs and farm products are transported over long distances. However, the countermovement from consumers during the recent decades for local and environment-friendly production has led to the establishment of several small-market gardeners to provide vegetables to local communities (directly) in and around cities and towns in Sweden. Understanding the sustainability of market gardens requires credible and holistic assessment in terms of the three sustainability pillars, *viz* Social, Environment, and Economic. This exploratory study aims to highlight the multidimensional benefits and trade-offs of market gardeners by assessing them using '*Tool for Agroecology Performance Evaluation*' (developed by FAO), and by comparing them with a few large-scale reference farms in Scania. The results revealed that market gardens had higher crop diversity, more efficient resource use and management, and more synergies between components than large-scale reference farms. Additionally, market gardens scored high in terms of responsible governance, co-creation, and sharing of knowledge and involved a high number of young people (below 40 years of age) as either direct employees or interns. However, market gardeners tended to have lower economic income and higher workloads compared to the reference large-scale farms, which created a sense of insecurity for its long-term continuance. Another important challenge reported by market gardeners was the lack of direct government support and subsidies. In conclusion, the resilience of market gardeners seemed to be high especially in relation to recent limitations in global trade due to covid-19 pandemic, high fuel and fertilizer costs, and changing weather patterns, as they do not depend much on external inputs and have diverse crops.

**Keywords:** agroecology, local food, resilience, sustainability assessment, TAPE

**AG-15-26**

# Development of the Biological Salt Utilizing System for the Management of Saline Agricultural Field in Khon Kaen, Thailand

**Takashi KUME[a]*, Chuleemas Boonthai IWAI[b], Tadao YAMAMOTO[c], Katsuyuki SHIMIZU[d], Fumikazu UBUKATA[e], and Hirotaka MATSUDA[f]**

*[a]Ehime University, Japan*
*[b]Khon Kaen University, Thailand*
*[c]Hokkaido University, Japan*
*[d]Tottori University, Japan*
*[e]Okayama University, Japan*
*[f]Tokyo University of Agriculture, Japan*
**Corresponding email: kume@ehime-u.ac.jp*

**Abstract**

About 1.5 million hectares of agricultural land are lost to soil salinization each year worldwide. Khon Kaen in Northeast Thailand is located in the low-lying Korat Plain, where approximately 336,000 hectares of soil are salinized. The study site, Ban Phai district, is one of the areas in Khon Kaen where there are many farmlands where salinization has not yet been resolved. The average farmer's landholding area in Ban Phai district is about 2-4 hectares. The farmland parcels here are not well developed, and the flat topographical slope makes it difficult to construct a network of drainage channels to facilitate salt removal, resulting in the existence of many salinized farmlands. In this study, we developed a biological salt utilization system that promotes salt management and utilization within farmers' own 2-4 hectares of farmland, without relying on drainage channel networks. The system was applied to test plots to promote salt removal within farmer-owned agricultural lands and to conduct empirical experiments to improve farmers' cash income through salt-tolerant crop cultivation (*Sesbania rostrata* and *Moringa oleifera* Lam.) and traditional salt production using the removed salts. The implementation of the system began in 2017. Four months after the system was introduced, a clear decrease in soil salinity was observed compared to before the introduction of the system. It was also evident that the use of vermicompost improved the growth of salt-tolerant crops compared to conventional cultivation. Traditional salt production in the downstream part of the system was also found to promote the utilization of discharged salt, and the salt produced was sold for about 20 baht per kg, contributing to improved cash income for farmers.

**Keywords:** soil salinization, drainage, salt utilization, vermicompost, salt-tolerant crop, traditional salt production

**AG-15-27**

# Plant Growth and Fruit Quality of Tomato (*Solanum lycopersicum*) Using Advanced Treated Water in Hydroponics

**Antonio Perez FUENTES[a], Kazuha WAKASUGI[a], Sarvesh MASKEY[b], Dickson M. MAZIBUKO[a], Takahiko NAKAMURA[b], Hiroyuki OSHIMA[c], Taku KATO[c], Ayako SEKIAYMA[b], and Hiromu OKAZAWA[b]***

*[a]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
*[c]Faculty of Applied Biosciences, Tokyo University of Agriculture, Japan*
**Corresponding email: h1okazaw@nodai.ac.jp*

## Abstract

The classification of reclaimed water depends on both its destination and the treatment it has undergone. As the product of the advancement treatment process, Biologically Treated Water (BTW) accounts for the reclaimed water previous the disinfection while Chlorinated Disinfected Water (CDW) is the BWT that has been treated with a chloride solution (NaClO) to eliminate microorganisms. Wastewater discharged from urban areas is generally released into the ocean after such processes. Despite this treatment, BTW and CDW report significant amounts of nutrients, which could be used in hydroponic systems to create a more advanced water recycling process. Further research is needed to apply these treated waters to hydroponic vegetable production systems. This study discusses the effects on Cindy Sweet tomatoes grown with BTW and CDW and demonstrates the effectiveness of a hydroponic system utilizing treated sewage water. The experiment was carried out at a greenhouse in the wastewater treatment plant in Yokohama, Japan. The nutrient solutions were balanced to 1.3 mS/cm using commercial fertilizer. The results showed that tomatoes supplied with BTW had higher fresh weight than those in the CDW and control water (Tap water and liquid fertilizer). Concerning fruit quality, statistical analysis showed that the fruits in treatment 2 were larger in diameter and weight, and further ANOVA analysis showed no significant differences between the control and BTW. This study also discovered that the application of BTW and CDW resulted in larger fruit clusters without a corresponding increase in fruit density. Chlorophyll analysis, however, showed no difference between BTW and CDW, while the control showed the best performance with about twice the photosynthetic activity. Furthermore, despite the lower chlorophyll content of the plants from BTW, higher yields can be obtained in leafy vegetables, where biomass and water content are the main research questions.

**Keywords:** hydroponic, tomato, wastewater, advanced treated water

**AG-15-33**

# Impact of Irrigation Methods on Water Delivery Performance in Large-Scale Irrigation Scheme in Morocco

**Dayyabu Muhammad ZAHARADDEEN[a], Katsuyuki SHIMIZU[b]*, Yuri YAMAZAKI[b], Vinay NANGIA[c], Anas MANSOURI[c], Mohamed BELAARABI[d], and Lahcen OUSSTOUS[d]**

*[a]United Graduate School of Agricultural Sciences, Tottori University, Tottori, Japan*
*[b]Faculty of Agriculture, Tottori University, Tottori, Japan*
*[c]International Center for Agricultural Research in the Dry Areas (ICARDA), Rabat, Morocco*
*[d]Regional Office for Agricultural Development in Tadla (ORMVAT), Morocco*
**Corresponding email: talk2deenee@yahoo.com*

## Abstract

Water scarcity is a significant issue worldwide, which is a hindrance to sustainable development and sufficient food production. Morocco is one such country that is severely affected by water scarcity, making it essential to manage irrigation effectively. Various studies have suggested methods to manage irrigation during water scarcity, including modifying cropping patterns, reducing irrigation time, and modifying irrigation areas and methods. However, the impact of different irrigation methods on water delivery performance (WDP) needs to be determined. To understand how irrigation methods affect WDP, a proposed partial drip irrigation method was assumed, which irrigates only tree crops using drip irrigation and surface for other crops. The evaluation of WDP was done at the lateral canal level in the Beni Amir irrigation district, Morocco. The study analyzed the adequacy, dependability, and equity of both the prevailing furrow irrigation method and the proposed partial drip method. The irrigation scheme has 14 lateral canals that were classified into three parts: head, middle, and tail. The same data on climate and crops, such as cropping areas and patterns, to calculate the irrigation water requirements for the dry seasons of 2016, 2017, and 2018. The daily discharge of each lateral canal and the irrigation time for each field were collected to calculate the monthly water supply to all fields. Water sufficiency and performance indicators were calculated under each irrigation method. The study found that surface irrigation delivered 19%, 35%, and 33% less water than required in 2016, 2017, and 2018, respectively. However, if the proposed drip method is used, the water delivered in 2016 will exceed requirements by 10%. In 2017 and 2018, it will fall short by only about 3% and 2%, respectively. The prevailing furrow method resulted in fair and poor water delivery performance in terms of adequacy, dependability, and equity. In contrast, the proposed drip method is expected to improve the performance to good and fair in all years.

**Keywords:** water scarcity, cropping patterns, surface irrigation, drip irrigation

**AG-15-34**

# Effects of Different Agricultural System Practices on Soil Erosion Using RUSLE Model in Ratanak Mondul District, Battambang Province, Cambodia

**Sarey RIM[acd]*, Nareth NUT[ad], Lyhour HIN[a] Sophoanrith RO[b], Lytour LOR[a], Sakdanupol CHAN[a], and Machito MIHARA[cd]**

*[a]Faculty of Agricultural Biosystems Engineering, Royal University of Agriculture (RUA)*
*[b]Faculty of Agronomy, Royal University of Agriculture (RUA),*
*[c]Faculty of Regional Environment Science, Tokyo University of Agriculture (TUA), Japan*
*[d]Institute of Environmental Rehabilitation and Conservation (ERECON)*
**Corresponding author: rimary300@gmail.com*

## Abstract

Cambodia faces a severe soil erosion crisis due to rapid land-use changes, deforestation, and unsustainable agricultural practices. The loss of fertile topsoil significantly threatens the country's agricultural productivity, food security, and overall environmental health. Conventional agricultural practices, such as intensive tillage and monoculture cropping, contribute to soil degradation and increase erosion risk. To combat soil erosion and its associated nutrient loss, the northwestern region of Cambodia has promoted different agricultural system practices. This research aims to understand the soil erodibility factor (K-factor) value under different agricultural system practices, non-tillage practice (NT), conventional tillage (CT), green manual (GM), and forest soil (FS), and to estimate the amount of soil erosion by comparing the soil loss of different agricultural system practices using the Revised Universal Soil Loss Equation (RUSLE) model intergraded with a Geographic Information System (GIS) environment. GIS and RUSLE models are useful tools for building soil erosion maps and defining vulnerable areas through spatial distribution data. The result showed that the K-factor values ranged from 0.109 to 0.156 t/hr/MJ/mm, which was 0.109 for NT, 0.111 for CT, 0.141 for GM, and 0.123 for FS, respectively for Acrisols soil, and 0.156 t/hr/MJ/mm for Cambisols soil. In these various changes of K-factor, the soil loss in Ratanak Mondul was 2.65 tons/ha for NT, 4.53 tons/ha for CT, 2.07 tons/ha for GM, and 1.49 tons for FS practices. In comparison, the estimated total soil loss in 2020 was 87,829 tons/year, 149,989 tons/year, 68,710 tons/year, and 49,455 tons/year for NT, CT, GM, and FS agricultural systems, respectively. Thus, conserving agricultural practices (NT and GM) has significantly contributed to erosion prevention and made agricultural practices more sustainable. Understanding the causes of soil erosion will help us protect and sustain land and natural resources. This knowledge will be essential for planning conservation efforts and policy changes.

**Keywords:** soil erosion, GIS, RUSLE, green manual, conventional tillage, non-tillage LULC-2020, K-facto

**AG-15-36**

# Recent Expansion and Future Perspectives of Direct Seeding in Miyagi Prefecture of Japan

**Hiroei KANNO[ab] and Koki HOMMA[a]***

*[a]Tohoku University, Japan*
*[b]Organization Miyagi Prefectural Furukawa Agricultural Experiment Station, Japan*
**Corresponding email: koki.homma.d6@tohoku.ac.jp*

**Abstract**

The recent social situation in Japan has forced rice farmers to increase their scale and save labor. To achieve the two purposes, direct seeding is rapidly applied to their fields. We report on the expansion of direct seeding in Miyagi Prefecture of the Tohoku region in Japan and discuss the technology that led farmers to accept direct seeding. Future perspectives are also discussed.

The farmers in Miyagi ordinarily transplanted rice seedlings with the machine. 1st major turning point was the Great East Japan Earthquake, which required the reconstruction of paddy fields and farmers' associations after the tsunami. The direct seeding area occupied 1.5% of the rice planting area in 2011, just after the earthquake, and increased by 4.8% in 2022. The wet seeding method was applied at the initial expansion stage because heat retention by flooding would be necessary. One of the major constraints of wet seeding is low germination, driving technological development from Calper coating, Iron coating, and Bengala and Molybdenum coating. Especially, Iron coating contributed to the initial expansion of direct seeding. The recent expansion of direct seeding has been driven by a dry seeding method. Dry seeding in early spring has been established to obtain relatively stable germination. Since the farmers can avoid work conflict in spring, early spring seeding has been strongly accepted. Based on the experience, the cultivar is being changed. Since one of the major problems in direct seeding is weeds, technological improvement in the management of herbicides also contributed to the expansion. Since high-quality rice production with organic is expected in Japan, the development of nonchemical weed management is required. As mentioned above, social changes and technological improvements enhance the increase of direct seeding. However, it only accounts for 5%. The rice quality recommendation of consumers seems a key factor in addition to the rice price which is still high enough to continue transplanting.

**Keywords:** rice, wet seeding, dry seeding, weed management, work conflict, technological improvement

**AG-15-37**

# Production and Marketing Systems of Crops Replacing Rubber of Farmers Under the Production Volume Control Project in Kalasin Province

**Walaipan PREEPRADIT[a]* and Arunee PROMKHAMBUT[a]**

*[a]Department of Agricultural Extension and Development, Faculty of Agriculture, Khon Kaen University, Khon Kaen, Thailand*
**Corresponding email: walaipan@kkumail.com*

**Abstract**

In Thailand, the continuously decreasing price of natural rubber has urged the government to reduce rubber area by launching the Production Volume Control Project nationally in 2015 by subsidizing 2,857 USD/ha for participating farmers. How farmers who participated in this project receive the advantages and disadvantages has not been documented. The objectives of this study were to study the general characteristics of farmers and managements of rubber plantations under the project, to assess the social, economic, and environmental benefits of farmers from participating in the project, and to identify problems facing farmers. Data were collected through in-depth interviews by selecting 3 farmers representing 3 cropping systems designed by the government, replacing rubber with fruit trees (mango) (FT), integrated rubber-based farm (IRF), and rubber trees (RT). The results showed that all farms are immature periods of rubber. The farmers who chose to continue growing rubber (RT) were active farm labor (45 years old) and earning most of their income from cassava, while IRF and RT farmers were old-age farmers (64-65 years old). Lack of labor, aging labor, and having capital inputs from remittance cause the RT farmer to switch from rubber to mango. The RT farmers intercropped rubber plantation with cassava during the immature period which complemented their farm expertise in cassava. The IRF farmer reduced the number of rubber trees per area to 33% of the normal recommendation and varied farm activities into vegetables, fruit trees, and animals, therefore, earned the highest annual income from the farm (1,586 USD) and a high crop diversity index in the farm. This farmer also earned the societal value of landscape in the area by being a local expert in integrated farming. The IRF marketing system went beyond the village into the neighboring province due to the diversity of farm activities. However, high investment in irrigation at the early stage of farming and no market support from the government are the key problems of this farmer, while lack of knowledge support from the government in mango production is the main problem of the FT farmers.

**Keywords:** crops replacing rubber; rubber farmer, government project, Northeast, Thailand

**AG-15-44**

# Seroprevalence of Brucellosis Disease and Lumpy Skin Disease on Cattles at Svay Rieng and Prey Veng Province, Cambodia

**Khoeun SOKUN[ad]*, Kong SAROEUN[ad], Bun CHAN[c], Ren THEARY[c], Ith MANAY[b], Chan BUNYETH[a], Lay HORT[c], Hin LYHOUR[b], and Theng KOUCH[b]**

*[a]Faculty of Agriculture, Svay Rieng University, Svay Rieng 200705, Cambodia*
*[b]Royal University of Agriculture, Phnom Penh 12401, Cambodia*
*[c]General Directorate of Animal Health and Production, Phnom Penh, 120603, Cambodia*
*[d]Graduate School, Royal University of Agriculture, Phnom Penh, Cambodia*
**Corresponding email: sokunkhoeun@ymail.com*

**Abstract**

LSD (Lumpy Skin Disease) is a poxviral disease with significant morbidity in cattle and belongs to the family Poxviridae, genus Capripoxvirus, and is transmitted by hematophagous arthropod vectors. Despite the typically low mortality rate, economic costs arise from deterioration in health, decreased milk production, miscarriages, infertility, and harmed hides. Brucellosis disease is one of the most common contagious and communicable zoonotic diseases with high rates of morbidity and lifetime sterility. Serological tests with ELISA (Enzyme-Linked Immunosorbent Assays) indicate exposure to Brucella and LSD in cattle. To identify the presence of those diseases, the research was conducted in two provinces, Svay Rieng and Prey Veng, in Cambodia, starting from July 2021 to January 2022. In the study, the 2018 Thusfield method was adopted, and two cattle were selected from 216 households in the two provinces (112 in Svay Rieng and 104 in Prey Veng). However, not all the families had two cattle, so the total sample size was 300 cattle (150 in Svay Rieng and 150 in Prey Veng). As a result, there was only one brucellosis disease case in Svay Rieng Province, while that disease was not found at all in Prey Veng. Meanwhile, LSD was higher in Prey Veng (80% of the tested cattle) than in Svay Rieng (69%). Among all of the tested cattle, 66.7% had the highest BS (Body Score = 4). The finding suggests that LSD was prevalent in the studied areas, which may cause economic losses. Thus, preventive measures should be taken properly to tackle this issue. Although Brucellosis was a rare case in the studied areas, it may spread faster, causing abortion in cattle and women. Biosecurity is needed to ensure strict control over this disease.

**Keywords:** zoonoses, Brucellosis, LSD, antibody, ELISA

**AG-15-48**

# Recent Trends in Consumption of Traditional Fermented Foods in Cambodia

**Sothea KONG[ab], Hisako NOMURA[c], Tamon BABA[d], Hiroyuki HATTORI[e], Samnang NGUON[a], and Kasumi ITO[f]***

*[a]Graduate School, Royal University of Agriculture, Cambodia*
*[b]Graduate School of Bioagricultural Sciences, Nagoya University, Japan*
*[c]Faculty of Agriculture, Kyushu University, Japan*
*[d]College of Letters, Ritsumeikan University, Japan*
*[e]Graduate School of Agricultural Science, Tohoku University, Japan*
*[f]International Center for Research and Education in Agriculture, Nagoya University, Japan*
**Corresponding email: kasumito@agr.nagoya-u.ac.jp*

**Abstract**

The health benefits associated with fermented foods are well-known across the world. Cambodia is one of the treasure troves of diverse fermented foods. However, in recent years, the landscape of dietary habits and food culture has been changing due to the proliferation of Western fast-food restaurants in countries and the increased participation of women in the workforce. Preserving the legacy of traditional fermented foods necessitates a comprehensive understanding of actual consumption patterns and the implementation of countermeasures. This study aimed to explore the consumption trends of local fermented food products. A questionnaire-based interview survey was undertaken in three primary local markets situated in the capital city of Phnom Penh. The survey covered the young (10–20s), middle-aged (30–40s), and elderly (50–60s) generations. Overall, 510 customers were interviewed, and 506 (99.27%) valid responses were received. Consequently, 5 types of meat, 30 types of fish, 58 types of vegetables, fruits, and cereal products, 7 types of seafood, and 78 local fermented foods were identified as fermented products consumed by the respondents. Of these, fish sauce, fermented freshwater fish paste, Khmer noodles, and soy sauce were familiar staples with more than 480 (95%) consumers. The average number of products respondents had ever consumed was consistent across the three generations. Although the study hypothesized reduced consumption among the young generation, this demographic tended to consume more vegetables, fruits, and cereal products compared to other generations. Most consumers relied on purchases or obtained fermented foods from neighbors and relatives due to a lack of time on busy days. Further research is imperative to gain an understanding of how young people navigate amidst significant changes in the social environment. This will also help in devising strategies to preserve and pass down Cambodia's heritage of traditional fermented foods.

**Keywords:** trends, consumption, traditional fermented foods, Cambodia

**AG-15-49**

# Elucidation of The Chemical Structures and Antioxidant Property of Cambodian *Melaleuca* Extract

**Ravor SENG[ab], Akane KUROKI[a], Masashi KAWAGUCHI[a], Fumie NAKASHIMA[a], Takahiro SHIBATA[a], and Hiroyuki HATTORI[c]***

*[a]Nagoya University, Graduate School of Bioagricultural Sciences, Japan*
*[b]Royal University of Agriculture, Graduate School, Cambodia*
*[c]Tohoku University, Graduate School of Agricultural Science, Japan*
**Corresponding email: hiroyuki.hattori.b4@tohoku.ac.jp*

## Abstract

The Myrtaceae family is found in tropical and warm-temperate regions worldwide. In Cambodia, *Melaleuca* species are particularly common in the Svay Rieng, Kampot, Koh Kong, and Preah Sihanouk provinces, as well as other regions. Essential oil production using the plant's leaves is popular in Australia, New Guinea, and Southeast Asia. The essential oil and the extract of *Melaleuca alternifolia* are widely acknowledged to possess several beneficial bioactivities, including anti-inflammatory, antibacterial, and antifungal properties, that contribute to our health. Although many useful compounds in the *Melaleuc*a essential oil are well known, it has not been fully studied on the constituents in the *Melaleuca* extract and the bioactivities contributing to enhancing our health. In this study, we aimed to isolate and identify the chemical structure of the constituents in *Melaleuca* extract and investigate its bioactivity. The plant material of *Melaleuca* leaves was collected in the Svay Rieng, Kampot, and Koh Kong provinces. The dried samples were powdered and extracted with methanol, and the extracts were successively extracted with hexane, chloroform, and ethyl acetate. The hexane and ethyl acetate fractions were separated by silica gel open column chromatography and obtained 28 fractions (HFr. 1–28) and 11 fractions (EFr. 1–11), respectively. Com.1 and 2 were isolated from HFr. 6 and EFr. 4 respectively using preparative high-performance liquid chromatography (PHPLC). The nuclear magnetic resonance (NMR) and high resolution-electrospray ionization mass spectrometry (HR-ESIMS) were used to elucidate their chemical structure. According to the instrumental analyses, Com.1 was identified as 7-*O*-methyl-cryptostrobin, which is a known compound from the *Eugenia mattosii* plant but has not yet been reported from the *Melaleuca* plant. The analyses revealed Com.2 is pinocembrin, previously characterized by the *Pinus cembra* tree and possessed anti-inflammatory activity. To understand the bioactivity of *Melaleuca* extracts, we examined if it shows antioxidant effects such as the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging and the superoxide dismutase (SOD) like properties. The results indicated that the extract from Svay Rieng province showed the strongest antioxidant activities.

**Keywords:** *Melaleuca* extract, isolation, structure elucidation, antioxidant

**EM-15-01**

# People - Peatland Interconnections: Socio-economic Determinants of Local Livelihoods Underlying Effective Peatland Protection in Riau, Indonesia

**Mohammad YUNUS[a] and Adcharaporn PAGDEE[b]***

*[a]Biological Science International Program, Department of Integrated Science, Faculty of Science, Khon Kaen University, Khon Kaen, 40002, Thailand*
*[b]Department of Environmental Science, Faculty of Science, Khon Kaen University, Khon Kaen, 40002*
**Corresponding email: adcpag@kku.ac.th*

**Abstract**

Peatlands provide a wide array of ecosystem services that greatly contribute to our well-being. Simultaneously, our practices determine the peatland's existence, molding "people - peatland interconnections." In this study, we examined socio-economic determinants of local livelihoods underlying effective peatland protection. A semi-administered questionnaire was conducted in five villages located in the Sungai Kiyap - Sungai Kampar Kiri Peatland Hydrological Unit (SKKI PHU) in the Kampar Regency, Riau Province, Indonesia, from May to June 2023. A total of 200 household representatives participated in the questionnaire survey, investigating 1) household socio-economic conditions, 2) economic valuation of peatland ecosystem services – an indication of people's perceptions toward peatland importance, and 3) local practices in peatland utilization and protection. We identified 14 types of ecosystem services from various peatland settings, ranging from private plantations to community peat swamp forests, public lands, and nature reserves. A total economic value was estimated at US$ 3,174.31 per household per year, of which 80.75% illustrated a use value, especially direct benefits from fish, wild plants, wildlife, and soil fertility, which accounted for nearly an amount of annual household income (~US$ 2,816). Socioeconomic factors, such as respondents' age, length of residence, gender, participation in training/workshops, household spending, and debt/loan/mortgage procession, determined villagers' perception towards the peatland's economic importance and local practices, including rule and regulation obedience, cooperative collaboration, resource utilization, harvesting seasons, and use of eco-friendly tools. Finally, the study illustrates people-peatland interconnections and emphasizes the socioeconomic conditions of local livelihoods that underlie effective peatland protection.

**Keywords:** peatlands, socio-economic determinants, local livelihoods, effective protection, Ria

**EM-15-03**

# Application of Soil Amendments as a Strategy for Water Holding Capacity in Sandy Loam Soil and Grapevine Performance

**Mohammad Mirwais YUSUFI[a]* and Machito MIHARA[a]**

*[a]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
**Corresponding email: mirwaisyusufi@gmail.com*

**Abstract**

Afghanistan has a very large area of sandy loam soil with great potential for use as an alternative land for agriculture. water is a precious natural resource, and sandy loam soil has limiting factors in the water holding capacity, high infiltration, high evapotranspiration, deficient organic matter, and soil moisture content, making it less productive for plant productivity and growth. The research aimed to enhance soil physical properties and increase water holding capacity in sandy loam soil, which is crucial for improving crop productivity in areas with limited water resources. To achieve this, we need to understand the soil moisture content and matric potential of soil. The soil moisture content only indicates the amount of water present in the soil but cannot indicate when to apply a reasonable irrigation regime. Therefore, understanding the matric potential allows for a more precise determination of when and how much to irrigate, optimizing water usage for crops. However, the pot experiment was conducted in a controlled environment at the Tokyo University of Agriculture to evaluate the impact of different soil amendments on the sandy loam soil. The type of soil amendments consisted of 4 treatments: Experiment 1: Chicken manure varied rates in sandy loam soil. Treatments (T): T1 (2.5%), T2 (5%), T3 (7.5%). Experiment 2: Combination of (sawdust+botanical compost+chicken manure) varied rates in Sandy Loam Soil. Treatments (T): T1 (2.5%), T2 (5%), T3 (7.5%). Experiment 3: Botanical compost varied rates in Sandy Loam Soil. Treatments (T): T1 (2.5%), T2 (5%), T3 (7.5%). Experiment 4: Control (100% sandy loam soil). Different treatments with varying soil amendments may influence water retention. Various parameters related to plant growth and health were likely assessed. All treatments are repeated three times with the installation of two data logger sensors in each pot to monitor matric potential and soil water content. The data was analyzed by ANOVA randomized designed block with one single factor. The result of the initial analysis of soil amendments indicated that chicken manure at 7.5% of the total mass and the combination of (sawdust+ +chicken manure+botanical compost) at 7.5% improved water holding capacity the most compared to the control and other treatments. Overall, the study appears to be a significant contribution to improving agriculture in regions with sandy loam soil and limited water resources, such as Afghanistan. It offers practical guidance on soil management for better crop yields in these challenging conditions.

**Keywords:** soil amendments, water holding capacity, sandy loam soil

**EM-15-12**

# Performance of a Covered Lagoon Digester in Wastewater Treatments from Mango Processing

**Chan Makara MEAN[ab]*, Lyhour HIN[ab], Meng Chhay KIM[ab], Buntha KUN[b], Dyna THENG[ab], Nareth NUT[a], and Lytour LOR[ab]**

*[a]Faculty of Agricultural Biosystems Engineering, Royal University of Agriculture (RUA), Dangkor district, Phnom Penh, Cambodia*
*[b]Biogas Technology and Information Center (BTIC), Royal University of Agriculture (RUA), Dangkor district, Phnom Penh, Cambodia*
**Corresponding author: meanmakara321@gmail.com*

## Abstract

In 2022, Cambodia exported more than 163,400 tons of fresh mangoes and 18,490 tons of dried mangoes. Currently, about 250–300 tons of fresh mango are processed daily. With this production volume, wastewater treatment is still a major concern and must be handled properly. This study aimed to (1) ascertain the physio-chemical characteristics of wastewater; (2) estimate the biogas production and its quality; and (3) determine the greenhouse gas emission reductions throughout the installation of the lagoon digester. The study was carried out from July to November 2023 in Treng Trayoeung commune, Phnom Srouch district, Kampong Speu province, with a lagoon digester volume of 6,000 $m^3$. The factory produced up to 300 $m^3$ of wastewater per day, which was then treated with NaOH and powdered calcium carbonate to raise the pH before the feedstock was released into the lagoon pond. Three wastewater samples were taken by the lab for measurement of chemical oxygen demand (COD), biological oxygen demand (BOD), total suspended solids (TSS), total organic carbon (TOC), total nitrogen (TN), total phosphate (TP), total potassium (TK), and pH both before and after treatment. The biogas production was estimated and measured using the vortex flow meter, while a portable biogas analyzer was used to measure the biogas quality. As a result, the COD concentration of wastewater was 28,400 mg/L (above the standard), whereas the COD concentration was reduced to 15,000 mg/L, or 47%, after treatment. It was estimated that the biogas generation would yield 2,541 $Nm^3$/day. While the $H_2S$ concentration was over 5,000 parts per million (permissible norm <200 ppm), the $CH_4$ content was 52%. In conclusion, the firm can lower the COD concentration and benefit from using biogas instead of LPG gas for cooking and boiling. The factory may have decreased carbon gas emissions by approximately 10,570 $tCO_2eq$ annually.

**Keywords:** lagoon digester, biogas, wastewater treatment, greenhouse gas, COD

**EM-15-13**

# Recycling of Nitrogen and Phosphorus from Urban Wastewater Using Calcium-Silicate-Hydrate (CSH): Case Study in Cambodia

**Somara OUM[a]*, Narong TOUCH [b], and Machito MIHARA[b]**

*[a]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]Faculty of Regional Environment Science, Tokyo University of Agriculture, Japan*
**Corresponding email: oum.somara128@gmail.com*

## Abstract

The effluents from wastewater contain nutrients that have been identified as the primary causes of eutrophication in natural waters. A case study from Cheung Ek, an urban wastewater lake in Cambodia, has indicated polluted with $NH_4^+$ (18-22 mg/L) and $PO_4^{3-}$ (2.3-4.6 mg/L). Even though phytoremediation through water morning glory cultivation was introduced into the lake, only a certain amount of nutrients can be removed from the lake's water (65.22% and 17.36% for $NO_3^-$ and $PO_4^{3-}$, respectively). Hence, this wastewater's lake must receive suitable treatment before being discharged into other water bodies. Low-cost and high-performance materials or techniques that could synergistically remove pollutants in a simple manner are highly desired. Therefore, the main goal of this research study is to evaluate the CSH synthesized from calcium carbonate ($CaCO_3$) and rice husk ash as a promising strategy both economically and environmentally friendly for wastewater treatment as well as nitrogen and phosphorus recovery. The CSH material was prepared by combining calcium carbonate ($CaCO_3$) and rice husk ash with a ratio (1:4) and mixed with 75% deionized water. Following the mixing process with a vibrator, the CSH was kept in the mold for 3 weeks at room temperature before starting the experiment. The absorption experiment considers parameters such as pH, EC, Ca, K, $NH_4^+$, and $PO_4^{3-}$ in 2 weeks period. Results of the absorption experiment indicated that CSH can effectively remove nutrients from wastewater, achieving removal rates of 96% - 98% for $NH_4^+$ and 96% - 97% for $PO_4^{3-}$. The absorption capacity of CSH remains consistent over one week across all scenarios, with the highest nutrient absorption observed in cases with 3 minutes of vibrations. These results suggest that CSH, derived from $CaCO_3$ and rice husk ash, could serve as a cost-effective solution to water pollution in Cambodia, given the material's affordability and widespread availability throughout the country.

**Keywords:** nutrients recycling, CSH, Cambodia

**EM-15-14**

# The Bio Circular Dairy Farming Model of Thai-Danish Dairy Cooperatives Lam Phaya Klang Limited, Saraburi Province, Thailand

**Anucha WITTAYAKORN-PURIPUNPINYOO[a]***

*[a]School of Agriculture and Cooperatives, Sukhothai Thammathirat Open University, Parkkred, Nontaburi, Thailand, 11120*
**Corresponding email: puanucha@windowslive.com*

**Abstract**

To respond to the Bio Circular Green Economy (BCG) of the Thai Government, Thai-Danish Dairy Cooperative Lam Phaya Klang Limited launched the Bio Circular Dairy Farming Model to generate the model for community economic development by using waste from dairy farms to create the value added which comprised of 1) production of compost from cow dung, 2) production of biogas from wastewater, 3) raising tilapia in farm wastewater treatment ponds, 4) growing mushrooms from leftover straw, and 5) production of milk fertilizer from inferior quality milk. The research objective was to evaluate the cost-benefit of these projects. The financial analysis was applied with the Benefit Cost Ratio (BC Ratio), Net Present Value (NPV), and Internal Rate of Return (IRR). The primary data on cost and benefit were collected from the cooperatives. Also, in-depth interviews of cooperative members and the community were collected to evaluate their acceptance and satisfaction. Questionnaires and interview forms were utilized as tools for data collection. In total, there are 536 cooperative members. Using Yamane's formula and allowing a 5 percent error to determine the sample size, it turned out to be 147 individuals as the sample size. The purposive sampling technique was applied for in-depth interviews of 50 individuals. The research showed that all 5 projects under the Bio Circular Dairy Farming Model of Thai-Danish Dairy Cooperative (Lam Phaya Klang) Limited were financially worthwhile. Cooperatives, members, and the community had their great satisfaction and full acceptance. This meant that the Bio Circular Dairy Farming Model has been and is still the best practice project to respond to the BCG economy policy of the Thai Government to move forward with the sustainable development of the Thai economy.

**Keywords:** bio circular, dairy farming, financial analysis, dairy cooperatives

**EM-15-17**

# Ecotourism in Southeast Asia: A Systematic Review of Ecotourism Activities and Factors Determining Tourists' Willingness to Pay for Ecosystem and Biodiversity Protection

**Desvia Norita ANGELINA[a]* and Adcharaporn PAGDEE[b]**

*[a]Master's Student in Bioscience and Bioinnovation for Sustainability (International Program), Department of Integrated Science, Faculty of Science, Khon Kaen University*
*[b]Department of Environmental Science, Faculty of Science, Khon Kaen University*
*123 Moo 16 Mittraphap Hwy., Khon Kaen University, Khon Kaen 40002, Thailand*
**Corresponding email: desvianorita.a@kkumail.com*

**Abstract**

Ecotourism is defined as responsible traveling to natural areas that help protect ecosystems, conserve biodiversity, sustain local livelihoods, and involve interpretation and education. Globally, ecotourism manifests in a rich array of activities and exhibits a spectrum of success. While ecotourism demonstrates the potential to generate income, create job opportunities, and raise tourist awareness, there is a concern over the effective protection of local ecosystems and biodiversity. In this study, we conducted a systematic review and analyzed 72 articles published on Scopus and ProQuest during 2019-2023. The study investigated ecotourism practices in Southeast Asia (SEA) – one of the world's most popular destinations for ecotourism and examined factors determining tourists' willingness to pay (WTP) to protect ecosystems and biodiversity in this region. Ecotourism in SEA focused on nature-based recreation from mountains down to beaches and seas, together with local tradition and cultural exposure known as a "homestay." Ecotourism markets mainly serve domestic tourists but with a growing number of international travelers. Tourists were unaware of management activities such as wildlife protection, fire prevention, and invasive species control rather than educational communication such as nature trails and signs. However, tourists expressed their WTP for biodiversity and ecosystem protection, especially extra payments on local tour guides, recreational facilities, and conservation packages, such as bird watching, coral reef restoration, and firefly conservation. Amounts of WTP varied depending on the country, from a minimum of US$ 0.07 to a maximum of US$ 48 per visit. Education, age, and perception of tourists were identified as key factors determining tourists' WTP. Integration of educational activities to raise tourist awareness and promote their actions in biodiversity protection across ages is crucial for effective ecotourism.

**Keywords:** ecotourism, willingness to pay, biodiversity conservation, ecosystem protection

**EM-15-18**

# Long-Term Hydrologic Trend Analysis of Diamphwe River Basin in Central Malawi

**Kenford A.B. LUWEYA[a], Lameck FIWA[b], Ke ZHANG[c], Sarvesh MASKEY[d], Hiroko GONO[e], and Hiromu OKAZAWA[d]***

*[a]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]Agricultural Engineering Department, Lilongwe University of Agriculture and Natural Resources, Malawi*
*[c]Japan International Research Center of Agricultural Sciences, Japan*
*[d]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
*[e]Faculty of International Agriculture and Food Studies, Tokyo University of Agriculture, Japan*
**Corresponding email: h1okazaw@nodai.ac.jp*

## Abstract

Extreme weather events in developing countries can cause socio-economic consequences, livelihood losses, and increased costs. Identifying these events is crucial for managing water resources, often done through trend analysis of climatic and hydrologic events. The study focuses on the Diamphwe river basin in central Malawi, a vital region supporting wetlands, ecosystems, agriculture, and water supplies as well as rainfed and vegetable winter cropping for Dedza and Lilongwe districts. Using statistical analysis methods such as Mann-Kendall, Pettit, and Standardized Precipitation Index (SPI), this study examined hydrologic trends from 1975 to 2010 to identify long-term hydrologic trends in the region that are important for improving agricultural productivity. The research findings revealed that there is a high correlation between rainfall and river discharge with decreasing trends over time. However, rainfall significantly impacts river discharge only during the rainy season. In the dry season, water for river discharge comes from sources like aquifers and subsurface flow. Through the Pettit test and SPI, it was discovered that 1989 was a transition year, and the 1990-2000 decade was the dryer decade with the worst drought during the 36 years. The study concludes that decreasing trends in rainfall and river discharge, along with a sudden drop in 1989 and drought, indicate a changing climate in the river basin. This change is linked to factors like increased land use changes, leading to reduced forest land. The research provides crucial knowledge for water and environmental stakeholders, aiding in the development of research-based, local-specific policies to mitigate and adapt to potential adverse effects of climate change on society and the environment.

**Keywords:** climate change, trend, river discharge, rainfall, Mann-Kendall test, Pettitt test

**EM-15-21**

# Population Assessment of Agarwood (*Aquilaria* sp.) on Leyte Island

**Lorraine Cristy E. CENIZA[a]*, Jimmy O. POGOSA[b], Marlito M. Bande[c], and Suzette B. LINA[d]**

*[a]Institute of Tropical Ecology and Environmental Management, Visayas State University, Baybay City, Leyte, Philippines.*
*[b]Institute of Tropical Ecology and Environmental Management, Visayas State University, Baybay City, Leyte, Philippines*
*[c]Institute of Tropical Ecology and Environmental Management, Visayas State University, Baybay City, Leyte, Philippines*
*[d]Department of Soil Science, Visayas State University, Baybay City, Leyte, Philippines*
**Corresponding email: lorrainecristy.ceniza@vsu.edu.ph*

**Abstract**

*Aquilaria* trees are known for producing the world's most expensive oils which are naturally occurring throughout the Philippines. Agarwood, eaglewood, gaharu, aloeswood - these are just few of the names for the resinous, fragrant, and highly valuable heartwood produced by *Aquilaria malaccensis* and other species of the Indo-Malesian tree under the genus *Aquilaria*. Agarwood is a resinous part of the non-timber *Aquilaria* tree, which is a highly valuable product for medicine and fragrance purposes, but illegal harvests and trade further undermine efforts to manage the exploitation of *Aquilaria* species. It has been reported to be extinct in the wild due to the heavy exploitation of agarwood resources. In the Philippines, there are few published information available on the ecological and population status of *Aquilaria,* which is an important factor to determine the optimum requirements to develop *Aquilaria*-based production system. Hence, this study was conceptualized to assess the population status of *Aquilaria* in the natural habitat. The results revealed that there were two species of *Aquilaria* documented in the study site, namely: *A. malaccensis* and *A. cumingiana*. Moreover, statistical analysis showed a significant ($p \leq 0.05$) difference on the population and species composition of *Aquilaria* in relation to different topographic expositions. The plant height and diameter at breast height of matured *Aquilaria* recorded at the south-oriented are significantly ($p \leq 0.05$) taller and bigger compared to east-oriented and west-oriented. Therefore, it is highly recommended that *Aquilaria* should be protected particularly *A. malaccensis* since it is rare and considered a new record of occurrence on Leyte Island as one of the significant findings of the study. The establishment of *an Aquilaria*-based production system is necessary to minimize or reduce the overexploitation of *Aquilaria* in the wild and eventually conserve the remaining population within the natural habitat.

**Keywords:** *Aquilaria*, topographic expositions, agarwood, population status

**EM-15-25**

# Preliminary Survey on Farmers' Perceptions of Environmental Protection in Okinawa Prefecture, Japan

**Naoko OKA[a]* and Toshihiko ANZAI[a]**

*Japan International Research Center for Agricultural Sciences, Japan*
**Corresponding email: okanaoko@affrc.go.jp*

**Abstract**

Increasing environmental impact is an urgent global issue, especially climate change, biodiversity, land use, nitrogen, and phosphorus, which are pointed to exceeding their limits. Agriculture, which changes the landscape and inputs nitrogen and phosphorus as fertilizer into the farmland, is one of the significant load sources and is required to take measures to reduce the environmental load simultaneously and increase production volume to support a growing global population. To address these issues, technologies to reduce environmental loads or methods to assess ecological changes have been developed, but in some cases, farmers do not adopt the technologies as expected. There is a growing need to reconsider the technology adaptation based on farmers' perceptions and intentions. Okinawa Prefecture, a sub-tropical region in Japan, has made many efforts to prevent soil runoff into the coral reef surrounding its islands, including establishing the ordinance on red soil erosion prevention, monitoring the coral reef environment based on a prefectural masterplan, and supporting farmers to adapt prevention measures. However, it is reported that the estimated reduction volume from the farmland is not high and that runoff from farms accounts for most of the total runoff volume; thus, prevention measures need to be promoted more (2019, Okinawa Prefecture). This study explores the farmers' perception of taking prevention measures on their farmland to find more effective ways to promote prevention measures. As a preliminary survey, we conducted an interview and questionnaire survey to build a hypothesis on the mechanism of environmentally conscious behavior in agricultural production, involving farmers, non-farmers, and the Coordinators on Agriculture and Environment who function as intermediary supporters of local governments and farmers whose farms are in the basin area connected to the critical monitoring sea areas outlined in the master plan, which is reported here.

**Keywords:** conscious behavior, island, environmental conservation, agriculture, erosion

**EM-15-28**

# Evaluation of Chemical Contaminants in Recycled Water for Firefighting Purposes

**Barry N. NOLLER**[a]*

[a]*The University of Queensland, Sustainable Minerals Institute, St Lucia Queensland 4072, Australia*
**Corresponding email: b.noller@uq.edu.au*

**Abstract**
Recycled water provides a viable means to supplement the water supply. Wastewater generated may be treated for drinking water supply and other purposes. Drivers to use purified recycled water are climate change, severe drought, rainfall-independent water supply, seawater desalination, and purified water supplies. Recycled water has been recognized as an additional input to water use in both urban and farming communities. A particular application of water from its regular supply points is for firefighting when water supply is limited. A review of the potential risks that might apply to firefighters identified that specific and explicit guidance exists endorsing the use of Queensland Class A+ recycled water for firefighting is appropriate. Based on existing domestic and international guidance, seeking to use the highest class of recycled water, the Queensland Class A+ can reasonably be permitted for firefighting use. A study of chemical contaminants was undertaken at a water treatment facility producing recycled water, which was used for dual reticulation and open space firefighting but not yet for firefighting purposes. The health risks to firefighters from recycled water mains were associated with the chemical and endotoxin composition of Class A+ recycled water produced by the advanced water treatment plant compared to potable water supply. Whilst the coverage of microbial hazards was detailed, the specific reference to chemical hazards was limited to endotoxins and briefly mentioned the health effects from exposure to chemicals through chronic exposure to contaminated water rather than from short-term (acute) exposure. Finally, the comprehensive data set of microbiological data from the other study and the current chemical contaminant study were combined in a more informed risk assessment. The overall finding from the risk assessment was that provided additional controls were implemented, the Class A+ recycled water from the water treatment facility used in this study would be safe for fighting.

**Keywords:** wastewater, recycle, firefighting, human health, risk assessment

**EM-15-29**

# Study on Local Awareness and Perception of Fertilizer Application: A Case Study in Anuradhapura District, Sri Lanka

**Arachchillage Buddhika Priyadarshani BANDARA[a]* and Machito MIHARA[ab]**

*[a]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]Faculty of Regional Environment Science, Tokyo University of Agriculture, Tokyo, Japan*
**Corresponding email: abpbandara@gmail.com*

**Abstract**

Sri Lanka, with a rich history of two thousand five hundred years, has long been rooted in an agricultural-based civilization. Recent statistics reveal that agriculture constitutes 10% of the overall economy and engages 26% of the labor force, portraying the pivotal role of the agricultural sector in the country's economic growth. Rice, a staple in the main diet of Sri Lankans, is primarily sourced from extensive paddy cultivations spanning all districts of the country. Paddy cultivation, predominantly practiced as a wetland crop, thrives in the tropical climate. The use of fertilizer in paddy cultivation significantly influences its overall output. Farming practices heavily rely on large amounts of inorganic fertilizer, providing quick merits but posing substantial impacts on paddy soil and the environment. This underscores the pressing need for a shift towards sustainable farming strategies involving organic fertilizer. This study aims to delve into local awareness and perceptions regarding fertilizer application. Seventy farmers within the Tisa Wewa Irrigation Scheme in the Anuradhapura district were randomly selected for the study. Data collection involved structured questionnaires and in-depth individual discussions. The results revealed that 77.1% of the population was aware of the advantages of organic fertilizers, yet only 21.4% were currently using them. This gap was attributed to limitations arising from the high cost and low availability of manure, extended time and quantity requirements for nutrient acquisition, unavailability of suitable products, and constraints related to the self-production of organic fertilizer. A preference for a mixed application of organic and inorganic fertilizer was expressed by 87.1% of the respondents. Furthermore, 94.3% of the population accepted the prospect of using effective and quality organic fertilizers in the future. The findings of this study underscore the necessity for the development of a new organic fertilizer product, paving the way for a more sustainable approach to paddy cultivation.

**Keywords:** fertilizer application, paddy farmers, awareness, perception, Sri Lanka

**EM-15-30**

# Assessing the Efficiency of Different Biogas Generators in Energy Production and Greenhouse Gas Emissions for Commercial Pig Farms in Cambodia

**Meng Chhay KIM[ab]*, Lyhour HIN [ab], Chan Makara MEAN[ab], Dyna THENG[ab], Sovanndy YUT[ab], Nareth NUT[a], Lytour LOR[ab], and Gerald Hitzler[a]**

*[a]Faculty of Agricultural Biosystems Engineering (FABE), Royal University of Agriculture (RUA), Phnom Penh, Cambodia*
*[b]Biogas Technology and Information Center (BTIC), Royal University of Agriculture (RUA), Phnom Penh, Cambodia*
**Corresponding author: kmengchay@rua.edu.kh*

## Abstract

Covered lagoon digesters are commonly used by commercial pig farms in Cambodia to manage their wastewater and produce biogas for electricity generation. In these biogas systems, dual or modified pure biogas generators are utilized, but the efficiency of different generators has not been identified concretely in this country. Therefore, the study aimed (1) to determine biogas production and quality in two pig farms, (2) to compare the working performance of a pure biogas generator and a dual generator, and (3) to estimate $CO_2$ emission reduction in the two cases. The study was carried out between May 2022 and May 2023 on two large-scale pig farms that fully operated biogas systems. The first farm operated an all-in-all-out system with 8,000 fattening pigs in Kampong Speu Province, while the second farm operated a full system with 5,000 fattening pigs and 600 sows. The portable biogas analyzer, electrical power logger, and vortex flowmeter were used to measure biogas quality and record the power consumption and daily biogas production. The results show that the first farm produced 792 $Nm^3$/day, whereas the second farm produced 495 $Nm^3$/day of biogas daily. Additionally, the methane content in both cases was not significantly different (60% of $CH_4$). However, the dual generator can generate power up to 1,118 kWh/day, while the pure biogas generator can produce only 743 kWh/day. The first farm that used the dual generator could save up to 80% of total power consumption, whereas the second farm could save only 24% due to a larger demand for electricity. Thus, the first farm (3,408.2 $tCO_2equ$) could reduce more greenhouse gas emissions than the latter (697.8 $tCO_2equ$). In Conclusion, using biogas can treat wastewater to produce electricity, save electricity costs, and reduce greenhouse gas emissions.

**Keywords:** covered lagoon, pig farm, biogas, electricity, dual generator, and greenhouse gas

**EM-15-31**

# Detecting and Tracking the Positions of Deer Using Sound Recordings at Ozegahara Wetland in 2023

**Kazuo OKI[ab]* Masayasu MAKI[c], Tadanobu OKUMURA[d], Masahiro ONISHI[d], Salem Ibrahim SALEM[a], and Sakae SHIRAYAMA[a]**

*[a]Kyoto University of Advanced Science, Japan*
*[b]The University of Tokyo, Japan*
*[c]Fukusima Universiy, Japan*
*[d]Wildlife Management Office Inc, Japan*
**Corresponding email: oki.kazuo@kuas.ac.jp*

## Abstract

Ozegahara is the largest peatland high marsh in Honshu area, Japan, measuring 6 km from east to west and 2 km from north to south, with an area of approximately 8 km$^2$. It is thought to have been formed around 6,000 years ago, making it valuable in 2005. It was registered as a wetland under the Ramsar Convention due to the large plant community growing here. On the other hand, since the mid-1990s, the Japanese deer (*Cervus nippon* Temminck, 1838, hereinafter referred to as "deer") has been observed, and the natural environment and vegetation of the area are being affected by deer. There are concerns that the impacts will become apparent and irreversible impacts on the ecosystem. Up until now, changes in the number of sightings based on light census surveys have been mainly used as an indicator of the deer population in Ozegahara. However, light census surveys are strongly influenced by weather conditions and deer movement on that day. There is a problem of large observation errors in the data. There are also dung pellet surveys, dung particle surveys, and zoning methods, but these methods involve walking around ridges and mountains looking for deer and their traces and are difficult to find in wet areas where it is difficult for humans to explore. These are not suitable for wetlands such as Ozegahara. To date, the authors have used multiple microphones to observe the "fee-yo fee-yo" calls of male deer during the breeding season (mid-September to November) in the Ozegahara wetland. We have used the data and developed a method to instantly identify the location of the crying. In this study, we attempted to compare deer movement ranges and observations in the Ozegahara wetland area in 2023 using this multiple microphone system with past observations.

**Keywords:** multiple microphones, deer crying, deer population, remote sensing

**EM-15-36**

# Environmental Factors Relating to Termite Mound Distribution in Dry Dipterocarp Forest on the Khon Kaen University Campus

**Phoorit LEELAN [a], Araya PHANOMKHET[a], and Adcharaporn PAGDEE[b]***

*[a]BSc. student, department of Environmental Science, Faculty of Science, Khon Kaen University, 40002, Khon Kaen Thailand*
*[b]Assoc. Prof., Department of Environmental Science, Faculty of Science, Khon Kaen University, 40002, Khon Kaen Thailand*
**Corresponding email: adcpag@kku.ac.th*

## Abstract

"Sustainable green campus" is one of the efforts academia contributes to building sustainable cities and communities (Sustainable Development Goal: SDG 11). Protection of natural habitats, biodiversity, and ecosystem services can be executed not only in protected areas but also on university campuses. Large patches of Dry Dipterocarp Forest, a major vegetation in northeast Thailand, extend throughout the Khon Kaen University (KKU) campus. To maintain forest biodiversity and ecosystem services, especially a living laboratory for students, KKU, in collaboration with the Department of Environmental Science, established a permanent plot in 2022 for long-term ecological monitoring. Tree inventory, including name tag, diameter at breast height, and coordinates, was done. In this series of student research projects, we present a study examining environmental factors relating to termite mound distribution on the KKU's permanent plot. A total of 45 sampling points were located 25m apart, started from the upper left down to the bottom right corner of the permanent plot. At each sampling point, the presence/absence of termite mound(s) was noted, and environmental conditions were measured, including climatic factors, soil conditions, elevation, and surrounding vegetation within a 5m radius. If the mound is present, a number of mounds and mound dimensions (max. width and height) were recorded. A total of seven termite mounds were observed with an average size of 0.48x0.22 m, randomly distributing throughout the permanent plot. All the seven mounds were established individually without neighboring mounds but with higher tree densities surrounded. All tested environmental variables did not show any significant differences between locations where the mounds were present or absent, except soil moisture. Termite mounds were found in areas where percentage of soil moisture was significantly higher than those locations where the mounds were not observed (t-test, p-value < 0.05). Soil conditions, especially moisture, pre-determine where termites will build their mound.

**Keywords:** environmental factors, termite mound distribution, dry Dipterocarp Forest, Khon Kaen University

**EM-15-37**

# Potential of Waste Bank Establishment for Waste Management at the Faculty of Science, Khon Kaen University

**Takdanai PHANSAWAT[a], Jinnatam SUEBPHENG[a], and Adcharaporn PAGDEE[b]***

*[a]BSc. student, Department of Environmental Science, Faculty of Science, Khon Kaen University, 40002, Khon Kaen Thailand*
*[b]Assoc. Prof., Department of Environmental Science, Faculty of Science, Khon Kaen University, 40002, Khon Kaen Thailand*
**Corresponding email: adcpag@kku.ac.th*

**Abstract**

Recycling is one key component of effective waste management. Adding monetary value to the waste incentivizes people to participate in waste recycling. In Thailand, a so-called "waste bank" has been introduced for at least two decades, aiming to improve public participation in waste management, especially in villages, schools, and even universities. In this series of student research projects, the potential of waste bank establishment at the Faculty of Science, Khon Kaen University (KKU) was assessed, including student willingness to participate and their actual involvement in waste bank activities. An investigation at the Department of Environmental Science (ES) was conducted from August to October 2023 focused on undergraduate students. Since they have learned and taken courses in environmental management, including waste management, they can act as trail blazers for waste bank establishment at the faculty. The study consists of two parts: 1) an online questionnaire to examine student's willingness to participate in waste bank establishment and 2) an action experiment to observe student's final decisions to actually be involved in waste bank activities. A total of 204 students responded to the online questionnaire (~81% of the total number of ES students), of which 70% were female. The two largest groups of participants are fourth year and third-year students (37% and 25%, respectively). Approximately 89% of the respondents were familiar with the waste bank concept, and 83% expressed their willingness to participate in waste bank establishment, with around 55% confidence in involving in waste bank activities. However, less than 5% of the students actually participated in a one-month period of waste bank demonstration at the Department. These findings illustrate a big gap between knowing and acting even among a group of people studying ES, and clearly confirm the limited potential of waste bank establishment. Participation is a big challenge for effective environmental management.

**Keywords:** waste bank, waste management, environmental science students, Khon Kaen University

**EM-15-38**

# Relationships Between Undergrowth Flora and Canopy Gap at Dry Dipterocarp Forest in Khon Kaen University

**Kanchana CHAENGPHAI[a], Maengpor SONMANEE[a], and Adcharaporn PAGDEE[b]***

*[a]BSc. student, Department of Environmental Science, Faculty of Science, Khon Kaen University, 40002, Khon Kaen, Thailand*
*[b]Assoc. Prof., Department of Environmental Science, Faculty of Science, Khon Kaen University, 40002, Khon Kaen, Thailand*
**Corresponding email: adcpag@kku.ac.th*

**Abstract**
The structure and species composition of undergrowth flora in deciduous forests are unique, and so are they in evergreen forests, differing the two vegetations. Forest gaps play a key role in determining amounts of sunlight penetrating the forest floor and consequently influencing other environmental factors such as temperature and humidity. In this series of student research projects at Khon Kaen University (KKU), we illustrated relationships between undergrowth flora and canopy gap in a Dry Dipterocarp Forest (DDF) on KKU's permanent plot, established in 2022 for long-term ecological monitoring. A total of 45 sampling plots (5x5m) were located 25m apart from the plot center, starting from the upper left down to the bottom right corner of the 2-ha permanent plot. In all sampling plots, undergrowth flora species and area coverage (%) were recorded in which environmental factors were measured, including climate conditions, soil factors, and surrounding tree density within a 5.6m radius from the plot center. Canopy gaps were captured and quantified using ImageJ – the hemispherical and canopy photographing software. In total, 52 undergrowth flora species from 31 families were identified, with four remaining unknown. Overall vegetative cover was measured at 54.89%, of which 34.72% were dominated by native species and 20.17% were exotic plants, including invasive alien species. The average size of the canopy gap was 26.79%. There are no significant correlations between canopy gap (%), undergrowth flora diversity (# of species), and density (% coverage). However, significant connections between the ratios of area coverage of exotic and native plants and canopy gap (%), light intensity (lux), and surrounding tree density (trees/Rai) were observed (r = 0.335, 0.302, and -0.295, respectively). Amounts of exotic plant coverage were higher when the canopy gap and light intensity increased but lower when tree density increased. Protecting the trees will help control the spreading of exotic species.

**Keywords**: undergrowth flora, canopy gap, environmental factors, Dry Dipterocarp Forest, Khon Kaen University

**EM-15-39**

# Economic Value of Carbon Storage in Forest Trees: An Ecosystem Service from Dry Dipterocarp Forest at Khon Kaen University, Thailand

**Narongchai NAMKORT[a], Natchanon THIRATANABOON[a], and Adcharaporn PAGDEE[b]***

*[a]Department of Environmental Science, Faculty of Science, Khon Kaen University, 40002, Khon Kaen Thailand*
*[b]Department of Environmental Science, Faculty of Science, Khon Kaen University, 40002, Khon Kaen Thailand*
**Corresponding email: adcpag@kku.ac.th*

**Abstract**
Climate change is a global issue that threatens biodiversity, ecosystem services, and our well-being. The United Nations includes Climate Action in one of the 17 Sustainable Development Goals (SDG 13), amplifying the needs and contributions of all stakeholders, including academia, to cope with climate change. In this series of student research projects, the economic value of carbon storage in forest trees in the dry Dipterocarp Forest at Khon Kaen University (KKU), Thailand, was measured. It depicts a local climate regulation service from the forest. Protecting it demonstrates KKU's commitment to climate action and sustainable development. A study took place on the KKU's permanent plot, which was established in 2022 for long-term ecological monitoring. All trees with girth at breast height (GBH) ≥ 14cm were measured in their GBH and height. An allometry equation (Ogawa et al., 1965) was used to estimate amounts of tree biomass while quantifying amounts of carbon storage was based on the IPCC (2006) equation, and the economic value of carbon storage was measured according to 2023 carbon credit prices from Thailand's Greenhouse Gas Management Organization. In total, 610 trees were measured (tree density 610 trees/ha), including 40 species from 38 genera and 21 families, with an average GBH 57.32 cm and a height of 12.79 m. Total amounts of tree biomass were estimated at 183.49 tons, storing amounts of carbon of 86.24 tons or equivalent to 316.21 tons $CO_2$. These amounts were valued at approximately US$ 2,585 per ha (at a purchase price of US$ 8.18 per ton of $CO_2$). The estimated area of the DDF on the KKU campus is at least 25.2 ha. Therefore, the total economic value from carbon storage in forest trees was estimated at least US$ 65,143 – a valuable treasure line on the KKU campus.

**Keywords:** economic value, carbon storage, forest ecosystem service, Khon Kaen University

**EM-15-40**

# Factors Relating to the Ecological Footprint of Students at Khon Kaen University, Thailand

**Chonrada KOONSRIMAK[a], Kanphitcha JANPHITCHA[a], and Adcharaporn PAGDEE[b]***

*[a]Department of Environmental Science, Faculty of Science, Khon Kaen University, 40002, Khon Kaen, Thailand*
*[b]Department of Environmental Science, Faculty of Science, Khon Kaen University, 40002, Khon Kaen, Thailand*
**Corresponding email: adcpag@kku.ac.th*

**Abstract**

Effective environmental management requires participation from all stakeholders, including academia – and university citizens, to take action for sustainable development. Khon Kaen University (KKU), one of Thailand's leading universities, is making a commitment to reach humanity's goals – the 17 Sustainable Development Goals (SDGs). In a series of student research projects, this study investigated KKU's undergraduate student consumption practices by measuring their ecological footprints (EF) and examining factors relating to the EF. A Google form-based online questionnaire covering student backgrounds and activities describing their food consumption and energy use was conducted from August to October 2023. Calculation of students' EF, as well as carbon footprint and Earth overshoot day, was performed using the Global Footprint Network application. A total of 405 undergraduate students participated in the online questionnaire. The majority of students studied Humanity and Social Sciences (46%), followed by Sciences and Technologies (34%) and Medical Sciences (20%). Fourth year and first-year students participated in the survey the most, accounting for 29% and 25%, respectively. The average monthly allowance was 7,700 Baht. Approximately 41% lived in KKU dormitories, 50% lived in off-campus apartments, and 9% lived with their family. The majority of students (>60%) had heard of EF and carbon footprint but did not understand how such footprints were measured. The average size of EF was 5.27 gha/student with a carbon footprint of 6.81 tons $CO_2$ equivalent/student. The Earth overshoot day was April 27, 2023, indicating that students' daily consumption had already surpassed the Earth's biological capacity. One-way analysis of variance illustrated a significant difference in EF among students from different years ($p$-value<0.05), while other factors, such as monthly allowance and student's major, did not show any significant connections with the EF. Higher-year students tended to consume more resources and energy, making their EF bigger than that of low-year students.

**Keywords:** ecological footprint, carbon footprint, earth overshoot day, Khon Kaen University

**EM-15-41**

# Environmental Factors Relating to Tree Selection for Nesting of Green Tree Ants (*Oecophylla smaragdina*) on Khon Kaen University Campus

**Patompong SINGTONG[a] and Adcharaporn PAGDEE[b]***

*[a]Department of Environmental Science, Faculty of Science, Khon Kaen University 40002, Thailand*
*[b]Department of Environmental Science, Faculty of Science, Khon Kaen University 40002, Thailand*
**Corresponding email: adcpag@kku.ac.th*

**Abstract**

This study is part of a series of student research projects aiming to establish baseline data on ecosystem services and environmental conditions at Khon Kaen University (KKU) Thailand. The study examined environmental factors relating to tree selection for nesting of green tree ants (*Oecophylla smaragdina*) – a species with high economic value due to a large demand for their queen broods and eggs. A kilogram of queen broods and eggs of the green tree ants can reach up to 1,000 Baht or nearly US$ 30, incentivizing people to harvest them for income generation even on KKU campus. A total of 60 trees with girth at breast height (GBH) at least 30 cm were selected from two locations: a dry Dipterocarp Forest (DDF, n = 30) and a forest patch at the Faculty of Humanity and Social Sciences (HUSO, n = 30). Two rounds of field observation were conducted in July-August and September-October (SO) 2023. Tree species and structure i.e., tree height, GBH, crown depth and shape, and leaf types were recorded with a number of nests on trees and environmental factors i.e., air temperature and light intensity, around the observed trees. A number of nests recorded in July-August were fewer than what observed in September-October, while a number of nests on trees in the DDF were greater than in the HUSO. A total of 115 nests from 28 trees altogether were recorded with an average of 4.11 nests per tree. The majority of nests (59.13% of the total number of nests) were larger than 5cm of maximum length. Tree height, crown depth and temperature did not show any influence on the nesting, whereas GBH and light intensity did (p-value < 0.05). Green tree ants tended to select trees with smaller GBH but higher light intensity for their nesting.

**Keywords:** green tree ant, environmental factors, nesting, dry Dipterocarp Forest, Khon Kaen University

**EM-15-44**

# Evaluation of Salt-affected Farmland by Different Sensing Methods

**Tadao YAMAMOTO[a]*, Takashi KUME[b], Katsuyuki SHIMIZU[c], and Chuleemas Boonthai IWAI[d]**

*[a]Hokkaido University, Japan*
*[b]Ehime University, Japan*
*[c]Tottori University, Japan*
*[d]Khon Kaen University, Thailand*
**Corresponding email: tady@agr.hokudai.ac.jp*

**Abstract**

In recent years, remote sensing has been used to determine the condition of salt-affected farmland. However, a large amount of on-site sensing data and complex protocols are required to identify the condition accurately. Therefore, it is difficult for farmers to determine soil salinization status quickly. In this study, we compared different on-site and remote sensing methods, which are relatively simple, capture the condition of soil salinization at the field level, and discuss points to keep in mind when assessing salt-affected farmland. Apparent electric conductivity ($EC_a$) maps obtained from electromagnetic induction instrumentation as on-site sensing indicated that salt was more abundant in the shallow than in the deep layer. In those layers, the values tended to be higher downstream than upstream. On the other hand, the salinity index map ($EC_{1:5}$ equivalent) obtained from multispectral imagery using UAV showed that salinity tended to be distributed upstream rather than downstream. In order to utilize simple on-site or remote sensing for evaluating salt-affected farmland, the following points should be noted. Remote sensing is effective in understanding soil salinization at a given time because it provides information on the distribution of salt on the soil surface. However, it is difficult to predict the damage potential. Therefore, remote sensing effectively predicts soil salinization for temporary measures such as desalination by removing topsoil. On the other hand, on-site sensing is desirable for predicting future soil salinization and implementing fundamental countermeasures, even if it takes more time and effort.

**Keywords:** soil salinization, electromagnetic induction, multispectral image, salinity index, Geographic Information System (GIS)

**EM-15-47**

# Predicting the Water Vapor Movement in Unsaturated Soil

**Sunny Eng Giap GOH[a]*, Khairul Ikhwan MOHD JAMALLUDIN[a], and Mohammad Fadhli AHMAD[a]**

*[a]Faculty of Ocean Engineering Technology, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia*
**Corresponding email: sunnygoh@gmail.com*

**Abstract**

The water entering the soil surface through a mechanism that is better known as diffusion where the water mass movement depends on the differential soil water pressure. The water mass is moving from a high-pressure soil region to the low. Another mechanism would be the gravitational pull that continuously pulls water mass to move downward. In addition to liquid water, water vapor is another phase (gas) that mechanism(s) would be driving vapor mass movement in the unsaturated soil. Similar to water mass, the water vapor mass movement is also governed by diffusion mechanism in the air space in the soil. However, soil under temperature gradient condition, water vapor mass movement appears to be four to ten times more than that can be given by diffusion equation. Hence, this has triggered many interests from the scientific community as to what mechanism(s) could have made up this additional mass flux in the unsaturated soil. While Richards' equation is commonly used to govern liquid water mass movement and to model soil moisture content distribution in the unsaturated soil, the water vapor mechanism contributing to soil moisture content distribution would remain significant. Both liquid water and water vapor movement mechanisms are important to predict soil moisture distribution in the soil. In the current study, we explore the contribution of water vapor mass movement in the overall mass movement in unsaturated soil. The study found that water vapor mass movement is equally significant as the mass flux given by the force of gravity. In addition, our study is pointing to the possible exploration of other water vapor mechanisms that remained unknown to the soil physicist.

**Keywords:** vapor flux, soil water content distribution, vapor enhancement factor, vapor movement mechanism, water vapor diffusion

**ESD-15-01**

# High Entrepreneurial Intention Among Agricultural Students in Adverse Business Environment: Findings from a Cross-sectional Study in Haiti

**Rival VALCIN[a]*, Tomohiro UCHIYAMA[a], Absalon PIERRE[b], and Bénédique PAU[b]**

*[a]Graduate School of International Food and Agricultural Studies,*
*Tokyo University of Agriculture,*
*Chome-1-1 Sakuragaoka, Setagaya City, Tokyo 156-8502, Japan*
*[b]Faculty of Agriculture and Environmental de Sciences, Quisqueya University,*
*Port-au-Price, Haiti (zip code: HT6120)*
*https://orcid.org/my-orcid?orcid=0000-0003-1423-4097*
*Postal Code: 214-0034*
*Address Street & Bldg.: (2-3297 Shibata Sou 301)*
*Phone: +81 70 4217-3794*
**Corresponding Author: Email: rivalcing7@gmail.com*
*13822002@nodai.ac.jp*

**Abstract**

Risk-taking propensity and optimism are among the most relevant entrepreneurial traits. However, people tend to be less intentional about creating new ventures in a hazardous business environment. Therefore, this study focused on Haitian Agri-students as potential future agricultural entrepreneurs. An online survey took place in the middle of a socio-political and economic crisis (winter 2022). In total, 302 students from 33 agricultural schools were surveyed. In addition, the theory of plan behavior was used to suggest an alternative model for Agri-students under particular circumstances. The model was estimated using a Weighted Least Square (WLS) Analysis. Motivated by successful role models and the relentless quest for autonomy, Agri-students demonstrate high willingness (97.4%) and intention (65.7%) toward entrepreneurship despite the adverse business environment. When the stakes are high, people tend to be risk averse, which limits entrepreneurship. However, people in adverse situations exhibit a higher propensity to take risks, particularly having limited alternatives. This study suggests that adverse environments can drive innovation and momentum for venture creation. The study concluded that entrepreneurial training and a better operationalization of the funding system are crucial to enhancing students' readiness with regard to their intention to become agricultural entrepreneurs. As a premier of this kind for Haiti, this study is meant to be an amplification and an alternative to the studies conducted on students majoring in entrepreneurship. We also suggest insights into detecting and weighing the students' entrepreneurial intentions.

**Keywords:** agricultural education, entrepreneurship intention, Haiti, business

**ESD-15-02**

# Land Use Changes and Deforestation Causes in the Last 30 Years using Satellite Images in the Municipality of Cobija, Province of Pando, Bolivian Amazonia

**Juan UEGO PEREZ[a]* and Machito MIHARA[b]**

*[a]Graduate School of Agri-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
*Institute of environmental Rehabilitation and conservation, Tokyo Japan*
**Corresponding email: uego.juan@gmail.com*

**Abstract**

This study conducts a comprehensive assessment of Land Use and Land Cover (LULC) changes and deforestation trends over the past three decades in the Cobija Municipality, Bolivian Amazonia. Leveraging advanced Geographic Information System (GIS) techniques and satellite imagery, we delve into the dynamic interplay between anthropogenic activities and environmental transformations in this specific locale. methodology involves the extraction and analysis of high-resolution satellite data, enabling a detailed examination of LULC changes and deforestation patterns. The spatial and temporal dimensions of these alterations are scrutinized to unravel the complex drivers and implications of environmental shifts in the Cobija Municipality. Preliminary findings reveal nuanced relationships between specific LULC transitions and corresponding instances of deforestation. Through a meticulous spatial analysis, we identify key hotspots and temporal trends, providing insights into the evolving landscape of this critical region. Moreover, our study explores the potential impacts of these changes on biodiversity, ecosystem services, and the overall ecological balance of the Bolivian Amazonia. The integration of LULC changes and deforestation assessments in the Cobija Municipality not only enhances our understanding of local environmental dynamics but also contributes to the broader discourse on sustainable land management and conservation strategies. By highlighting the specific challenges and opportunities within this geographic scope, our research aims to analyze how the deforestation is growing year by year and inform policymakers, environmental practitioners, and local stakeholders engaged in the preservation and sustainable development of the Bolivian Amazonia. This study serves as a valuable contribution to the ongoing dialogue surrounding the delicate balance between human activities and the preservation of one of the world's most vital and diverse ecosystems.

**Keywords:** Land Use and Land Cover (LULC), deforestation, satellite imagery, Amazonia

**ESD-15-03**

# Factors Influencing the Accounting for Biological Assets: The Case of Selected Agritourism Farms in the Philippines

**Hanna D. MIRANDA-QUIBOT[a]* and Yasuo OHE[b]**

*[a]Department of International Agribusiness Management, Graduate School of International Food and Agricultural Studies, Tokyo University of Agriculture, Tokyo, Japan*
*[b]Department of International Agribusiness Management, Graduate School of International Food and Agricultural Studies, Tokyo University of Agriculture, Tokyo, Japan*
**Corresponding email: hdmiranda@up.edu.ph*

**Abstract**

The accounting standard for agriculture was introduced to harmonize the accounting procedures of entities engaged in agricultural production. However, there has been little awareness of applying the standard, especially in the agritourism industry. This study assessed the accounting practices of selected agritourism farms in Region IV-A, Philippines. Specifically, it aims to identify the factors that influence their accounting practices. Interviews were conducted with 19 farms and their financial records were reviewed. A descriptive analysis composed of mean rating and odds ratio analysis were performed. Additionally, sentiment analysis was conducted to evaluate the attitudes of the respondents toward the factors that influence their practices. The results show that most farms do not recognize and measure their biological assets as per accounting standards. The recognition and measurement of biological assets are based on their current practice and are not influenced by the provision of the standards. Only three farms recognize and measure biological assets using the fair market value approach. On the other hand, the preference of the owners or the management and the ease of calculation contribute very extensively to the farm's accounting practices. Farms will have higher odds of adopting the standard if there is training in accounting and if external auditors will recommend the use of the standard. Based on the sentiment analysis, the recommendations of the auditors received a moderately positive score. It is further recommended that education on the accounting of agriculture should be enhanced. An application guideline must be developed to improve the accounting practices of agritourism farms and their compliance with the accounting standard.

**Keywords:** agritourism, accounting practices, biological assets, odds ratio analysis, sentiment analysis

**ESD-15-05**

# Characterization of Liming Materials Derived from Apple Snail Shell Biochar

**Kasamaporn KAEWPROM[a], Pancheewan PONPANG-NGA[a]*, and Praphat KAWICHA[a]**

*[a]Faculty of Natural Resources and Agro-Industry, Kasetsart University, Chalermphrakiat Sakon Nakhon Province Campus, Thailand*
**Corresponding email: pancheewan.po@ku.th*

**Abstract**

The production of biochar from waste golden apple snail shells was carried out through slow pyrolysis processes conducted at an average temperature of 500°C, serving as a value-added application for soil amendment, its functions as a liming material. The objective of this study is to quantify the main components and characteristics of golden apple snail shell biochar. The golden apple snail shell biochar was crushed into a powdered condition and filtered through nylon sieves of three sizes: 500 micrometers, 250 micrometers, and 180 micrometers. A comparison was made with raw golden apple snail shells. The results indicated that golden apple snail shell biochar filtered through 180 micrometers nylon sieves obtained the highest rate of $CaCO_3$ at 86.78% with pH value of 11.32. The maximal calcium carbonate equivalent (CCE) is determined to be 86.84%. Raw golden apple snail shell filtered through 250 micrometers obtained the highest rate of $CaCO_3$ at 78.79% with pH value of 8.75. The maximal calcium carbonate equivalent (CCE) is determined to be 78.91%. Scanning electron microscope (SEM) images reveal pore structures only on the surface of the golden apple snail shell biochar powder. The study concludes that apple snail shell biochar, with its high calcium carbonate equivalent (CCE), can be an alternative liming material. With a high pH and porosity, apple snail shell biochar has the potential to neutralize soil acidity, providing a sustainable solution to waste management.

**Keywords:** biochar, calcium carbonate, golden apple snail shell, liming material

**ESD-15-06**

# Effects of Forest Environmental Education on Awareness and Attitudes of Local Students in Relation to Tree Survival Rate – Case of School Greening Activity in Cambodia

**Keiko AOKI[a]*, Kumiko KAWABE[a], Santa PANDIT[a], and Machito MIHARA[b]**

*[a]Institute of Environmental Rehabilitation and Conservation, Headquarters, Japan*
*[b]Faculty of Regional Environment Science, Tokyo University of Agriculture, Japan*
**Corresponding email: hq-erecon@nifty.com*

## Abstract

The forest cover in Cambodia has decreased rapidly from 73% in 1960s to 41% in 2020. In Tbong Khmum Province, natural forest covers only 20% in 2020, due to the expansion of plantations and farmlands, as well as the excessive use of forest resources by a growing population. To strengthen the foundation for future forest conservation for sustainable community development, an international NGO has been implementing a series of participatory school greening activities aiming at the environmental education in collaboration with local schools in Dambae District of Tbong Khmum Province. One of the significant challenges in community-based project is how to increase the participation rate of local students in planting and management practices to maintain the survival rate of young seedlings, which require manpower to take care for during their vulnerable early stage. So, research interests have been focused on how environmental education contributes effectively to increase the awareness and attitudes of local students, ultimately aiming to increase the tree survival rate. For this objective, the questionnaire surveys were conducted with 402 school students at 10 schools who participated in the environmental education activities in 2022. Additionally, in the following year in 2023, the field inspection was conducted to monitor the management practices, interview with school teachers, and evaluate the survival rates of trees at each school. The key findings through the statistical analysis of the results were the strong correlations between the tree survival rates and the degrees of students' awareness of the importance of forest conservation ($r=0.748^*$) as well as the percentage of students' awareness with responsibility in tree management ($r=0.708^*$) at 95% confident interval. Further consideration on the factors influencing local students to take responsible environmental action, as well as the effective approach to environmental education are discussed in the manuscript.

**Keywords:** environmental education, ESD, school greening, tree survival rate, participation rate, environmental awareness and attitude, Cambodia

**ESD-15-10**

# Geographic Features, Ecosystems Quality and Human Well-Being as Indicators of Sustainability of the Island-Barangays of Bohol

**Bernabe M. MIJARES JR.[a]***

[a]*Bohol Island State University, Bohol, Philippines*
**Corresponding email: mijaresjrb@gmail.com*

**Abstract**

Sustainable development (SD) is a global objective that is yet to be fully accomplished. In the Philippines, SD has already been a national campaign since 1990 with PSSD and Philippine Agenda 21 as grand strides of initiatives. But challenges continue to hinder its realization, the most lingering of which is localization. This study addressed the problem of SD localization in the Philippines by determining SD in the community level from the perspective of the local residents. In particular, island-communities were investigated where resources were apparently limited to sustain the existence of their inhabitants. Specifically, it assessed the geographic features, ecosystems quality and human well-being of the economically "poor" island-barangays of Bohol and how these variables influence or affect each other. Descriptive-correlational design was deemed appropriate and hence was utilized to gather and analyze pertinent data.

Results reveal that (1) of the 9 island-barangays surveyed, Nasingin had the highest population with 2,045 individuals while Butan had the lowest at 569. Pamilacan was the biggest among them, with 144 hectares as its land area, while Nasingin was the smallest at 3.6 hectares. Pamilacan was likewise the farthest with a distance registered at 15 kilometers from the mainland while Tintinan was the closest at 1.2 kilometers; (2) they were at a better level in their ecosystem's quality; and (3) they were at a better level both in their socio-economic sustainability or human well-being and personal well-being. And utilizing the Barometer of Sustainability and the Egg of Sustainability as models of analyses, it was determined that the island-barangays of Bohol were "potentially sustainable" and that indeed there was sustainability or sustainable development among them.

All findings considered, this research concluded that (1) contrary to cited literatures, geographic features such as population, land area and distance from the mainland did not significantly relate to the ecosystems quality and human well-being of the island-barangays of Bohol; (2) despite limited resources, the island-barangays of Bohol sustained community life because they were able to strike a balance and harmonized their social, economic, and environmental aspects evidenced by the positive and significant correlation of their ecosystems quality and human well-being; (3) sustainability or sustainable development was a more encompassing and multifaceted condition of a community or society. Hence, although the island-barangays of Bohol were generally classified as economically "poor," they were, however, "potentially sustainable" and "sustainable" from the standpoint of the *Barometer of Sustainability* and *Egg of Sustainability*, respectively; and (4) having accomplished the assessment process in the island-barangays through its residents, this study had therefore addressed the lingering challenge of localization in the country. In general, the research recommended that its results be disseminated to government agencies and other stakeholders for policy development and implementation intervention measures.

**Keywords**: sustainable development, ecosystems quality, human well-being, Island-Barangays

**IS-15-01**

# Evaluation of Flood Peak Cut Effect Through Paddy Field Dam as Green Infrastructure in Toyama Prefecture in Japan

**Koshi YOSHIDA[a]*, Keigo NODA[b], and Taichi TEBAKARI[c]**

*[a]Graduate school of Frontier Sciences, The University of Tokyo, Japan*
*[b]Graduate school of Agricultural and Life Sciences, The University of Tokyo, Japan*
*[c]Graduate school of Civil Engineering, Chuo University, Japan*
**Corresponding email: kyoshida@edu.k.u-tokyo.ac.jp*

**Abstract**

Paddy Field Dam (PFD) is an attractive activity to use paddy fields as green infrastructure to prevent inland flood. The runoff control devices used in PFD can be manufactured for several thousand yen per unit and are expected to be inexpensive and highly effective since they utilize rice paddies spread over an area. However, in order for such efforts to spread, the effectiveness and safety of PFD must be evaluated, and the understanding of local residents and farmers must be promoted. In this study, a survey of drainage volume during heavy rainfall was conducted in a group of rice paddies in Fuchu-cho, Toyama City, and the study was conducted in the rice paddies along the Y1 drainage channel located at the end of this basin. This area is located at the confluence of the Ida River and its tributary, the Yamada River, and is subject to waterlogging due to inland flooding during heavy rains. The study area is approximately 8.8 ha in size, and rainfall and drainage channel water levels were continuously observed to obtain a rainfall-runoff relationship. The observation period was from May to November 2022, and the measurement interval was 10 minutes. During the observation period, rainfall events on 7/23 (40.5 mm) and 9/1 (54 mm) were analyzed. The measured and calculated flow rates for the 7/23 and 9/1 rainfall events are simulated by using the paddy water balance model, as well as the runoff volume when the PFD was implemented. The calculated discharge accurately represented the measured peak flow when the roughness coefficient n was set to 0.034 and the infiltration coefficient T to 0.015 (1/hr). Assuming the implementation of PFD with a 5 cm notch set devise in the weir plate to control runoff, a peak cutoff effect of 42.9% was observed for the 7/23 event and 53.4% for the 9/1 event. 10-minute rainfall intensity was greater for the 9/1 rainfall event compared to the 7/23 event, and the peak discharge was also greater. Therefore, the peak cutoff rate for the rice paddy dam implementation was also considered to be larger.

**Keywords:** paddy field dam, flood peak cut ratio, green infrastructure, Jinzu river

**RD-15-02**

# Costs and Returns from Black Soldier Fly Farming as an Alternative Protein Source in Animal Feed for Small-scale Farmers in Thailand

**Yardroong MAWONGWAI[a]*, Yupa HANBOONSONG[a], and Yaowarat SRIWARANUN[a]**

*[a]Khon Kaen University, Thailand*
**Corresponding email: thunma@kku.ac.th*

**Abstract**

The continually increasing prices of raw materials in animal feed is having a direct impact on the production costs for small-scale farmers in Thailand. Black Soldier Fly (BSF) (*Hermetia illucens*) has therefore been chosen as another alternative protein source for animal feed due to its high protein content, which is comparable to fish meal and soybean meal. Moreover, farming BSF uses less water and energy compared to other protein sources, thereby producing lower amounts of carbon and pollution. Rearing BSF also helps in eliminating organic wastes, while promoting and supporting a circular economy, which is in line with goal no. 12 of the Sustainable Development Goals (SDGs) of the UN, related to sustainable production and consumption. The objectives of this study are 1) to study the costs and returns of BSF rearing among 20 small-scale farmers who use BSF as a protein substitute in animal feed, and 2) to compare the costs and returns of the situations before and after using BSF to replace the protein source in animal feed for small-scale farmers. The study is divided into three real case studies: broiler farm, cricket farm, and catfish farm. The results of the study found that the total BSF production costs averaged at 0.97 USD/kg. Farmers receive net benefits from raising BSF, both in cash and non-cash forms, equal to 7.39 USD/kg. From the case studies, where the small-scale farmers used BSF together with ready-made animal feed, it was found that on a broiler farm, the farmer was able to reduce cash-related animal feed costs by 41.21%, while cricket farmer reduced the cash costs of animal feed by 52.16%, and catfish farmer reduced the cash costs of animal feed by up to 100%.

**Keywords:** black soldier fly, costs and returns, small-scale farmers

**RD-15-04**

# Innovative Shareholding Arrangements for Producer Groups Providing Machinery or Marketing Services to Smallholders

**Randel ESNARD[a], Michael Charles LYNE[a]*, Kevin OLD[a], and Ani KARTIKASARI[a]**

*[a]Lincoln University, New Zealand*
**Corresponding email: michael.lyne@lincoln.ac.nz*

**Abstract**

Smallholder producer groups are vulnerable to institutional problems when they pursue value-adding enterprises requiring capital and predictable deliveries. This paper provides insights into creative shareholding arrangements introduced by two producer groups to upgrade their business strategies from 'transactional' to 'value-adding' status. The first group planned to offer machinery services to reduce production costs and improve the quality of smallholder paddy rice. The second group intended to take advantage of a domestic niche market for non-traditional, high-value, rice varieties. Members and directors of these producer organizations were wary of free-rider problems that undermine collective efforts to finance assets and meet supply contracts. This study draws on the New Institutional Economics concepts of ill-defined ownership rights to analyze the innovative shareholding schemes devised by these groups to prevent free riding. It treats the producer groups as case studies, and the research is both exploratory and applied set within the framework of action research. Both groups issued non-redeemable, tradable, class B shares. Class B shares are appreciable but confer no (or limited) voting rights, allowing members to benefit as investors and as patrons while maintaining democratic control of their organization. The key, however, is to align investment with patronage in order to avoid conflicts of interest that discourage member investment and compliance with supply contracts. The first group linked member investment to progressive discounts on the cost of machinery services, thereby creating a strong incentive for larger patrons to buy more shares. The second group treated each share as a tradable obligation to deliver a specific quantity of high-value paddy, thereby requiring larger patrons to buy or lease more shares. This research adds to a small pool of literature that examines the attributes of well-defined ownership rights in smallholder organizations that pursue value-adding business strategies.

**Keywords:** small-scale farmers, value-adding producer organizations, free-rider problems, institutional arrangements

**RD-15-06**

# Farmers' Perspectives on Ecosystem Services Provided by Tree Windbreak System in Ovche Pole Region, Macedonia

**Ognen ONCHEVSKI[a]* and Machito MIHARA[b]**

*[a]Graduate School of Agro-environmental Science, Tokyo University of Agriculture, Japan*
*[b]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
**Corresponding email: ogneoncevski@hotmail.com*

**Abstract**

Ovche Pole is the second largest agricultural region in Macedonia. It is a plain with a dry climate, characterized by low precipitation and high ambient temperatures during the growing period and prevailing winds which are frequently present throughout the year. During the 1950s, the government implemented a large project for the establishment of tree windbreaks (field shelterbelts) with an aim to reduce wind velocity, protect agricultural land, and increase crop productivity. Even though these systems perform important functions, nowadays around half of the initially planted areas are lost due to land use transformation, and a significant part of the existing tree windbreak belts are damaged by local people. Actions for the protection, rehabilitation, and restoration of these systems are needed, however, without active support and understanding of farmers' perspectives on tree windbreak systems, any activity would be without major and long-term success. Therefore, the objectives of this study are to: (1) examine farmers' attitudes toward the tree windbreak system and their rehabilitation, and (2) assess farmers' awareness and perceptions of ecosystem services provided by the tree windbreak system. In this aim a semi-structured questionnaire was developed and following the convenience sampling method distributed to 72 farmers to gather the needed information. Data analysis showed that in general farmers have positively valued the tree windbreak systems and agreed that rehabilitation and restoration are needed. Regarding the ecosystem functions, the results indicate that farmers gave uniform answers in some cases, the farmers had split perceptions. According to farmers' responses, the most important ecosystem service provided by the tree windbreaks is climate regulation, this is followed by the reduction of soil erosion and runoff and the source of provisional materials function.

**Keywords:** tree windbreak systems, ecosystem services, farmer's perceptions and attitudes

**RD-15-07**

# Assessing Locals' Perceptions on the Environmental, Economic, and Socio-Cultural Impacts of Agritourism Versus Conventional Farming in Tanzania

**Issa Abrahaman KACHENJE[a]* and Yasuo OHE[b]**

*[a]Tokyo University of Agriculture, Japan*
*[b]Tokyo University of Agriculture, Japan*
**Corresponding email: Issakachenje@gmail.com*

**Abstract**

Agriculture and tourism are two critical sectors with a considerable influence on the socio-cultural, economic, and environmental aspects of Tanzanian society. These two sectors not only offer substantial employment opportunities but also contribute significantly to income generation and foreign exchange earnings. Nevertheless, the success of these sectors depends upon the participation and support of local communities, whose engagement is closely linked to their perceptions. In recent years, agritourism has emerged as a unique form of diversification in the agricultural sector, offering Tanzanian farmers a potential avenue to introduce a blend of agriculture and tourism-related activities and open a new income stream. Furthermore, since the impact of the COVID-19 pandemic on conventional farming and agritourism was different, post-pandemic opinions in the local community are likely to differ. Therefore, this study aimed at providing insights on the locals' perceptions and the factors that influence their perceptions in order to support a sustainable post-pandemic recovery. The study was conducted in the Arusha and Mwanza regions of Tanzania, and a total sample of 191 respondents was selected randomly for interviewing and filling out the questionnaires. To analyze the data, descriptive analysis and factor analysis were used. The findings indicate that locals' perceptions of conventional and agritourism farming are, on average, positive. Despite both sectors being perceived positively, the underlying reasons for the perception and support were different. For agritourism, the positive perception was primarily associated with the economic benefits, including income generation and the creation of employment opportunities. Whereas, for conventional farming, positive perception was associated with environmental conservation, economic benefits, food security, and community cohesion.

**Keywords:** locals' perceptions, agritourism, sustainability, factor analysis, Tanzania

**RD-15-08**

# Economic Analysis of Rice Yield: Insights from IADA Barat Laut Selangor, Malaysia

**Rika TERANO[a]*, Nurul Nadia RAMLI[b], Juwaidah SHARIFUDDIN[b], and Fazlin ALI[b]**

*[a]Tokyo University of Agriculture, Japan*
*[b]Universiti Putra Malaysia, Malaysia*
**Corresponding email: rt200005@nodai.ac.jp*

**Abstract**

Despite Malaysia's efforts to increase rice production, the self-sufficiency ratio has declined since 70.0% in 2018 to 62.6% in 2022. Malaysia's rice production relies on 10 granary areas in Peninsular Malaysia, and IADA Barat Laut Selangor is known for its high yields. In the main season of 2015/2016, the yield was 6.0 tons per hectare, higher than the national average of 4.6 tons per hectare and the average 5.0 tons per hectare for other granary areas. However, the yield level gradually decreased and reached 4.8 tons per hectare in the 2020/2021 main season. This trend was observed in IADA Barat Laut Selangor and other granary areas. During the same period, the national average yield was 3.8 tons per hectare, and the average in the granary area was 4.4 tons, showing an overall downward trend. Here come research questions about what currently influences yield in IADA Balat Laut Selangor, a region struggling to maintain high yields. In order to clarify the yield determinants, this study aims to measure technical efficiency and clarify other related factors. An interview survey guided by a questionnaire was conducted with 74 farmers, including Malay and Chinese farmers. Multiple linear regression revealed that the diverse level of technical efficiency seems to offer room for yield improvement. Furthermore, those farmers with lower yield and technical efficiency show hints of improving productivity in other granary areas as well.

**Keywords:** paddy farmer, yield, technical efficiency, trust, agricultural information

**RD-15-10**

# Prospects of Nutmeg Industry Development in North Maluku, Indonesia

**Riskina JUWITA[a]* and Siti JAHROH[b]**

*[a]Department of International Food and Agricultural Science, Tokyo University of Agriculture, Japan,*
*[b]School of Business, IPB University, Indonesia*
**Corresponding email: rj205559@nodai.ac.jp*

**Abstract**

Producing a total of 40,653 tons nutmeg in 2019, nutmeg industry in Indonesia has rapidly increased by an average growth of around 9.5 percent per year during the period of 2010-2019. Accounting for more than 66 percent of the total nutmeg demand in global market, Indonesia is also currently the largest producer of nutmeg oil in the world, providing 75% to 80% of the global supply. Known as the Spice Island for the origin of nutmeg, North Maluku is served as one of the main nutmeg producing areas in Indonesia with a total cultivating area of 35,419 hectares which contributes 24.22% of the total national production. However, despite its importance as superior export commodity, nutmeg industry in Indonesia has been facing two major problems, namely low productivity and low quality, which also affected nutmeg products selling value in the international market. This paper aims to analyze the actual condition of nutmeg production and sales in North Maluku and to evaluate the prospects of nutmeg industry for the rural development in North Maluku. Primary data was collected in April 2018 and September 2023 through interview surveys to local government and farmers group in Ternate Regency, North Maluku Province. The results can be concluded as follows. 1) Development of nutmeg industry in North Maluku has been deeply related to its long historical background and strongly connected to local wisdom and culture that creates more personal value for the local farmers than economic aspects. 2) However, high market demand of nutmeg products has brought promising prospects for development of nutmeg industry, especially considering the potential of North Maluku natural resources as the origin of nutmeg. 3) Proper nutmeg production and distribution system are highly necessary for the future development of nutmeg industry in North Maluku to become a sustainable leading producing area.

**Keywords:** nutmeg products, spice island, local culture, rural development

**RD-15-15**

# Living with Salt: A Social History of Salt-affected Area in Khon Kaen, Thailand

**Fumikazu UBUKATA[a]*, Hirotaka MATSUDA[b], Chuleemas Boonthai IWAI[c], Takashi KUME[d], and Tadao YAMAMOTO[e]**

*[a]Okayama University, Japan*
*[b]Tokyo University of Agriculture, Japan*
*[c]Khon Kaen University, Thailand*
*[d]Ehime University, Japan*
*[e]Hokkaido University, Japan*
**Corresponding email: ubukat-f@okayama-u.ac.jp*

**Abstract**

It is said that around 300 thousand hectares of land are salinized in northeast Thailand due to the combination of natural and anthropogenic influences. In such areas, government agencies have tried to take mitigating measures such as soil rehabilitation and tree planting, as well as tighten the regulations of inland salt production. However, this approach, which views saline soil as a "chronic problem", may not necessarily reflect the local villagers' lifeworld, as they view saline soil not only as a risk to agricultural production but also as a resource for local inland salt production. From the cases of two salt-affected villages in Khon Kaen province, this study therefore tried to show how villagers had built relationships with saline soil, and how the related government policies have affected their lifestyle. The authors conducted field surveys in these villages in September 2017 and March 2019. A total of 17 villagers were interviewed about their life histories. Additionally, we utilized the information from the first author's field survey in 2000, as well as the related documents with regard to local salt production and government policy. With the help of these additional sources, collected information were reconstructed chronologically. The result confirmed that the villagers have formed down-to-earth relationships with the saline soil according to their natural and social context. While most villagers had lost their interest in saline soil and salt production in the course of deagrarianized rural development, some salt-producing villagers who formed sociocultural attachments with salt production had recently rediscovered its value. On the other hand, the government has totally neglected such villagers' viewpoints in its policy to regulate salt production and rehabilitate salt-affected areas. In that sense, we can conclude that villagers' lifestyles to live with salt have been overlooked in existing scientific and "solution-driven" approaches.

**Keywords:** life history, saline soil, villagers, Khon Kaen, Thailand

**RD-15-16**

# The Impact of Adopting the Alternate Wetting and Drying Technology on the Technical Efficiency of Rice Production in Suphan Buri Province

**Benjamas JANGJAIDEE[a] and Thanaporn ATHIPANYAKUL[b]***

*[a]Thai Roong Ruang Corporation Limited, Thailand*
*[b]Kasetsart University, Thailand*
**Corresponding email: thanaporn.at@ku.th*

**Abstract**

Alternate wetting and drying (AWD) rice cultivation is one of the technologies promoted by the Rice Department to rice producers. The objective is to conserve water, reduce costs, and increase profits, which can lead to improved technical production efficiency. This research aimed to analyze the factors influencing the adoption of AWD technology and to compare the technical efficiency between rice producers who adopted AWD technology and those who did not. A total of 107 rice producers were gathered from the project titled, "Mechanism Design for Central Agricultural Driving toward Thailand Modern Agriculture: A Case Study of Rice". A Switching Regression Model was employed to analyze factors affecting technology adoption and estimate technical efficiency values. The research findings indicated that factors positively associated with the adoption of AWD technology at the 0.05 significance level include educational level and loan amount of each farm. Conversely, factors that negatively influence AWD adoption at the 0.05 significance level include the average age of rice producers, the ratio of area to the number of household members working full-time on rice farms, the ratio of land rental to total farm size, and the ratio of non-agricultural income to total income. Regarding the results of the technical efficiency analysis, it was observed that farmers adopting AWD technology exhibited a higher technical efficiency level (0.8619) compared to those adopting conventional farming (0.5841), with statistical significance at the 0.05 level.

**Keywords:** rice, Thailand, efficiency, AWD technology

**RD-15-18**

# Changes in the Evaluation of Rural Landscape Before and After Farmland Improvement

**Eiji YAMAJI[a]* and Shoko NISHIWAKI[a]**

*[a]The University of Tokyo, Japan*
**Corresponding email: yamaji@edu.k.u-tokyo.ac.jp*

**Abstract**

In recent years, rural landscapes especially in hilly and mountainous areas have been attracting attention and some farmlands have become busy tourist destinations, but the combination of low workability, aging farmers, and declining demand for rice often results in abandoned farmland. In general, farmland improvement is carried out to prevent abandoned fields and to continue sustainable agricultural production activities. While productivity is improved by field consolidation and shaping, the consolidation and shaping of fields through farmland improvement has a significant impact on the rural landscape. This is because the shape and layout of plots, which are the components of the rural landscape, are significantly changed. In 2006, the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF) published a guide for landscape consideration in agricultural and rural development projects, which recommends that farmland development should be done in harmony with the environment and with the landscape, considering the impact of farmland development projects on the rural landscape. Although there have been many studies on the economic evaluation of landscapes, recognition and impression of cultural landscapes, and ecology of field improvement projects, there have been few studies on the changes in the impression of farmland landscape before and after field improvement. Therefore, we surveyed two districts in Japan to clarify the differences in impressions of the landscape before and after farmland improvement. Specifically, we used the Semantic Differential method to ask the respondents about their impressions of the landscapes before and after the farmland improvement project. As a preliminary step, we also asked about the general image and awareness of rural landscapes, as well as conservation awareness of rural landscapes. The concern that the improvement of the fields would increase labor productivity but decrease the value of the landscape did not occur, at least not in these districts.

**Keywords:** farmland improvement, landscape impression, fieldwork efficiency

**RD-15-19**

# Herder's Willingness to Inherit Grassland Animal Husbandry Production and Its Influencing Factors

**Ping LI[a]* and Ruiyao ZHANG[a]**

[a]*Institute of Grassland Research, Chinese Academy of Agricultural Sciences*
*Hohhot, China*
**Corresponding email: lipingcau@126.com*

**Abstract**

Based on the household survey data of 238 herdsmen from Inner Mongolia, a number of Logit regression models were used to empirically analyze the intergenerational transmission willingness and influencing factors of grassland animal husbandry operation of herdsmen and their children. The results showed that: (1) At present, the proportion of herdsmen who have inherited grassland animal husbandry is relatively low, and the intergenerational transmission of animal husbandry in future generations faces difficulties; (2) Among them, the intergenerational transmission intention of grassland animal husbandry management of the father's herdsmen was mainly affected by two types of production factors: grassland resources and labor resources, and the grassland area and total family size used by one's own family had a significant impact on the wishes of the fathers. (3) The choice of intergenerational transmission of the willingness of herdsmen to manage grassland animal husbandry is mainly affected by their own conditions and family conditions such as the total number of families, education level, and the area of grassland used. Therefore, the government should actively improve the basic production conditions of animal husbandry in pastoral areas, increase the recognition of herdsmen engaged in animal husbandry, strengthen policy support for pastoral areas, actively guide herdsmen to establish and join herdsmen's cooperatives, shorten the intergenerational transmission period of grassland animal husbandry in the pastoral areas, and inject young endogenous impetus into the sustainable development of animal husbandry in pastoral areas.

**Keywords:** intergenerational transmission, willingness, livestock production, rural sustainability

**RD-15-22**

# Factors Affecting the Use of *Trichoderma* spp. in Rice Fields of Farmers in Phitsanulok Province

**Seerasarn NAREERUT[a]*, and Parichad Tarbud[b]**

*[a]Assistant Professor Dr, Lecturer in Agricultural Extension and Development, Sukhothai Thammathirat Open University*
*[b]Agricultural Officer at Area Management Group Office of Agricultural Research and Development, Region*
**Corresponding email: nareerut.see@stou.ac.th*

**Abstract**
The objectives of this research were to study 1) the social and economic conditions of farmers. 2) Farmers ' knowledge about Trichoderma in rice fields, and 3) Problems and suggestions of the use of Trichoderma in rice farmers. This research was survey research. The population of this research was 1,500 oil palm farmers who collaborated in Tak Province. They were registered with the Department of Agricultural Extension in 2023. The 316-sample size was based on the Taro Yamane formula with a marginal error of 0.05. Structured interviews were used for data collection. Statistics used were frequency, percentage, mean, and multiple regression. The results of the research can be summarized as follows: 1) Most farmers were female, with an average age of 54.92 years, completed primary school. The average household agricultural worker was 2.19 people. The average experience in rice cultivation was 20.18 years. The average number of Trichoderma trainings was received 2.97 times. Most received training from the District Agricultural Office. Trichoderma were used in rice farming an average of 3.33 times. The average rice cultivation area was 8.37 rai. The average rice production costs 2,400.20 baht/rai and average income from selling price of 3,495.35 baht/rai. 2) Farmers had a high level of knowledge about Trichoderma on issue Trichoderma was a fungus that did not cause plant disease. And 3) Farmers had problems with the production and applying of Trichoderma to a moderate level on issue a shortage of Trichoderma and Trichoderma must be used many times. Suggestions regarding the production and applying of Trichoderma fungi at high levels on issue, agencies should continually provide knowledge about Trichoderma. And should provide knowledge about plant diseases.

**Keywords:** farmers, Taro Yamane formula, Extension use of *Thichoderma*, *Trichoderma,* rice field

**RD-15-26**

# The Consumption Smoothing of Rural Households in Developing Country under the Threaten of Climate Change and Salt Damage: A Case in North-Eastern Part of Thailand

**Hirotaka MATSUDA[a]*, Fumikazu UBUKATA[b], Chuleemas Boonthai IWAI[c], Takashi KUME[d], and Tadao YAMAMOTO[e]**

*[a]Tokyo University of Agriculture, Japan*
*[b]Okayama University, Japan*
*[c]Khon Kaen University, Thailand*
*[d]Ehime University, Japan*
*[e]Hokkaido University, Japan*
**Corresponding email: hm206784@nodai.ac.jp*

**Abstract**

The household economies in rural areas of developing countries are generally exposed to various exogenous shocks and stresses, which may lead to a decline in living standards and welfare, indicating high vulnerability. Coping with these shocks and stresses, or in other words, achieving high resilience, is crucial for these vulnerable rural households in developing countries. Various means are employed to address them. As one indicator of such adaptation, the smoothing of real consumption and, as a means to that end, the smoothing of real income are highlighted. This report aims to elucidate the realities of responses to exogenous shocks and stresses among rural households in northeastern Thailand, focusing on the smoothing of real consumption and income. The surveyed households reported experiencing droughts or excessive rainfall in the past five years. While the surveyed area is rural, it became evident that households with diversified income sources achieve consumption smoothing to a greater extent as a survival strategy.

Consumption smoothing is vital for vulnerable rural households in developing countries as a response to exogenous shocks and stresses. Diversification of income sources proves to be an effective means. However, achieving income source diversification is often challenging. The surveyed area in this report acknowledges the decline in agricultural productivity due to salinization, suggesting considerations such as the cultivation of salt-tolerant crops and engineering solutions for saline-affected soils alongside income source diversification to enhance agricultural productivity and revenue, thereby strengthening livelihoods.

**Keywords:** consumption smoothing, livelihood, climate change, salt damage

# POSTER PRESENTATION

**AG-15-02**

# Determine and Assess the Organic Fertilizer Production in Xiengkhouang Province, Lao PDR

**Sisavath PHIMMASONE[ab]*, Chuleemas Boonthai IWAI[b], Hoa TRAN QUOC[c], And Pascal LIENHARD[c]**

*[a]Department of agricultural Land management, Vientiane capital, LAO PDR*
*[b]Khon Kaen University, Thailand*
*[c]Centre de coopération internationale en recherche agronomique pour le développement/GECO research unit*
**Corresponding email: Sisavathphimmasone@yahoo.com*

**Abstract**

In Lao PDR agricultural development and improving agricultural income are the focus of food security and poverty eradication very significant due to more than 70% of the population depends on agriculture for their livelihoods to ensure the achievement of the long-term goals of national socio-economic development set out by the Party and Government of Lao PDR. The Lao government policy aims at using organic fertilizer as a source of fertilizer for improving soil fertility and reducing fertilizer import. However, a high proportion of organic fertilizers in the farm and/or market have not been subjected to scientific scrutiny, resulting in poor-quality products with little or no impact on soil fertility and crop yields. The farmers lose confidence in these products and end up reverting to the traditional practice of applying chemical fertilizers instead of taking advantage of beneficial microorganisms capable of nourishing their soils. Therefore, the study was conducted in Xinegkhouang province in 2023. The typology of organic fertilizer, in particular, the type of raw material, and quality (Macro and micronutrients) was investigated by literature review and a questionnaire survey of 70 key payers (farm, farmer, extension agency, etc.) and organic fertilizers also were collected for nutrient quality. The result of this study will be useful for providing significant data on the typology of the potential of organic fertilizer production and suggestions for farmers and development partners to support organic agriculture production.

**Keywords:** typology, organic fertilizer, quality, organic agriculture

**AG-15-05**

# Decadal Change of the Planting Date and Planted Area of Rainfed Rice Cultivation in Northeast Thailand

**Hiroki ODA[a]* and Koshi YOSHIDA[a]**

*[a]The University of Tokyo, Japan*
**Corresponding email: 2215920513@edu.k.u-tokyo.ac.jp*

**Abstract**

Northeast Thailand, hosting 60% of the nation's rice paddies is a crucial rice-producing region, yet over 90% of its fields are rain-fed, rendering them susceptible to variations in precipitation. Therefore, studying the impact of precipitation change on rice cultivation is required. Numerous studies have examined how climate change affects rice production. However, most studies focus on yield variations, neglecting the fluctuation in planted areas, and they often fix planted dates without considering annual or regional variations. This leads to overestimating of rice production, especially in rain-fed fields where planted areas depend on precipitation. In this study, we developed a model that estimates planted areas in Northeast Thailand using meteorological, elevation, and surface water level data. The model not only predicts the planted area but also the planting date, incorporating daily precipitation data to anticipate the spatiotemporal expansion of planted areas. The model calculates surface water levels, designating the day they exceed 50mm as the planting date. Model parameters were calibrated using observed data from 2004 and 2005. We then assessed the impact of precipitation changes on planted area extents by inputting climate data from 1981-2017. In analyzing the temporal changes of planted area and date, the model reveals significant variations from the past to the present. Specifically, when comparing decadal shifts in planted areas from 1981-1990 (past) to 2008-2017 (present), the percentage had more variability than past. In the past period, the increment of planted areas was consistently observed in June. In contrast, the present period showed a more unstable distribution with area expansion in June, July, or both June and July. Furthermore, a comparative analysis of four periods of 1981-1990, 1991-2000, 2001-2010, and 2008-2017 indicates a progressive delay in the planted date from past to present, due to the uncertainty of precipitation during the early part of the rainy season.

**Keywords:** climate impact, water balance model, topographic effect, rain-fed rice

**AG-15-07**

# The Value Addition of Thai Traditional Food and Beverage for Healthy from Sacred Lotus Towards Green Products

**Natsima TOKHUN[a]*, Weerawat OUNSANEHA[a], Kanokwan PUNAATERKOON[a], Phatsara WONGSUDEE[a], Rattanapon PUTTAPONTHIP[a], and Chuleemas Boonthai IWAI[b]**

*[a]Valaya Alongkorn Rajabhat University under the Royal Patronage, Thailand*
*[b]Khon Kaen University, Thailand*
**Corresponding email: natsima@vru.ac.th*

**Abstract**

A part of Buddhist rituals, the sacred lotus is the material of healthy food and beverage production. In particular, lotus petal tea and rice wrapped in lotus leaves are on the traditional food menu, but they lack well-known nutritional information. Hence, the objective of this research was to develop the value addition of Thai traditional food and beverages from lotus toward green production under the concept of a Bio-Circular-Green Economy. Firstly, rice supreme wrapped in lotus leaves was developed as the main course with lotus petal tea and the nutritional analysis for presenting the nutrition information and labeling. The result showed that the nutrition value of rice wrapped in lotus leaves per net weight of 180g was 390 kcal (20%) of total energy, 14g (22%) of total fat, 285mg (95%) of cholesterol, 18g of protein, 48g (16%) of total carbohydrate and 620 mg (31%) of sodium. For the nutrition value of a lotus petal teacup per net weight of 100g, only 20 mg (1%) of sodium was found. The findings of nutrition value in both products were approved by the criteria of Percentage of Thai Recommended Daily Intakes for the population over 6 years of age (% Thai RDI) with a 2,000-kcal diet. Lastly, the preliminary result of this study was assessed by the values index in five years. The results found that the value addition of sacred lotus presented the 8,859 Thai Baht of net present value (NPV), 1.34 benefit-cost ratio (BCR), and 8.1% internal rate of return (IRR) and showed the break-even value of project budget. Therefore, the result finding should enhance the sacred lotus products toward green production with carbon footprint assessment in the next phase of the research study.

**Keywords:** lotus, traditional food, nutrition information, Thai RDI, green product

**AG-15-08**

# The Effect of Different Levels of Potassium on Nutrient Content in Cherry Tomato Fruit Grows under Hydroponic System

**Kanokporn MANANTAPONG[a], Anongnat SRIPRACHOTE[a]*, Rattaphol KRAIKLANG[b], Sirirat ANUTRAKULCHAI[c], and Pornthiwa KANYAWONGHA[d]**

*[a]Department of Soil Science and Environment, Faculty of Agriculture, Khon Kaen University, Thailand*
*[b]Deparment of Public Health Administration, Health Promotion and Nutrition, Faculty of Public Health, Khon Kaen University, Thailand*
*[c]Department of Medicine, Faculty of Medicine, Khon Kaen University.*
*[d]Department of Plant Production Technology, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Thailand*
**Corresponding email: anonsr@kku.ac.th*

**Abstract**

Cherry tomato (*Solanum lycopersicum* var. cerasiforme) is a broadly consumed fruit and vegetable in the world. It has good taste, is rich in nutrition, and has an abundance of antioxidant substances. The CKD patients had limited potassium consumption of 2,000 mg per day. The objective of these experiments was to investigate the effect of potassium on the nutrient content of cherry tomato varieties, Tabtim Deang T2021 and Sweet Boy 1. The experiment layout was CRD design in five levels of potassium nitrate culture solution (3.0, 1.5, 0.75, 0.50, and 0.375 mM $KNO_3$) and 4 replications. Results indicated that there was no statistical difference between levels of potassium ion, nitrate ion, and phosphorus content. Potassium content in fruits was lower than 200 mg 100 $g^{-1}$ FW for CKD patients for all treatments. Whereas calcium and sodium content were slightly increased when the potassium solution was decreased. Additionally, the content of potassium and sodium ions in both cherry tomatoes fruit was less than the daily nutrient intake of CKD patients. The results indicated that reducing potassium content in the culture solution could produce the low potassium content cherry tomatoes. On the other hand, it could be maintained the cherry tomato productivity.

**Keywords:** Potassium, cherry tomato, hydroponic, CKD

**AG-15-09**

# Relationships Between Soil Characteristics and Brewing Grape Quality in Katsunuma, Yamanashi Prefecture, Japan

**Ai KURIHARA[a]* and Machito MIHARA[b]**

*[a]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
**Corresponding email: 12522006@nodai.ac.jp*

**Abstract**

In this study, the qualities of brewing grapes were analyzed in Katsunuma and Yamanashi Prefecture, and the physical and chemical properties of the soils around the target fruit trees were also investigated to discuss the relationships between the qualities of vinification grapes and soil properties. The survey covered three garden sites from one winery in Katsunuma Town. Undisturbed soil and disturbed soils were sampled from a depth of 20 cm and 30 cm below the trunk of the vines, and were used to measure physical and chemical properties, respectively. The physical properties measured were three-phase distribution, soil particle size composition, and hydraulic conductivity. Chemical properties measured were pH, EC, $K_2O$, $Na_2O$, CaO, $P_2O_4$, and $NO_3$-N. Grapes were collected at harvest time, destemmed, and pressed, and then analyzed for sugar content, glucose, fructose, acidity, malic acid, and tartaric acid. The statistical analysis software R was used for statistical analysis. The experimental results indicated that differences in soil particle size composition and soil properties may affect the sugar and acid levels of vinification grapes. In addition, soil pH, permeability, EC, $K_2O$, and CaO were found to be important factors to be considered in winemaking. In particular, soil pH has a strong correlation with glucose, grape pH, and sugar content, and may serve as an indicator when evaluating soil pH in the future. The measurements that did not correlate were considered to not affect grape quality for vinification. In summary, soil's physical and chemical properties affect fruit quality.

**Keywords:** wine, terroir, vinification grapes, soil pH, Yamanashi

**AG-15-11**

# Comparison of Useful Components of Red Swamp Crayfish (*Procambarus clarkii*) and Signal Crayfish (*Pacifastacus leniusculus*)

**Saki HIGUCHI[a]*, Akira KUROSAWA[a]*, Toshihiro SUZUKI[a], Keiko TANAHASHI[a], and Kouji TAKEDA[a]****

*[a]Tokyo University of Agriculture, 1-1-1, Sakuragaoka, Setagaya-ku, Tokyo, 156-8502, Japan*
**Equal contributors to this work and designated as co-first authors*
***Corresponding email: k2takeda@nodai.ac.jp*

**Abstract**

Crayfish is consumed worldwide as a food resource. However, although signal crayfish are consumed in Japan, red swamp crayfish are not widely recognized as a food resource due to lack of nutritional knowledge. In fact, there have been few nutritional studies on the red swamp crayfish. Furthermore, there are no comprehensive comparisons of the useful components of the inedible and edible parts. In this study, we attempted to determine the usefulness of red swamp crayfish as a food resource by comparing pigments in the shells of inedible parts of signal crayfish and red swamp crayfish and by making a comprehensive comparison of nutrients in the edible parts. In general, the exoskeleton of the signal crayfish is brown, whereas that of the red swamp crayfish is reddish-black, although blue is also present in both. A comparison of the pigments in the exoskeletons of the two crayfish colors by thin-layer chromatography showed bands corresponding to the ester form of astaxanthin as well as the free form of astaxanthin in all samples. The pigments in the exoskeletons of both species were the same, regardless of body color.

A comparison of the three major nutrients in the edible part of the tail muscles showed that the signal crayfish had higher lipids than the red swamp crayfish, while the protein content was the same. In addition, a comprehensive analysis of hydrophilic compounds in the muscles was conducted using triple quadrupole gas chromatography-mass spectrometry. In total, 152 common components were identified in each sample, including various sugars, nucleic acid-related substances, vitamins, and several functional compounds. Principal component analysis using these component data showed that the clusters of both crayfish were largely divided between the samples, reflecting the differences in their components.

**Keywords:** signal crayfish, red swamp crayfish, food resource, pigment, nutrition, SDGs

**AG-15-13**

# The Green Infrastructure Supporting Circular Economy in Semi-urban Tokyo: A Holistic Analysis

**Ivana ANGELOVA**[a]*

*School of Science and Technology*
*Meiji University, Tokyo, Japan*
*4 Chome-21-1 Nakano, Nakano City, Tokyo 164-8525*
**Corresponding email: ivanaangelova@meiji.ac.jp*

**Abstract**

This research examines the interplay between urban farming practices and the circular economy in semi-urban areas of Tokyo. As a dynamic metropolitan area that faces challenges of limited space, rapid development, and a commitment to sustainability, Tokyo's urban farming initiatives emerge as crucial agents of positive change. The study aims to comprehensively analyze the circular economy aspects embedded within these urban farming practices, drawing insights from both literature review and on-site practices and the networks that they establish. By incorporating on-site observations, this research seeks to bridge the gap between theoretical frameworks and practical implementation. The study explores the dynamics of networks formed by urban farming initiatives, analyzing how these links contribute to the circular economy by fostering collaboration between consumers, farmers, and local businesses. The focal point of this research is Tokyo's suburban areas like Saitama and Machida wards, where urban farming plays a pivotal role in transforming underutilized spaces into thriving centers of agricultural activity. From innovative vertical farming structures to community gardens and rooftop green spaces, these practices contribute significantly to the local landscape, redefining the urban-rural continuum. The initial steps of this study will illustrate how and why farming in the city serves as an economic catalyst by creating opportunities for entrepreneurship, fostering local businesses, and contributing to the farm-to-table movement. By doing so, Tokyo's farmers stimulate the local economy, establishing a sustainable and resilient foundation for economic growth. Moreover, these practices transcend their role as mere food sources, evolving into vibrant city commons that foster social interactions, education, and community resilience. The study explores the profound societal impacts, including enhanced mental well-being, social inclusion, and the cultivation of a sense of shared responsibility among residents. This research aims to contribute valuable insights into the circular economy dimensions of urban farming in semi-urban Tokyo, shedding light on its multifaceted impacts in the closed-loop economy.

**Keywords:** urban farming, local-circular economy, semi-urban Tokyo, entrepreneurship, farm-to-table movement

**AG-15-23**

# Effect of Alternate Wetting and Drying Irrigation on Nitrogen Uptake and Water Consumption in Rice Paddy Farming

**Kiseki KURASHINA[a], Sarvesh MASKEY[b], Takahiko NAKAMURA[b], and Hiromu OKAZAWA[b]***

*[a]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
**Corresponding email: h1okazaw@nodai.ac.jp*

**Abstract**

Climate change-induced extreme weather events have caused irrigation water shortages in rice-growing regions of Asia, impacting rice production. Alternate Wet and Dry irrigation (AWD) is a water-saving strategy that can reduce irrigation frequency even when water shortages occur without decreasing yields. However, AWD reduces plant nutrient uptake under water stress conditions compared to Continuous Flooding irrigation (CF). In this study, pot-growing experiments were conducted to investigate the water use efficiency and nitrogen uptake (nitrogen content of leaves, stem, and rice grains) under AWD and CF irrigation with different nitrogen fertilizer application rates to evaluate the effect of irrigation on nitrogen uptake. The application rate of nitrogen was 40 kg N $ha^{-1}$ and 80 kg N $ha^{-1}$. This was done to evaluate how plant nitrogen uptake corresponds under different irrigation systems when fertilization is doubled. AWD irrigation reduced irrigation water use by approximately 7.8% to 14.0%. Nitrogen content was higher in CF irrigation plants than in AWD irrigation plants under the 80 kg N $ha^{-1}$ nitrogen application rate. However, no difference in nitrogen content was observed between CF and AWD irrigation plants under the 40 kg N $ha^{-1}$ nitrogen application rate. According to the result of this study, it was concluded that AWD was efficient in irrigation water saving. Additionally, it was also confirmed that drought conditions during AWD do not affect nitrogen uptake when nitrogen fertilization is applied between 40 kg N $ha^{-1}$ and 80 kg N $ha^{-1}$.

**Keywords:** AWD, rice paddy, irrigation, nitrogen, water consumption

**AG-15-25**

# Method Validation for Determination of Cadmium and Lead Content in Herbs (Plai and Turmeric) by Using a Simple Sample Extraction Method

**Nattira KLEAWKLAHARN[a] and Chuleemas Boonthai IWAI[b]***

*[a]Office of Agricultural Research and Development Region 3, Ministry of Agricultural and Cooperatives, Khon Kaen, Thailand*
*[b]Department of Soil Sciences and Environment, Faculty of Agriculture, Khon Kaen University, Thailand*
**Corresponding email: chuleemas1@gmail.com*

**Abstract**
Medicinal plants or herbs are a valuable bioresource in Thailand. They are widely used as a medicine for treating diseases of people and animals. In agriculture, it is used to control pests. Herbs that are available in the market through a simple production process could be contaminated with agrochemical substances, and residues, including various heavy metals. In order to analyze the heavy metals content in herbs such as Plai and Turmeric. In the laboratory, AOAC Official Method 2016 standard methods were used. In the sample digestion and extraction process, samples were prepared using a microwave digester. In cases where heavy metals must be analyzed in the field using test kits a simple sample extraction method is required. The currently developed test kit has been widely used because it is a simple, convenient, fast, and accurate method of checking. This study aims to validate the method and facilitate the extraction of samples to determine the cadmium and lead content in Plai and Turmeric. In this experiment, the validity of the analytical method was studied by extracting the sample by adding acid and boiling it at high temperatures. Linearity, limit of Detection (LOD), Limit of Quantitation (LOQ), test accuracy (Trueness), and accuracy of test results (Precision) were studied. The results of analysis by simple extraction were compared with the results of analysis using standard methods.

**Keywords:** simple extraction, validation, herb

**AG-15-28**

# Evaluation of Soil Ecosystem Services in Terms of Water Storage and Soil Fertility in Different Land Uses in Northeast Thailand

**Jutatad RATTANAPONG[a] and Chuleemas Boonthai IWAI[ab]***

*[a]Department of Soil Sciences and Environment, Faculty of Agriculture, Khon Kaen University, Thailand*
*[b]Integrated Land and Water Resource Management Research and Development Center in Northeast Thailand, Khon Kaen University, Thailand*
**Corresponding email: chuleemas1@gmail.com*

**Abstract**
Soil ecosystem services (ES) provide multiple benefits to humans but to date no consensus has formed on a comprehensive framework for their classification and economic valuation. Soil natural capital, its properties and soil support functions that underlie other ecosystem services and are in a dynamic relationship with soil processes and soil natural capital Different land uses affect soil properties. It also affects the value of ecosystem services differently. Soil water retention and soil fertility are service of the soil ecosystem. The focus of this study aims to assess the economic value of soil ecosystem services in terms of soil water storage and soil fertility. Under the land use types of forest sugarcane and cassava. Evaluation of the field capacity of the soil using hydraulic parameters from the soil water retention curve (SWRC) with $\theta_{FC}$ to estimate available water capacity ($\theta_{AWC}$). The result informs that the value of storing water in the soil of forest, cassava and sugarcane are 5,912 baht per hectare 5,426 baht per hectare and 4,843 baht per hectare, respectively. For value of soil fertility of sugarcane, cassava and forest 79,422.79 baht per hectare 49,916.45 baht per hectare and 49,544.80 baht per hectare, respectively. The agriculture area add the chemical fertilizer every year and fertilizer left in soil and it make high production cost. The results of this study show the different economic values of soil ecosystem services in different uses. In this regard, the development of a comprehensive framework for evaluating economics of soil ecosystem services are necessary. This provides information that can be used to make decisions for land resource management of the study area.

**Keywords:** Soil ecosystem services, Economic valuation, Soil water storage, Soil fertility

**AG-15-30**

# Accessibility to Small Credit Amongst Small Scale Farmers: A Case Study in Morogoro Region, Tanzania

**Sabra Yusuf ABDALLAH[a], Machito MIHARA[b], and Rika TERANO[c]***

*[a]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[b]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
*[c]Faculty of International Food Studies Information, Tokyo University of Agriculture, Japan*
*[c]Associate Professor of Agribusiness Management*
**Corresponding email: rt200005@nodai.ac.jp*

**Abstract**

In Tanzania, many households rely on on-farm income from small-scale farming as their primary livelihood. Because the majority of local farmers cultivate ranging from 1 to 2 hectares in size as small-scale farms, they face financial constraints hindering their agricultural activities. Microcredit plays a major role in supporting the agricultural activities of small-scale farmers, and many NGOs and government agencies provide small loans to farmers. Microcredit offers vital financial support, enabling them to purchase necessary inputs for farming. However, the issue remains. Because microcredits are not given to all farmers who need support, farmers without access to microcredit are left out of such support. This study aims to understand accessibility to microcredit among small-scale farmers in rural areas of the Morogoro region, Tanzania. We conducted a questionnaire survey among microcredit recipients and non-recipients to understand the challenges faced and explore potential solutions for future applicants. Data collection was conducted in three villages of Bigwa, Mlali, and Mlimani with randomly selected 29 respondents. Descriptive analysis illustrates the socio-economic characteristics, awareness of microcredit, whether or not being recipients, and economic activities as small-scale farmers. The findings revealed microcredit recipients experienced positive outcomes with the support of small loans, such as introducing new crop varieties, expanding land holdings, and increasing yields through manual labor. Nevertheless, they faced challenges like transporting products to urban areas and selling them at competitive prices. Non-recipients encountered issues like low yields and financial constraints, resorting to increased manual labor and personal savings. However, non-applicants lacked awareness of microcredit and had no chance to apply. This study revealed that recipients and non-recipients are in completely different situations even though they are farmers in the same region. The study could point out that it is important to raise awareness about microcredit among non-recipients, promote reasonable repayment plans, and empower farmers to enhance agricultural productivity among recipients.

**Keywords:** accessibility, small-credit, small-scale farmer

**AG-15-31**

# Guidelines for Pesticide Risk Management at the Community Level in Northeast Thailand

**Jarupong PRASOPSUK[a]*, Watcharaporn SRISAWANGWONG[a], Papatsorn SEELARAK[a], Natchayathon KHATTIYAPHUTTHIMET[a], Malisa WETCHAYANON[b], and Chuleemas Boonthai IWAI[cd]**

*[a]Office of Agricultural Research and Development Region 3, Ministry of Agricultural and Cooperatives, Khon Kaen, Thailand*
*[b]Department of Agricultural, Ministry of Agricultural and Cooperatives, Bangkok, Thailand*
*[c]Department of Soil Sciences and Environment, Faculty of Agriculture, Khon Kaen University, Thailand*
*[d]Integrated Land and Water Resource Management Research and Development Center in Northeast Thailand, Khon Kaen University, Thailand*
**Corresponding email: ja.prasopsuk@gmail.com*

**Abstract**

This study aims to assess the risk of pesticide use and study guidelines for pesticide risk management at the community level in North-East Thailand. In 2022, data was collected by using semi-structured interviews and group discussions. Representatives of a group of farmers who use pesticides were purposively selected 10 per group with a total of 19 villages. Data from farmer interviews about pesticide use, including type of substances, application rates, spraying frequency, and plot size of plantations. This is used in the EIQ Field Use equation to assess environmental risks. Group discussion includes Farmer representatives, community leaders, agricultural extension officers, public health officials, and researchers. It was found that the average Field Use EIQ of vegetable plots had a high-risk level. Especially, the village grows chilies, tomatoes, kale, and cabbage. From the group discussion on guidelines for reducing the risk from pesticide use in each village, there were common guidelines: Personal safety, requiring regulation of the use of appropriate spraying equipment. To prevent exposure to pesticides, applicators should wear protective clothing and personal protective equipment. 2) Safety of people in the community. Do not spray pesticides in villages or communities, schools, temples, and hospitals. Spraying chemicals in areas close to the community or village must notify the village headman with a spraying plan. Areas where pesticides are sprayed must have warning signs indicating the date and time. 3) Safety for the ecosystem and public areas of the community. Do not spray chemicals, and do not leave chemical bottles in public areas, water sources, and community forests. 4) Food safety. Farmers must comply with the requirements according to GAP standards. 6) Set up a community committee to control the community's use of pesticides. The committee is responsible for coordinating the correct and safe pesticide use in the community. The guidelines will be used as policy recommendations for reducing the pesticide risk in commercial agricultural communities.

**Keywords:** pesticide, community, risk management

**AG-15-32**

# Estimating Leaf Area Index of Cassava Plantation Using UAV Imagery

**Mol PENGKHEANG[a]*, Hor SANARA[a], Pok SOPHAK[a], and Chea CHETHA[a]**

*[a]Royal University of Agriculture, Cambodia*
**Corresponding email: mpengkheang@rua.edu.kh*

**Abstract**

Cassava is a vital crop for Cambodia's economy and food security. It ranks fourth in Asia and tenth in the world in cassava production. Cassava can grow in harsh conditions and provide food during famines. This study uses remote sensing methods to estimate the leaf area index of cassava using multispectral images from a Parrot Sequoia camera and compares different indices for this task. The study focuses on Battambang Province, a northwestern region of Cambodia that borders Thailand. Although the province cultivates a variety of crops, rice and cassava are the most significant ones. Cassava had the second largest area and production after rice, with 128,434 ha and 2,703,927 tons in 2022. The LAI-2200C device was used to measure the cassava canopy together with a sensor covering with a diffuser hat and placed under a leaf by following device's manual for these data collection and calibration. LAI was estimated from vegetation indices and Random Forest Algorithm using R Programming. Multispectral images and indices such as OSAVI, NDVI, EVI2, GCL and REGCL were used. Cross-validation was used to evaluate the LAI estimation values with collected in-situ LAI values by the LAI-2200C device for validation. Regression, RMSE, and NRMSE were used as statistical methods. This study uses multispectral images from a Parrot Sequoia camera to estimate the leaf area index of cassava. It applies indices analysis and machine learning algorithms and compares them with previous indices. This study is new and useful for remote sensing and rural planning in Cambodia.

**Keywords:** multispectral images, cassava, leaf area index, vegetation indices

**AG-15-35**

# Effect of LED Lighting on Vitamin C and Phenols in Ethiopian Kale Microgreens

**Ruth Nyambura MARU[a], John WESONGA[a], Dickson MAZIBUKO[b], Satoko AKIYAMA[c], Ayako SEKIYAMA[d], Shotaro KAWAKAMI[d], Sarvesh MASKEY[d], Agnes KAVOO[a], Johnstone NEONDO[a], and Hiromu OKAZAWA[d]***

*[a]School of Agriculture and Environmental Sciences,*
*Jomo Kenyatta University of Agriculture and Technology, Kenya*
*[b]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[c]Faculty of Applied Bio-science, Tokyo University of Agriculture, Japan*
*[d]Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
**Corresponding email: h1okazaw@nodai.ac.jp*

**Abstract**
Microgreens are innovative vegetable products due to their novelty and health-promoting benefits. However, media and light conditions affect microgreens' nutritional content, which may limit their production in rural community settings. *Brassica carinata* is an essential local Kenyan vegetable, but its production and full utilization are limited by its early maturity. The potential of using *B. carinata* as a microgreen would be an excellent alternative production technique to circumvent its early maturity limitation. This study investigated the influence of white and blue light on Vitamin C and phenols content in *B. carinata* microgreens. Microgreens were grown for 14 days in a growth chamber using plastic punnet containers filled with cocopeat and sand under white and blue light. The capillary wick watering technique was used for irrigation. Temperature and relative humidity were monitored and maintained at 25ºC and 60%, respectively. The photoperiod and intensity of light were also maintained at 12 hr and 160 ± 2.5 µmol $m^{-2}s^{-1}$) respectively. After 14 days, microgreens were harvested and freeze-dried to analyse phenols and Vitamin C. Data was subjected to ANOVA and means separated by Tukey's multiple comparison test. Results indicated that light had no significant effect on *B. carinata* phenol content. However, microgreens grown in sand showed statistically higher amounts of phenol content than those grown using cocopeat. For vitamin C content, media and light showed no significant effect. Based on our results, sand, as a locally available medium and in either light, can equally be used to produce microgreens for phenols and Vitamin C for *Brassica carinata.*

**Keywords:** microgreens, LED light, growing media, functional foods, nutraceuticals

**AG-15-42**

# Transfer of Producing Fermented Bio-Extract Method from Fermented Fish by Product for Using in Organic Vegetables Cultivation to Smallholder Farmers in Northeastern Thailand

**Supaporn PLUANGCHOMPOO[a]*, Keattichai MONTREEWONG[a], and Anan POLTHANEE[b]**

*[a]Department of Agricultural Economic, Khon Kaen University, Thailand*
*[b]Department of Extension and Agricultural Development, Khon Kaen University, Thailand*
**Corresponding email: psuppap@kku.ac.th*

**Abstract**

Organic agriculture is the process by which products are produced without the use of chemical agents. Organic agriculture, like a key to sustainable farming systems, has captured the interest of many countries throughout the world in response to the need to sustain the health of soils, ecosystems and people. There are various groups of smallholder farmers transforming their practices from chemical farming to organic farming. However, some groups succeed in converting to organic farming, but some remain in chemically based farming systems. Objectives of transfer such technology were, to improve yield and net income of the smallholder farmer groups who grow organic leafy vegetables at Khao-Pranon sub-district, Kalasin province, Northeastern Thailand in 2022. Three groups farmer (15 persons) who grow leafy vegetables namely, morning glory, chinese parsley, chinese green mustard, salad and chinese celery participate for testing of this technology. Training of smallholder farmers was carried out at the study site. Before and after training, evaluations of knowledge were tested in relation to the understanding of fermented bioextract fertilizer such as how to produce and use for organic vegetables cultivation. For testing technology treatments, farmer cultivation practices with single soil pig manure application as compared to recommendation practices with soil pig manure combined foliar application of fermented bioextract fertilizer were evaluated in term of yield and economic return. The results found that farmers grown all kinds of leafy cultivation vegetables practices following the recommendation increased yield by 25-100 % over famer cultivation practices. The farmers cultivation practiced following recommendation increased the net income by 34-335 USD over farmer cultivation practices, depending on kind of vegetables. Chinese parsley produced the maximum net income of 759 USD in year-round. While salad vegetables gave the highest benefit-cost ratio (4.7) in the present study.

**Keywords**: organic, vegetable, fermented bioextract, yield, economic return

**AG-15-43**

# Transfer Optimizing Use of Nutrients for Increasing Cassava Yield and Net Income to Smallholder Farmers in Northeastern Thailand

**Supaporn PLUANGCHOMPOO[a]*, Keattichai MONTREEWONG[a], and Anan POLTHANEE[b]**

*[a]Department of Agricultural Economic, Khon Kaen University, Thailand*
*[b]Department of Extension and Agricultural Development, Khon Kaen University, Thailand*
**Corresponding email: psuppap@kku.ac.th*

**Abstract**

Cassava is one main crop of smallholder farmers in Southeast Asia. It can grow in low fertile soils and in drought-prone areas with little risk of complete crop failure. In Thailand, cassava grow in large areas of northeastern region. However, inefficient nutrient management by the smallholder farmers may cause large yield gab of actual yield (farmer practices) to deviate from potential yields (recommendation based on soil testing). Smallholder farmers typically have limited amount of nutrients application and use general formula of fertilizer. Therefore, a major focus should be placed on properly addressing the fundamental issues of providing the crops with adequate nutrients under highly variable soil fertility conditions. The transfer of this technology was carried out at the Kao-Pranon sub-district, Kakasin province. Ten farmers were selected to participate in testing the use of nutrient following in 1965 the recommendation based on soil testing, in comparison with farmer cultivation practices. The results found that most farmers applied fertilizer with N and K deficiency while, P using below adequate amount only 50% of the total farmers. Application of nutrients following recommendation produced higher storage root yield (35 ton/ha) than farmer practices (18 ton/ha). The starch content of the storage root was obtained 29 and 28 percent for recommendation and farmer practices, respectively. For economic return, application of nutrients following recommendation gave higher net income (2,488 U$$/ha) than farmer practices (889 U$$/ha). Transfer of optimizing use of essential nutrients efficiency and minimize nutrients less to the environment. Extension of such nutrients management could be applied to cassava growing areas in the Northeastern of Thailand.

**Keywords**: Cassava, nutrients, storage root yield, starch content, economic return

**AG-15-45**

# Diversity of Insect Pollinators at the Conservation area of Chaiyaphum Province in the Northeastern Thailand

**Duangrat THONGPHAK[a]* and Ubon TANGKAWANIT[a]**

*[a]Entomology Section, Faculty of Agriculture, Khon Kaen University*
*Khon Kaen, 40002, Thailand*
**Corresponding email: duathg@kku.ac.th*

**Abstract**

Insect pollinators were collected from the Plant Genetic Conservation area, Chulabhorn Dam, Chaiyaphom Province using sweep net and by observation. The data was collected during the dry season (March 2018) and wet season (September 2018). In total, 41 species from 4 Orders and 34 families were found, of which 30 species from the Order Lepidoptera were the most found, followed by Hymenoptera, Diptera and Coleoptera with 10, 8 and 3 species respectively. Shanon's index of diversity (H) was compared to a variety of insect pollinators. The species diversity index showed that species diversity of insect pollinators in the study area is low (H' = 1.13) while the Evenness index showed high dominant species (J' = 0.30). Order Hymenoptera is the most common pollinator among the other species found in this study (with 35.01% frequency compared to all obtained insect specimens).

**Keywords:** Diversity, pollinators, Plant Genetic Conservation area, Chulabhorn Dam

**AG-15-46**

# The Influence of Copper and Cadmium Combined Pollution in Soil on Growth, Yield, and Copper and Cadmium Uptake of Soybean

**Choichi SASAKI[a]*, Chihiro KATO[a], Nobuhiko MATSUYAMA[a], Takeyuki ANNAKA[b], and Kiichi SASAKI[c]**

*[a]Hirosaki University, Japan*
*[b]Yamagata University, Tsuruoka, Japan*
*[c]Aomori Prefectural Improvement Projects Federation, Aomori, Japan*
**Corresponding email: chsasaki@hirosaki-u.ac.jp*

**Abstract**

Food produced in polluted farmland often damages human health. Studying various mechanisms further of how agricultural products are contaminated is always very important. The purpose of this study is to investigate the influence of copper-and-cadmium-combined pollution in soil on the growth and yield of soybeans and their uptake of copper and cadmium. Our models consisted of a layer of 14cm gravel at the bottom of the plastic containers, a layer of 20cm non-polluted soil on top of that, and another layer of 20cm polluted soil on the top. We cultivated eight soybean plants in every model. In this, we used a sample of cadmium-polluted soil (about 1.81 mg kg-1) taken from a paddy field. We controlled the copper concentrations in soil at 100 mg kg-1, 250 mg kg-1, and 400 mg kg-1; soybeans were seeded in early June and harvested in early October. Cd concentrations in soybean seeds in three different models with different levels of Cu contamination in soil, 100 mg kg-1, 250 mg kg-1, and 400 mg kg-1, became 0.48 mg kg-1, 0.53 mg kg-1 and 1.30 mg kg-1, respectively; also, Cu concentrations in soybean seeds in the three models became 10.53 mg kg-1, 15.40 mg kg-1 and 20.18mg/kg respectively. The order of copper and cadmium concentrations in the plants became seed<stem<root. The growth and yield of soybeans were lower in models with soil Cu concentration at 400 mg kg-1 than in the models with soil Cu concentration at 100 mg kg-1. The models with soil Cu concentration at 400 mg kg-1 only yielded three stumps. From those results, we concluded that the influence of the changes in Cu concentration in soil, which was polluted with both Cd and Cu, would be considerable on the growth and yield of soybean plants and cadmium and copper concentrations in them.

**Keywords:** soil contamination, cadmium, Copper, soybean

**AG-15-47**

# Functional Ingredients and Antioxidant Effect of *Planchonella obovata* Products in Cambodia

**Sothea KONG[ab], Chim CHAY[a], Hiroyuki HATTORI[c], Samnang NGUON[a], and Kasumi ITO[d]***

[a]*Graduate School, Royal University of Agriculture, Cambodia*
[b]*Graduate School of Bioagricultural Sciences, Nagoya University, Japan*
[c]*Graduate School of Agricultural Science, Tohoku University, Japan*
[d]*International Center for Research and Education in Agriculture, Nagoya University, Japan*
**Corresponding email: kasumito@agr.nagoya-u.ac.jp*

## Abstract

In Cambodia, typical traditional foods, including fish pastes and fermented vegetables, have been catered widely in wet markets because of high consumption. Most of them have not known yet about ingredients and nutrient information although they are popularized. *Planchonella obovata*'s product is one such food that has not been elucidated the benefit for consumer health yet. This study evaluates its nutrition and physiochemical properties. The fresh and processed (pickled and smashed-in-sugar) *Planchonella obovata* fruits were collected two times for experiment from 10 stores in Phnom Penh, Cambodia, in September 2022. These samples were analyzed the nutritional values (pH, total acid, moisture contents, vitamin C, total soluble solid, and total sugar) and mineral compositions (NaCl, Ca, Mg, and ash). In addition, the functional ingredients (total phenolic contents and tannin contents) and antioxidant activities were measured using the flesh of this plant. As a result, nutritional values showed that both processed fruits were not much different in NaCl, Ca, and ash; however, they were higher than fresh fruit. The moisture contents, total soluble solid, and total sugar of the smashed-in-sugar were the highest. Interestingly, the fresh fruit contained the highest vitamin C whereas the processed had the lowest one. The results of functional ingredient measurement indicated that the fresh fruit flesh was rich in total phenolic and tannin contents than those of the processed fruit flesh. For further studies, processing methods of *Planchonella obovata* should be modified properly to maintain essential antioxidants such as vitamin C, phenolic, and tannin contents. Particularly, bioactive compounds in *Planchonella obovata* should be clearly specified due to their usefulness for human health.

**Keywords:** physiochemical properties, *Planchonella obovata*, traditional foods, Cambodia

**AG-15-51**

# Designing the Future: How Business Model Innovations Drive Sustainable Food Systems

**Islam Mohamed KAMEL[a], Fadi ABDELRADI[a], Victor SHAKER[a], Hamid EL BILALI[b], Sinisa BERJAN[c]***

*[a]Faculty of Agriculture, Cairo University, Cairo, Egypt*
*[b]International Center for Advanced Mediterranean Agronomic Studies (CIHEAM-Bari), Valenzano (Bari), Italy*
*[c]Faculty of Agriculture, University of East Sarajevo, East Sarajevo, Bosnia, and Herzegovina*
**Corresponding email: sinisa.berjan@ues.rs.ba*

**Abstract**

Traditional agrifood business models have prioritized short-term profits over long-term sustainability. Such doctrine has resulted in environmental degradation, climate change, resource depletion, food insecurity, and social instability and urged the need for innovation in sustainable business models (SBM) design. In this context, many organizations in the agri-food system lack a comprehensive interpretation of SBM as they claim to implement SBMs, yet they often fall short of generating and capturing its value. The crucial need for design science research for developing and applying SBM to foster business model transformation and mitigate adverse economic, environmental, and social consequences has become indispensable. SBM, as an emerging unit of analysis from a holistic system-level approach, is not fully clear due to its substantial complexity. To fill this gap, a mixed method approach was used via a systematic review through the Scopus database as well as semi-structured interviews with an international panel of experts to collect the qualitative data. Furthermore, to overcome the quantitative imbalance between the components of the sustainability dimensions, as economic elements are often prioritized, the Triple Bottom-Line approach (3BL) and Multi-Criteria Decision-Making Analysis (MCDA) were adopted. The research results present a conceptual framework consisting of archetypes of SBMs in the agri-food system. These archetypes include maximizing efficiency, creating value from waste, substituting with renewables, delivering functionality, adopting a stewardship role, encouraging sufficiency, and scaling up solutions. The study also identifies key components of an SBM in this system, such as sustainable sourcing, resource utilization, waste reduction, social responsibility, stakeholder engagement, and value creation along the value chain. However, transition costs, limited awareness, market demand, complex supply chains, policy gaps, technical barriers, and resistance to change in adopting sustainable practices are still challenges facing the transformation to SBM in the agri-food system.

**Keywords:** sustainable business model, design science research, business model transformation, sustainable value creation, agri-food system

**EM-15-02**

# Impact of Ruzi Dissemination Characteristics on Land Use Change in Xiengkhoung Province, Lao PDR

**Soulikone CHAIVANHNA[ab]*, Chuleemas Boonthai IWAI[b], Pascal LIENHARD[c]**

*[a]Department of Agricultural Land management, Lao PDR, PhD student in Khonkaen University, Thailand*
*[b]Department of Soil Science and Environment, Khon Kaen University, Thailand*
[c]Centre de Cooperation International en Recherché Agronomique pour le Development *(CIRAD), France.*
**Corresponding email: csoulikone@gmail.com*

## Abstract

Land use and land cover change were affected by agriculture production dynamic related to demand of market and consuming as food and industrial sector. Ruzi grass dissemination and animal raising is one of the causes that led to land use change especially cropland change to ruzi pasture, forest to ruzi grass and ruzi grass to cropland and plantation. The objectives of the study were to evaluate ruzi grass dissemination effect to land use change. The study was conducted by field survey, group discussion with farmers and mapping by using GIS. The characteristics of ruzi pasture and their management and influence on other land use such as cropland, forest land and other tree plantation were studied. The results found that the history of ruzi grass planted in the area since 1995 since FLSP project funded by AusAid, the character of ruzi were demonstration plot in the pilot farmer in small area about 0.1-0.3 ha, then farmers continued extend by them self. In 2003 there was PRONAE project support seed and investment for fencing to farmer to extend ruzi grass area around1 ha in average per household in the high landscape, 0.3-0.5 ha per household in the medium and low landscape areas. There were very few lands use type in the high land area (upland rice, tree plantation and livestock area), medium land had annual crop (maize), vegetable, fruit tree, livestock, that more than high land and low land (paddy rice and vegetable). Up to now there are ruzi pastures extend to 10 to 30 ha per village or about 2-3 ha per household in high landscape but there was still not much in the medium and low land area. In term of ruzi grass management, there were three main model as: 1) animal grazing in the one plot during wet season and then open to the crop land in dry season after harvested mostly in the medium landscape areas, 2) animal grazing one plot whole year but leave ruzi grass regrowing 1-3 months then bring animal grazing again, this model was practiced mainly in the high landscape areas and 3) animal grazing + cut and carry practiced in the low landscape areas. In summary, Ruzi grass dissemination instead fallow, forest and crop land during 1998 to 2023 and tend to increase in the future if land degradation, crop yield low then farmer change land use to pasture.

**Keywords:** Ruzi grass dissemination, land use change, landscapes

**EM-15-04**

# Soil Biota, Soil Biological Activity, and Soil Carbon Storage in Different Land Uses in Northeast Thailand

**Yarapon PUTTAKOT[a], Chuleemas Boonthai IWAI[ab]*, and Anan WONGCHAROEN[c]**

*[a]Department of Soil Sciences and Environment, Faculty of Agriculture, Khon Kaen University, Thailand*
*[b]Integrated Land and Water Resource Management Research and Development Center in Northeast Thailand, Khon Kaen University, Thailand*
*[c]Department of Entomology and Plant Pathology*
**Corresponding email: chuleemas1@gmail.com*

**Abstract**

Land use changes from natural forest to agricultural land contribute to the release of greenhouse gases, such as carbon dioxide ($CO_2$), into the atmosphere and is a significant factor in causing global warming. The northeastern region of Thailand relies heavily on the agricultural sector, making the assessment and monitoring of carbon storage in soil, as well as the activities of microorganisms and other living organisms in the soil, crucial for reducing agricultural greenhouse gas emissions and promoting sustainable agriculture. This study aims to assess soil biota, soil biological activity, and soil carbon storage across various land use types in the region, with a focus on the case study of Ban Hua Bueng, Sai Mun Subdistrict, Nam Phong District, Khon Kaen Province. We aim to explore the relationships between land use types in six areas, including the community forest area (Fr), cassava cultivation involving the application of chemical fertilizer (Cs), cassava planting areas managed with the addition of organic fertilizer (Cs-O), sugarcane growing areas where chemical fertilizer is applied and plant residues are burned (Sc), sugarcane growing areas with the addition of organic fertilizer and without burning of plant residues labeled as (Sc-O), and rice cultivation areas designated as (Pd). The results showed that agriculture land use clearly affects soil biota. Specifically, earthworms are found in agricultural areas only 0-20% compared to forest areas. Additionally, the population of microorganisms is most abundant in forest areas. Soil organic carbon was found to be positively related to soil respiration activity, and total nitrogen showed statistical significance.

**Keywords:** carbon storage, soil biological activity, earthworm, land use

**EM-15-05**

# Investigating the potential of Azolla *microphylla* on wastewater treatment and carbon sequestration

**Nyein NYEIN[a] and Chuleemas Boonthai IWAI[ab]***

*[a]Department of Soil Sciences and Environment, Faculty of Agriculture, Khon Kaen University, Thailand*
*[b]Integrated Land and Water Resource Management Research and Development Center in Northeast Thailand, Khon Kaen University, Thailand*
**Corresponding email: chuleemas1@gmail.com*

**Abstract**

Nowadays, the environmental pollution including water pollution and climate change became significant issues. Therefore, the eco-friendly approaches for environmental conservation are essential among the new techniques. This study investigated the capacity of Azolla *microphylla* in wastewater treatment and carbon sequestration. The experiment was conducted with three treatments and three replications by using different water sources (tap water, domestic wastewater and swine wastewater) to grow the Azolla *microphylla* for 7 days. The results were found that the biomass growth of Azolla increased to 67.6%, 93.9% and 103.3% and absolute growth rate ranged from 5.67 to 8.69 g/day. The maximum growth rate was resulted from domestic wastewater, which is not significantly difference from tap water ($p < 0.05$). Biochemical Oxygen Demand (BOD) was reduced by 68%, 46% and 12% in tap water, swine wastewater and domestic wastewater. Chemical Oxygen Demand (COD) was reduced by 41% and 18% in swine wastewater and domestic wastewater. The increased organic carbon (OC) content of Azolla ranged 23 to 35% and the carbon dioxide ($CO_2$) sequestration of the Azolla was increased to 23%, 34% and 36% in swine wastewater, domestic wastewater and tap water. The study evaluated that the Azolla has the potential on wastewater treatment from different wastewater sources and it has the ability to sequester the carbon dioxide in the mitigation of the climate change.

**Keywords:** *Azolla*, phytoremediation, wastewater treatment, climate change

**EM-15-06**

# Determination of the Factors Affecting the Performances of Sediment Microbial Fuel Cells by Long-term Electricity Generation Using Lactic Acid Bacteria-attached Electrodes

**Narong TOUCH[a]* and Tadashi HIBINO[b]**

*[a]Tokyo University of Agricultural, Tokyo, Japan*
*[b]Hiroshima University, Hiroshima, Japan*
**Corresponding email: nt207118@nodai.ac.jp*

**Abstract**

Sediment microbial fuel cell (SMFC) performance can be improved using electrodes fermented with and without aeration as cathodes and anodes, respectively. However, this improved performance does not exceed 60 days. In this study, the cathode water-based factors affecting SMFC performance were identified using long-term electricity generation. Meanwhile, SMFC performance (polarization) was measured during the experiments. In addition to the polarization measurement, the pH, electrical conductivity (EC) of the cathode water, and adenosine triphosphate (ATP) on the cathode surface were measured. Experiments were conducted with and without the overflow of cathode water. Thereafter, the scanning electron microscopy–energy dispersive X-ray (SEM–EDX) analysis of the cathodes was performed. Similar to the literature, SMFC performance began to decrease on Day 60 from the commencement of the experiments. Furthermore, the pH difference before and after Day 60 was within 0.2, indicating that the pH of the cathode water did not directly affect SMFC performance. Moreover, EC was kept low with cathode water overflow, significantly decreasing SMFC performance. Further, the SMFC performance increased with an increase in ATP, indicating that the bacterial activities on the electrode affected SMFC performance. The SEM–EDX results revealed that metal ions were obtained from the dissolution of steelmaking slag attached to the cathode surface, indicating the crystallization of these metal ions during the experiments. These findings indicate that the crystallization on the cathode driven by long-term electricity generation inhibited bacterial activities and cathode reactions, thereby decreasing SMFC performance.

**Keywords:** sediment microbial fuel cell, performance, pH, electrical conductivity, adenosine triphosphate, crystallization

**EM-15-07**

# Design of a Two-chamber Microbial Fuel Cell Without a Proton Exchange Membrane for Electricity Generation from Food Wastes

**Narong TOUCH[a]* and Xiao XIAO[b]**

*[a]Tokyo University of Agricultural, Tokyo, Japan*
*[b]Tokyo Metropolitan University, Tokyo, Japan*
**Corresponding email: nt207118@nodai.ac.jp*

**Abstract**

A conventional biomass-fired power plant requires substantial construction costs, making its implementation difficult in rural areas of developing countries. In contrast, microbial fuel cell (MFC) technology offers numerous benefits over conventional plants; however, its performance is currently inadequate and requires improvement before it can be deployed. This study proposed a new design for the anode chamber of a two-chamber MFC without a proton exchange membrane when food waste is used as a substrate. Different configurations of the anode chamber, including those with and without a soil layer and different anode positions, were investigated. The effects of each structure on MFC performance were investigated by measuring temporal changes in the cathode potential and examining the electrical conductivity (EC), oxidation–reduction potential (ORP) of the cathode water, and electrical current of MFC. The analysis of EC and ORP variations revealed that the introduction of a soil layer in the anode chamber resulted in lower EC values and higher cathode potentials, indicating that the soil layer acted as a filter to reduce the diffusion of ions from the anode chamber to the cathode chamber. However, this adsorption process increased the ohmic losses in the MFC system and decreased the current density. In the designs without a soil layer, when the anode was installed in the steelmaking slag (SS) layer, a higher cathode potential was observed compared with the design in which the anode was placed on the SS layer. Consequently, this higher potential induced a higher current density. However, without the exchange of cathode water, the current density decreased temporally, and no significant difference in the current density was observed between these designs during the first 7 days after generating electrical current. Therefore, placing the anode on the SS layer is a suitable design for recovering electricity from food waste.

**Keywords:** two-chamber microbial fuel cell, food waste, diffusion, cathode water quality

**EM-15-08**

# Impact of Street Tree Management on the Plants Colonizing Street Tree Bases in an Urban Environment

**Masaaki FURUNO[a], Taizo UCHIDA[a]*, Xue Jun HUAN[b], Daisuke HAYASAKA[c], and Teruo ARASE[d]**

*[a]Kyusyu Sangyo University, Japan*
*[b]Suzhou Polytechnic Institute of Agriculture, China*
*[c]Kindai University, Japan*
*[d]Shinshu University, Japan*
**Corresponding email: uchida@ip.kyusan-u.ac.jp*

**Abstract**

The space at the base of street trees (hereafter called as "street tree bases") is invaded and colonized by a diverse plant population, primarily consisting of native species. Therefore, it is implied that street tree bases contribute to urban biodiversity. However, there is a lack of information regarding the plants that invade and colonize street tree bases, and comprehensive research is required in this direction. There are various types of street trees (hereafter referred to as "street tree types"), such as hedges, those with have planted beds at their bases. Therefore, we examined the effects of street tree types on plants that invade and establish street tree bases. In addition, their contribution to urban biodiversity is based on the presence of buried seed populations in street tree bases. The results showed that many plants that were not found in other types invaded and colonized in each street tree type, forming a plant community that differed from other types. In other words, we believe that street tree bases can further increase urban biodiversity by establishing various street tree types. In addition, it was found that buried seed communities were present in many street tree bases indicating that street tree bases also serve as urban soil seed banks.

**Keywords:** street tree type, urban biodiversity, nature positive, buried seed

**EM-15-09**

# Ecotoxicology of Microplastics Low-Density Polyethylene (LDPE) in Soil on Earthworms (*Eisenia foetida* and *Eudrilus eugeniae*)

**Laddawan UPAKHOT[a] and Chuleemas Boonthai IWAI[ab]***

*[a]Department of Soil Sciences and Environment, Faculty of Agriculture, Khon Kaen University, Khon Kaen, 40002, Thailand.*
*[b]Integrated Land and Water Resource Management Research and Development Center in Northeast Thailand, Khon Kaen University, Khon Kaen, 40002, Thailand.*
**Corresponding email: chuleemas1@gmail.com*

**Abstract**

Microplastics are particles of plastic less than 5 mm. in size. Recently, microplastics were found in oceans, rivers, and soil. Microplastics contaminated in the environment have been contributing to pollution and posing threats to ecosystems. This study aims to study the acute toxicity of microplastic low-density polyethylene (LDPE, ≤ 1 mm.) on earthworms (*Eisenia foetida* and *Eudrilus eugeniae*), which are essential organisms for soil health and functioning in different concentrations (0%, 0.1%, 0.25%, 0.5%, and 1%), with four replicates in artificial soil. Results show that the $LC_{50}$ values of low-density polyethylene microplastics at 14 days on *Eisenia foetida* and *Eudrilus eugeniae* were 5.96% and 3.6%, respectively. The microplastic that affected on earthworms (*Eisenia foetida* and *Eudrilus eugeniae*) and surface damage of earthworms was observed at the concentration of above 0.25% after exposure 14 days. While more than 10% of mortality was observed at concentrations of 1% in *Eisenia foetida* and more than 10% of mortality was observed at concentrations above 0.25% in *Eudrilus eugeniae*, a positive correlation was found between the concentration of microplastic and mortality in both earthworm species, while a negative correlation was found between microplastic concentration and weight of change in earthworms.

**Keywords:** effect, earthworm, microplastics, pollution

**EM-15-10**

# Sustainability Initiatives in the Wood Processing Industry: Studying the Possibility of Utilizing Sawdust in the Production of Mycelium-based Biocomposites to Develop Circular Material

**Thana TEERAPHANTUVAT[a], Kritsana JATUWONG[bc], Saisamorn LUMYONG[cde*], and Worawoot AIDUANG[bc*]**

*[a]Northfield Mount Hermon School, Mount Hermon, Massachusetts 01354, United States of America*
*[b]Office of Research Administration, Chiang Mai University, Chiang Mai 50200, Thailand*
*[c]Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand*
*[d]Center of Excellence in Microbial Diversity and Sustainable Utilization, Chiang Mai University, Chiang Mai 50200, Thailand*
*[e]Academy of Science, The Royal Society of Thailand, Bangkok 10300, Thailand*
**Corresponding email: scboi009@gmail.com and maxworawoot@gmail.com*

**Abstract**

The wood processing industry plays a pivotal role in the global economy and environmental preservation. With sustainability gaining increasing importance, wood processing industries are actively looking for innovative solutions to minimize waste and environmental impact. One promising approach involves the utilization of sawdust, a byproduct of wood processing, to produce mycelium-based biocomposites (MBCs) for the creation of circular materials. This research project explores the feasibility of utilizing sawdust, derived from three different wood types, including red alder, white oak, and yellow poplar, into the production of MBCs. The process involves employing fungal mycelium from the genus *Ganoderma* sp. (WE-CMU 011) as a biopolymer to bind the substrate particles together. The mechanical and physical properties of the obtained MBCs were then examined and compared with those of traditional synthetic materials. The outcomes reveal that the obtained MBCs exhibit density levels and compression strengths ranging from 167.71 to 208.28 kg/m$^3$ and 387.28 to 562.06 kPa, respectively, surpassing those of many synthetic foams. Particularly, MBCs produced from a combination of mixed sawdust and white oak sawdust demonstrate superior compression strength and density compared to MBCs from other wood types. Additionally, the study indicates that using a blend of sawdust from all three wood types during production results in MBCs with low average shrinkage and volumetric swelling. However, concerning water absorption, the obtained MBCs in this study show 110.99–139.37%, still higher than those of synthetic materials. Although these qualities may require improvement, the water-absorbing capacity of MBCs could find applications in agriculture for retaining moisture and in packaging materials for liquid chemicals prone to leaks during transportation. Importantly, this study not only provides valuable insights for the wood processing industry and environmental advocates but also highlights the potential of circular material production for achieving sustainable, eco-friendly, and economically viable practices.

**Keywords:** agro-industrial waste, green composite materials, mycelium technology, BCG Model, biobased economy

**EM-15-11**

# Co-digestion of Ensiled Napier Grass and Commercial Bakery Wastewater for Bioenergy Production

**Natagarn TONGPHANPHARN[a]*, Montip JANKAEW[a], and Natsima TOKHAN[a]**

*[a]Environmental Science and Technology program, Valaya Alongkorn Rajabhat University*
**Corresponding email: natagarn@vru.ac.th*

**Abstract**

Bioenergy derived from anaerobic digestion has gained attention for a decade because of its ability to convert waste into biogas. The advantages of this biotechnology could replace conventional energy, lower greenhouse gas emissions, and produce less biodegradable waste. This study focused on the methane production from ensiled Napier grass (Pak Chong 1) by co-digestion with anaerobic mixed cultures of an Expanded granular sludge bed (EGSB) from a bakery factory. The ratio of co-digestion between ensiled Napier grass feedstock and inoculum (F/I ratio) was 1:1 and 1:3 based on volatile solids (VS). The potential of methane production was evaluated using a batch experiment for 30 days in the laboratory at room temperature (32–35 ± 5ºC). To enhance the biogas production, alkaline pre-treatment of Napier grass by adding 1% NaOH was provided in this study. The results demonstrated that the methane production potential of the F/I ratio at 1:1 and 1:3 was at 146.83 ± 39 and 100.67 ± 69 mL $CH_4$/g COD, respectively. The maximum energy production based on methane production is approximately 9.17 kJ/L. The rage of pH was 6.96 ± 0.2 to 9.93 ± 0.2 and the percentage of SS, TS, and COD removal were 60.10, 24.69 and 48.63, respectively. The results of this study indicated that the feedstock and inoculum ratio (F/I), including pretreatment of feedstock and inoculum, is necessary for biogas potential production. The potential biogas production of the CSTR reactor and its economic feasibility should be further considered.

**Keywords:** bioenergy, methane production, Napier grass, commercial bakery wastewater

**EM-15-19**

# Evaluation of Soil Micronutrient Status Across Selected Land Use Types in Chembe Enclaved Village of Lake Malawi National Park

**Placid MPEKETULA[a], Dickson MAZIBUKO[ab], Sarvesh MASKEY[c], Hiroko GONO[d], and Hiromu OKAZAWA[c]***

*[a]School of Natural and Applied Sciences, University of Malawi, Malawi*
*[b]Graduate School of Agro-Environmental Science, Tokyo University of Agriculture, Japan*
*[c] Faculty of Regional Environmental Science, Tokyo University of Agriculture, Japan*
*[d]Faculty of International Agriculture and Food Studies, Tokyo University of Agriculture, Japan*
**Corresponding email: h1okazaw@nodai.ac.jp*

## Abstract

Management of soil micronutrients is vital for better crop production and ecosystem functionality. Better understanding of soil micronutrient status and variability is needed for productive and sustainable ecosystem health. This is relevant for soils of "Chembe" enclaved village which located within Lake Malawi National Park (LMNP), a world heritage site. The aim of this study was to obtain micronutrient baseline data for soils across various land use types and provide benchmark studies for long term monitoring and management. We measured the concentration of a panel of micronutrients in soils using Atomic Absorption Spectrometry (AAS) after acid block digestion with a mixture of concentrated nitric acid (70% $HNO_3$) and Hydrogen peroxide (30% $H_2O_2$). Measured micronutrients included zinc (Zn), manganese (Mn), copper (Cu), iron (Fe) and selenium (Se) from soil samples obtained from five different land use types of namely community garden, maize farm, dambo wetland, bare land and forest land at 0-5 cm and 5 -20 cm depths. Results indicated that land use type as well as soil depth were important factors. Mean soil Zn and Mn were significantly high in community garden (1.51, 663 mg/kg respectively) in the topsoils compared to the rest of the land use types ($p$<0.0001). On the other hand, topsoils from the forest had significantly high levels of Cu and Iron (3.7, 329 mg/kg respectively, $p$<0.001). The maize farm had the highest concentrations of Se (0.28 mg/kg) while the dambo wetland and the community garden had the lowest levels (0.01 mg/ kg). These finding suggest that micronutrient deficiency in soils of Chembe is tightly linked to such factors such as land use type and further research is warranted to investigate the impacts of the changes with respect to crop and plant productivity and other broader ecosystem wide implications in the enclaved village of LMNP.

**Keywords:** micronutrient, crop production, ecosystem, soil management, land use

**EM-15-20**

# Soil Carbon Sequestration and Soil Chemical Properties in Different Land Uses in Northeast Thailand

**Saharatkarin NAMSE[a], Chuleemas Boonthai IWAI[ab]*, and Thammared CHUASAVATHI[a]**

*[a]Department of Soil Sciences and Environment, Faculty of Agriculture, Khon Kaen University, Thailand*
*[b]Integrated Land and Water Resource Management Research and Development Center in Northeast Thailand, Khon Kaen University, Thailand*
**Corresponding email: chuleemas1@gmail.com*

**Abstract**
The problem of global warming is a big concern. Climate change affects human life and environmental, economic, and social problems. Agricultural land use is an activity that releases a large amount of carbon dioxide (CO2) that causes global warming. However, soil is also an important reservoir of carbon. Soil organic carbon (SOC) is an important component regulating soil fertility and crop productivity, as well as the global carbon cycle. This research was carried out in Ban Hua Bueng Traimoon Subdistric, located in northeastern Thailand. The objective of this study was to investigate the effects of different land-use and soil management practices on Soil carbon sequestration and soil chemical properties. Different land uses (paddy field, forest, organic cassava, chemical cassava and sugar cane) were studied in 2023. The results showed that the percentage of nitrogen (N) was found to be highest in paddy fields, followed by forest, organic cassava, chemical cassava, and sugar cane, have nitrogen (N) percentages from highest to lowest, respectively. Phosphorus (P) content was found to be highest in sugarcane, forest, rice, organic cassava, and chemical cassava, respectively. The exchangeable potassium (K) was found to be highest in the paddy field, followed by sugarcane, forest, chemical cassava, and organic cassava has exchangeable potassium (K) from highest to lowest, respectively. The pH and EC values in the forest are the highest. Plant nutrient management in agricultural areas involves the use of chemical fertilizers, which causes the pH value to decrease. In the forest, there is a lot of organic matter. And it is close to natural spring water that contains minerals, causing it to have a high EC value. The amount of soil organic matter and soil carbon sequestration was found highest in paddy field followed by forest, organic cassava, chemical cassava and sugarcane, respectively.

**Keywords:** land use, carbon storage in soil, economic crops, climate change

**EM-15-22**

# Effect of Tannery Sludge on Plant Germination

**Yoseph Junedi Nuwa Dhuge POA[a] and Chuleemas Boonthai IWAI[ab]***

*[a]Department of Soil Sciences and Environment, Faculty of Agriculture, Khon Kaen University, Thailand*
*[b]Integrated Land and Water Resource Management Research and Development Center in Northeast Thailand, Khon Kaen University, Thailand*
**Corresponding e-mail: chuleemas1@gmail.com*

**Abstract**
Tannery sludge has a main role as a contaminant in environmental problems. The consequences affected crops and the ground. Considering the negative impact of tannery waste, this research observes the effect of sludge from leather industry by germination test. Using common plants, *Brassica rapa* and *Triticum aestivum*, this experiment was set up under the conditions: soil and tannery sludge, combination soil, biochar and tannery sludge, soil mix biochar, also soil without addition material for the control. All are potted in plastic boxes with three replications for each treatment. Germination tests utilize 50 seeds in every pot, 60% of soil moisture, 27-30°C of temperature during 10 days of observation. Result in qualitative parameters informed *Triticum aestivum* in control pot and soil biochar mix had the potential to growth quickly moreover plants condition going well except in the tanneries-soil combined. *Brassica rapa* comes after just three days of monitoring although circumstances of the plants not in virtuous state, the stem not that solid also the leaves not in peak shape. Applied by Completely Randomized Design (CRD) with Analysis of Variance (ANOVA) for presentation of seed germination shows growth of *Brassica rapa* and *Triticum aestivum* significantly controlled by the soil combination for *Brassica rapa* soil treatment had a promising result however other mixtures related in same condition. In other hand *Triticum aestivum* present different effect. Composite of soil with biochar also soil, biochar and tannery sludge had fine outcomes. Thus, this analysis revealed that tannery sludge had a negative effect during germination process for plants.

**Keywords:** Chromium, germination, plant, soil, tannery sludge

**EM-15-26**

# Comparison of Macroinvertebrate Assemblages between Mountain Strem Constructions and Natural Streams

**Tetsuya SHIMAMURA[a]*, Ryosuke TSUJI[a], Masaki HAMAGUCHI[a], Kyosuke INO[a], and Eri NABESHIMA[a]**

*[a]Ehime University, Japan*
**Corresponding email: simamura@agr.ehime-u.ac.jp*

**Abstract**

Artificial river constructions, such as erosion control dams, are prevalent in many mountain streams in Japan, leading to a simplification of the river structure through channel straightening and narrowing. This alteration results in reduced habitat heterogeneity, causing severe degradation of the environment for living organisms. Consequently, biodiversity in these areas is significantly diminished. On the other hand, these artificial constructions、such as erosion control dams, have the potential to create an environment resembling stagnant water by smoothing the gradient, thus providing a habitat distinct from the natural streams. To evaluate the effect of the presence of artificial constructions on macroinvertebrate assemblages, we conducted research in the Ehime University Forest, Takanawa Peninsula, Ehime Prefecture, Japan, between April and June and October and November 2022.

Sampling was conducted at various sites, including natural streams, erosion control dams, culverts, and ditches. Using a 30 cm square frame, we collected benthic organisms from each site. Our findings revealed 1119 macroinvertebrates, with 756 and 363 individuals from natural streams and artificial structures, respectively. Of the 49 taxa identified, 26 were found in both artificial constructions and natural streams. Nine and 13 taxa were exclusive to artificial constructions and natural streams, respectively. Shannon's diversity index was 4.12 and 3.95 in natural streams and artificial structures, resulting in an overall diversity index of 4.30. Notably, lentic Dytiscoidea and Notonectidae were more abundant in the sediment basin of the erosion control dam than in natural streams. Additionally, the erosion control dam wall exhibited a higher abundance of specific Trichoptera and Ephemeroptera taxa. These findings suggest that artificial constructions in mountain streams provide habitats for macroinvertebrates that are less abundant in natural streams, emphasizing the ecological impact of river modifications.

**Keywords:** benthic assemblage, mountain stream, erosion control dam

**EM-15-27**

# Evaluation of the Effect of Wood Chips and Green Manure as an Amendment for Improvement of Soil Physical Characteristics

**Takanori KANEKO[a]*, Yuka OGUMA[b], and Tomonori FUJIKAWA[b]**

*[a]Department to Bioproduction and Environment Engineering Faculty of Regional Environment Science, Tokyo University of Agriculture, Japan*
*[b]Department to Regional Regeneration Science Faculty of Regional Environment Science, Tokyo University of Agriculture, Japan*
**Corresponding email: taka1504kaneko@gmail.com*

**Abstract**
Japan food self-sufficiency rate is under the average compared to other developed countries. To overcome this issue, it is necessary to sustainably improve paddy fields, increase the utilization of arable land, and increase the production of wheat and soybeans. Japanese institutions put significant efforts to do so. Currently, there are several ways for agricultural improvements that are promoted. These methods include underdrainage, compost, and green manure. Underdrainage is giving effective results; however, the installation takes a lot of finances. The effect of green manure and compost are less obvious in the short run, but more affordable for farmers and can significantly increase the organic matter in the soil. Therefore, this study explores the possibility of using wood chips as a soil amendment. Every year, forest management enterprises generate a large amount of thinned wood, however the utilization rate of this material is low. For the period from 2019 to 2021 only 35.9% of this biomass was utilized. This surplus of wood material can be used in agriculture purposes. Therefor the objective of this study is to clarify the effect of green manure and wood chips as soil improvement amendment. The experiment is designed to assess the influence of woodchips and two types of green manure in different combinations and quantities on the soil physical properties. The complete results will be presented in the full manuscript and conference presentation.

**Keywords:** wood chips, green manure, soil physical, land use conversion

**EM-15-32**

# Density Estimation of Deer Population Using Random Encounter Model (REM) at Oze Wetland in Japan

**Tadanobu OKUMURA[a]*, Kazuo Oki[bc], and Masayasu MAKI[d]**

*[a]Wildlife Management Office Inc, Japan*
*[b]Kyoto University of Advanced Science, Japan*
*[c]The University of Tokyo, Japan*
*[d]Fukusima Universiy, Japan*
**Corresponding email: okumura@wmo.co.jp*

**Abstract**

Ozegahara and Ozenuma are known as the largest marsh in Japan. Valuable plant communities grow in Oze, which was registered as a Ramsar Convention-listed wetland in 2005. The value of the natural environment and vegetation is widely recognised by the public, with many tourists visiting the area during the peak flowering period of marshland plants from May to July. On the other hand, since the mid-1990s, deer have been observed in the area and the impact of deer on the natural vegetation has become apparent.

Until now, the main indicator of the deer population in the Oze has been the change in the number of sightings from light census surveys, but this is strongly influenced by weather conditions and deer movements, which can lead to large observation errors in the data. Therefore, the density of the deer population was estimated using the random encounter model (REM), which estimates the number of individuals based on the frequency of automatic camera shots and movement speeds obtained from GPS collars.

Male individuals were captured using an anaesthetic gun in order to fit them with GPS collars; the GPS collars were equipped with an iridium communication function, which regularly transmitted positional information once an hour. For the automatic camera survey, 33 cameras were installed in the survey area and set to take three still images when an animal responded to the sensor, followed by 20 seconds of video.

The survey showed that the population density was 18.29 animals/km$^2$ in 2017, 8.53 animals/km$^2$ in 2018 and 19.44 animals/km$^2$ in 2019, with a lower density only in 2018. As the area of the study area was 2.66 km, the estimated number of animals within the study area was 48.69 animals/km$^2$ in 2017, 22.71 animals/km2 in 2018 and 51.75 animals/km$^2$ in 2019.

**Keywords:** density estimation, camera trap, GPS collar, deer population, random encounter model

**EM-15-33**

# Detecting the Impact of Water Resource Development on Flow Regime in the Mekong River Basin

**Takumi SHIMURA[a]* and Taichi TEBAKARI[a]****

*[a]Chuo University, Japan*
**Corresponding email: a18.wemj@g.chuo-u.ac.jp*
***Corresponding email: ttebakari896@g.chuo-u.ac.jp*

**Abstract**

In recent years, dam reservoir operations and construction in the upper reaches of the Mekong River Basin have caused changes in river flow regimes, which are feared to adversely affect agriculture and fisheries in the lower reaches. However, due to a lack of hydrological data and information on dam reservoirs in the entire basin, it is not clear whether dam reservoirs actually affect the river flow regime. In this study, in order to scientifically clarify the impact of dam reservoir operation and construction on the river flow regime in the upstream area, numerical experiments are conducted to reproduce the river flow regime without the impact of dam reservoir operation and construction, and the impact of dam reservoir operation are evaluated by comparing the current flow regime and the experimentally reproduced flow regime. In the numerical experiments, analytical flow rates are calculated for nine hydrological stations on the Mekong River using the RRI model. Since the first dam constructed on the Mekong River was the Manwan Dam in China in 1993, the model parameters is optimized using the observed flows prior to 1992 as the flow regime without the influence of reservoir operation and construction. The SCE-UA method is used as the parameter optimization method for the observed flows provided by the MRC. Since observed rainfall data prior to 1992 are not available, ensemble calculations are performed using precipitation products (APHRDITE, CHARPS, GPCC, and PERSIANN). The analytical flows without the effects of dam reservoir operation and construction calculated by ensemble calculations are compared with the observed flows in the top 25%, 50%, 75%, and 95% of flows per year, respectively, and evaluated.

**Keywords:** reservoir, water resource development, RRI model, the Mekong River basin

**EM-15-35**

# Evaluating the Performance of Managed Aquifer Recharge for Sustainable Shallow Groundwater Resources in Prachinburi Province, Thailand.

**Kewaree PHOLKERN[ab]*, Phayom SARAPHIROM[ac], Thanyaporn PROMMARACH[a], Rattaweep AKSORNKLANG[a], and Arunya LUEPRADIT[d]**

*[a]Groundwater Resources Institute, Khon Kaen University, Khon Kaen 40002, Thailand*
*[b]Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand*
*Faculty of Engineering, Khon Kaen University, Khon Kaen 40002, Thailand*
*[d]T.C. Pharmaceutical Industries Company Limited, Bang Bon, Bangkok 10150, Thailand*
**Corresponding email: kewaph@kku.ac.th*

## Abstract

Groundwater was rapidly developed, especially for an agricultural subject in Prachinburi Province, Thailand, due to the shortage of surface water in droughts. The Managed Aquifer Recharge (MAR) is implemented to harvest excess water by storing it in the aquifer for later recovery during the dry season to sustain aquifer storage. Nontree sub-district of Kabinburi district, Prachinburi Province was selected to be the MAR demonstration area. The area's shallow aquifer is unconsolidated rocks consisting of sand and laterite with a thickness of about 5-20 m and groundwater level depth of about 3.5-12.5 m.bgs. The MAR systems have been constructed under the study of hydrogeological investigation, MAR suitability maps, and detailed designs. The instruments for assessing the volume of recharged water and groundwater level were installed in the area. The MAR impacted area on groundwater level and mounding or spreading areas was assessed by numerical groundwater modeling, namely Visual MODFLOW, and monitoring data. The 49 MAR systems of 4 methods, including recharge basin (37), percolation tank (4), dry well (2), and rooftop harvesting (6), were conducted from 2019-2022 for harvesting excess water in rainy season to store in shallow groundwater. The total groundwater recharged by the MAR system is about 2,894,945 $m^3$/yr. in 2022. The efficiency of each MAR method compared to its volume is about 5-25, 16-20, 250-300, and 10-50 times for recharge basin, percolation tank, dry well, and rooftop harvesting, respectively. The result shows that the spreading area of recharged water is about 3,431 rais or 5.49 $km^2$ in 2022 and groundwater level was increased with range 0.5-3.7 m (average 1.7 m.). Monitoring shallow groundwater levels shows the continuity increased compared to the same time of the year, which means that the MAR system would be the conjunctive water management measure for other water shortage areas.

**Keywords:** shallow aquifer, hydrogeology, groundwater modeling, groundwater recharge, rainwater harvesting, water for agriculture

**EM-15-42**

# Development of ICP-MS Methodology for the Direct Strontium Isotope Ratio Analysis in Water and Its Application in Water Resource Management

**Madeleine FARRELL[a]* and Tatiana KOMAROVA[a]**

*[a]Inorganic chemistry laboratory, Queensland Public Health and Scientific Services, Queensland Health, 39 Kessels Road, Coopers Plains 4108, Australia*
**Corresponding email: Madeleine.Farrell2@health.qld.gov.au*

## Abstract

Strontium is an element with four naturally occurring stable isotopes ($^{84}Sr$, $^{86}Sr$, $^{87}Sr$ and $^{88}Sr$) and is found in most rock, water, plants and animals. One of the isotopes ($^{87}Sr$) is the product of the radioactive decay of Rubidium ($^{87}Rb$), which means a system containing both Rb and Sr will have a specific radiogenic signature, or $^{87}Sr/^{86}Sr$ ratio. Strontium Isotope Ratio analysis is an established technique and is recognised as a powerful tool in provenance studies due to inherent variation of Strontium sources within a system. Most traditional methodologies require relatively large volumes of samples to perform a multi-stage chemical separation of Rb and Sr prior to analysis.

The vital challenge for the determination of $^{87}Sr/^{86}Sr$ isotope ratios by ICP-MS is overcoming the spectral overlap of $^{87}Sr^+$ and $^{87}Rb^+$ ions. It has been demonstrated that triple quadrupole ICP-MS (ICP-QQQ) can resolve this issue by utilizing reaction gases inline to form a product ion with the target analyte, therefore, mass shifting the analyte away from interferences for accurate measurements. The use of an online chemical separation technique allows for precise determination of Strontium Isotope ratios without need for complicated pre-separation and risk of sample contamination.

The technique can be utilized in the analysis of water samples for the development of strontium environmental tracer maps, facilitating assessment of water resource management by describing aquatic species movement in relation to key environmental flow strategies. Access to Strontium Isotope ratio analysis routinely would allow a library of data across water catchments to be built upon and be beneficial for environmental monitoring.

**Keywords:** Strontium Isotope ratios, water, triple quadrupole ICP-MS, environmental management

**EM-15-45**

# Characteristics of Wastewater from Some Pig Farms in Laos

**Kengkham SANDKHAMLUE[a] and Santi KONGMANY[a]***

*[a]Center of Excellence in Environment, National University of Laos, Lao PDR*
**Corresponding email: s.kongmnay@nuol.edu.la*

**Abstract**

Pork is an important protein sources of Laotian leading to large expansion of pig farms nationwide in the Lao PDR. Most of pig farms are small and medium size ones contracted and controlled in all aspects by companies. However, it was found that most pig farms are equipped with 4 wastewater collecting ponds, and the wastewater is usually left naturally for solid-liquid separation. The untreated pig farm wastewater is known to be very polluted, and it would create a great concern to society and environment deterioration if it is naturally or accidentally discharged into environment. Therefore, the investigation of pig farm wastewater should not be overlooked, and to our knowledge, this study on characterization of pig farm wastewater in Laos is missing, leading to the objective of this study. In this initiative research, wastewater samples from the selected ponds (first and last pond) of 10 pig farms in Xaythany district of Vientiane Capital of Laos were collected and analyzed for pH, EC, COD, BOD, TDS, TSS, Cations, Anions, E. coli coliform, total coliform and antibiotics residue. The experimental results showed that the wastewater from the first pond was highly polluted by indication of measured BOD, COD, TSS, and $NH_4$ values. The residue of antibiotics such as amoxicillin, streptomycin, gentamycin, oxytetracycline, enrofloxacin, penicillin G were also detected in the wastewater. The water quality in the last pond was slightly better but it could still not be discharged into the outside environment. The detailed research finding results will be presented at the conference.

**Keywords:** pig farms, wastewater characteristics, Xaythany district, Vientiane capital, Laos

**EM-15-48**

# Urban Green Development in Siem Reap Town, Siem Reap Province: Case Study on Public Space

**Sokhieng CHEE[a], Yin Chan ENG[b], Sophak POK[a], Thapkonin CHHOENGSAN[a], and Sanara HOR[a]***

*[a]Faculty of Land Management and Land Administration, Royal University of Agriculture, Phnom Penh, Cambodia*
*[b]Graduate School of Environmental Engineering, Macquarie University, Australia*
**Corresponding email: hsanara@rua.edu.kh*

**Abstract**
Siem Reap holds the status of being the central area of the National Development Pole. This region is renowned for its remarkable collection of ancient temples, most notably the internationally recognized Angkor Wat, a UNESCO world heritage site. It stands as a destination of great cultural, historical, and natural significance, attracting a substantial influx of both domestic and international tourists. Urban Green Development is considered the key success for attracting tourists to historical regions but when urban expansion occurred Urban Green did not expand together. Thus, this study seeks to contribute to sustainable urban and community development by addressing crucial aspects related to establishing and upholding green spaces within the city. The study has three primary objectives: to explore the feasibility of introducing more public and green spaces in Siem Reap Town, to identify challenges hindering the creation of green spaces in specific communities within the town, and to comprehend public perceptions and common attitudes toward the creation and preservation of green spaces. Addressing the stated objectives, this study anticipates that its outcomes will effectively align with the designated research goals and inquiries. The projected findings or research hypotheses are as follows: Holistic comprehension among the public in creating and conducting studies on urban development through observations and related regulations. The study used both in-depth interviews and semi-structured questions to gather information. Descriptive statistics is adopted and both qualitative and quantitative information were integrated to conclude. Defining the recurring issues affecting the development of urban areas based on a select number of communes within Siem Reap and specifying the underlying land constraints are crucial in the formulation of urban development plans. Understanding the ability to create public infrastructure or additional facilities within Siem Reap city through each commune located in localities and urban outskirts.

**Keywords:** urban green, green infrastructure, public space, local people, Siem Reap, Cambodia

**ESD-15-04**

# Effectiveness of Hygiene Educational Training for Pre-school Students in Phnom Penh, Cambodia

**Sophorlkun YIM[a], Salyta CHAMRUEN[a], Phanna LY[c], Rathna HOR[c], Sunduk CHO[a], and Eunjin KANG[b]***

*[a]Department of Food and Nutrition, Duksung Women's University, Seoul, Republic of South Korea.*
*[b]Duksung Global Education ODA Development Cooperation Center, Duksung Women's University, Seoul, Republic of South Korea.*
*[c]Department of Food and Nutrition, Faculty of Agro-industry, Royal University of Agriculture, Phnom Penh, Cambodia.*
**Corresponding email: silverrat71@hanmail.net*

**Abstract**
Most germs that cause serious infections in humans are transmitted by people's actions. The act of washing hands with soap, one among the best defenses against COVID-19, has long been known to be crucial in preventing many diseases. In this research, a survey of awareness was conducted aimed to understand the current situation of preschool student awareness regarding hygiene. Additionally, hygiene educational training is also provided to the kids to help them improve on their daily hygiene practices including hand wash and teeth cleaning. The research was conducted from November 2022 until March 2023. Per an awareness survey from 180 preschool students who joined the training, the result showed that the daily practice of hand wash and teeth cleaning of the student changed into a better way after the training. This showed a fruitful result that the effectiveness of the training can help the students improve on their daily hygiene practices.

**Keywords:** hygiene, hand wash, teeth cleaning, survey of awareness, preschool student

**ESD-15-07**

# Organic Farmers Adopt Bio-Circular-Green Economy (BCG) in Agriculture for Food Safety and Environmental Sustainability

**Jiraphon CHOEICHIT[a]*, Waraphon WONGSIRIWAN[a], and Chuleemas Boonthai IWAI[b]***

*[a]Office of Agriculture research and Development Region3, 180 Moo 27 Mueang district, Khon Kaen, 40000, Thailand. Email:*
*[b]Khon Kaen University, Division of Land Resources and Environment, Faculty of Agriculture, Khon Kaen, 40002, Thailand.*
**Corresponding Email: chuleemas1@gmail.com; Jiraphonchoei@gmail.com*

## Abstract

Thai Agricultural Standard (TAS) applies to be used as a reference for agricultural commodity and food producers to advantages of food safety improvement, trade benefits and consumer's health protection. Thai agricultural standard (TAS) in the upper northeast region of Thailand. In 2023, it was found that there were 196 farms in an area of 173.89 and 142.28 hectare in organic and integrated agricultural farming systems, respectively. There were fruit 18.73-hectare, vegetable 6.09-hectare, mushroom 0.27-hectare and herb 0.64-hectare. It is considered to be a small amount compared to agricultural areas in the upper northeast. The main problems were 1) unable to find organic agriculture inputs and 2) planting area was located in the contaminated environment.

The objective of this study was 1) to reduce external production factors from outside the farm with agricultural waste management methods adopt bio circular and green (BCG) economic. 2) to study the opportunity for the transfer of organic agriculture knowledge. This study employed both qualitative and quantitative methods consisting of farmers interviewing, small group discussion and field observation. The data were collected from 10 organic farmers.

The results showed that farmers were able to reduce the cost of external production factor from aspects: 1) self-collection and exchanging seeds and planting materials within and between communities and improving soil agricultural waste management (vegetable waste, rice straw waste, and wood waste) by incorporating rice straw, adding compost animal manure. Vegetable waste management by vermicomposting as substances for use in soil fertilizing and conditioning. And sawdust, bark and wood waste management by Bio char is using charcoal burning a smokeless kiln to prevent carbon dioxide emissions into the atmosphere and used to improve soil quality and store nutrients for vegetables. 2) It was also found that there were clear systems of technology transfer. This resulted in a reduction of agricultural waste and zero waste. It also reduces the import of external production factors, reduces production costs, and maintains sufficient production factors throughout the year. It improves the environmental ecological balance within the farm, as well as increased sustainable agriculture.

**Keywords:** BCG model, agricultural waste, Thai Agricultural Standard, organic agriculture

**ESD-15-08**

# The Characteristics of Young Smart Farmer in Agricultural Development of Northeast Thailand

**Supaporn POUNGCHOMPU[a]*, Supawadee CHANTANOP[a], and Keattichai MONTREEWONG[a]**

*[a]Department of Agricultural Economic, Khon Kaen University, Thailand*
**Corresponding email: psuppap@kku.ac.th*

**Abstract**

Thailand's agricultural sector plays a very important role in the country's economic development. But agricultural workers are tending to enter an aging society that reflects less sustainable development in the agricultural sector. As a result, the Ministry of Agriculture and Cooperatives has established a policy to promote and develop new generations of farmers to become Young Smart farmers. Young smart farmers mostly inherit their agricultural production from their parents in large farming areas. Many young smart farmers in the Thailand 4.0 era have graduated at a high level either Master's or Ph.D. and come from many professions such as engineers, architects, civil servants, and factory owners, etc.; leading that the products are of high standard quality and generate income for farmers. Most farmers become young farmers directly through the Department of Agricultural Extension. accounting for 60.83 percent, followed by district agriculture and provincial agriculture under the Department of Agricultural Extension with 22.50 percent. The main reason for joining the project is to access marketing channels from exchanging products between networks of young farmers, accounting for 31.67 percent, followed by that some farmers want to be leaders in agricultural development in the community. equal to 5.83 percent.

**Keywords**: young smart farmer, agricultural development, agricultural sector

**ESD-15-09**

# Determinants of Reluctance: An In-depth Analysis of Factors Influencing Cold Water Fish Farmers' Unwillingness to Adopt Agricultural Product Insurance in Guilan Province in Iran

**Mohammadali GHAZI[a], Mohammad S. ALLAHYARI[a], Sinisa BERJAN[b]*, and Tarek Ben HASSAN[c]**

*[a]Agricultural and Rural Development and Economy Research Center, Rasht Branch, Islamic Azad University, Rasht, Iran*
*[b]Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina*
*[c]Program of Policy, Planning, and Development, Department of International Affairs, College of Arts and Sciences, Qatar University, Doha, Qatar*
**Corresponding email: sinisa.berjan@ues.rs.ba*

**Abstract**

Agricultural product insurance is designed to mitigate crop production risks by providing compensation to farmers and operators in the agricultural sector in the event of crop failure or risk. The reliance on continuous production heightens their susceptibility to risks, resulting in fluctuations in production and income. Given that product insurance is an effective risk management tool, this study explores the factors influencing the reluctance of cold-water fish farmers in Guilan province to engage with the services offered by the Agricultural Insurance Fund. The research employed a researcher-developed questionnaire to examine individual and demographic characteristics, as well as factors contributing to the non-acceptance of insurance. To ascertain the questionnaire's validity and reliability, experts were consulted, and its reliability was confirmed with a Cronbach's alpha of 0.962. Descriptive statistical methods were utilized to analyze primary data obtained from 120 cold water fish breeders in Guilan province, comprising the available sample. Among the participants, 64.8% expressed unwillingness to use product insurance in the following year. The results highlighted that the primary factor influencing this reluctance was the uncertainty regarding the payment of compensation. Additionally, lack of awareness about the possibility of splitting the insurance premium, the extended time interval from damage occurrence to compensation payment, and stringent rules governing compensation disbursement further contributed to the apprehension among cold water fish breeders. The exploratory factor analysis distilled the factors influencing insurance acceptance into five key factors, collectively explaining 66.46% of the variance in the unwillingness to utilize the services provided by the Agricultural Products Insurance Fund.

**Keywords:** insurance of agricultural products, cold water fish breeders, acceptance

**RD-15-03**

# Dispersion Approach to Make Matrix of Nanocellulose-Reinforced Polylactic Acid Biocomposites for Food Packaging Materials

**Yut SOVANNDY[a]*, Dyna THENG[a], Chim CHAY[b], Mouylin CHEM[c], CHHENGVEN CHHOEM[a], and Marc DELGADO-AGUILAR[d]**

*[a]Faculty of Agricultural Engineering, Royal University of Agriculture, Phnom Penh 12401, Cambodia*
*[b]Department of Agro-Industry-MAFF, Phnom Penh 12401, Cambodia*
*[c]Faculty of Agro-Industry, Royal University of Agriculture, Phnom Penh 12401, Cambodia*
*Faculty of Agricultural Engineering & Faculty, Royal University of Agriculture, Phnom Penh 12401, Cambodia*
*[d]University of Girona Department of Chemical and Agricultural Engineering and Agricultural Technologies Chemical Engineer*
**Corresponding Email: sovanndyyut19@mail.com*

**Abstract**
The use of nanocellulose, both in the form of cellulose nanofibers (CNF) and cellulose nanocrystals (CNC), as reinforcement of polylactic acid (PLA) has been an interesting topic during the last decade. However, the inclusion of CNF is still a challenge, particularly for the presence of water, the lack of appropriate dispersion methodologies and the low affinity between cellulose and PLA. The study aimed to assess how nanocellulose-based bio composites behave at their end of life and to determine the feasibility of incorporating high dosages of CNF into a thermoplastic starch matrix (TPS). Materials used in this study included commercial bleached eucalyptus pulp (BEP), mechanical CNF, enzymatical CNF, polyethylene glycol 400 (PEG), Mater-Bi (PTB), and polylactic acid (PLA). 15 treatments were designed with CNF addition (2% - 10%) and blended matrix of PEG and PTB (2% - 6%) on the PLA. The end-life nanofiber aimed to check the characteristics of fiber using high-pressure homogenizer (GEA Niro Soavi, Italy) at 900 bars in 3 cycles. The results show that the consistency of CNF mechanical was 0.725 % and CNF enzymatic was 0.875 %. The yield of mechanical and enzymatic CNF was 52.51 % and 58.7 %, respectively. The transmittance percentage of CNF mechanical and CNF enzymatical were 19.9%, 16.4%, respectively, at 600 nm wavelength. The Carboxyl content (-COOH) received the same value (42 µeq g/g). The masterbatch dispersed with CNF enzymatic at 2% obtained the highest tensile strength at 44 MPa, followed by CNFenzymatic 4%, CNF mechanic 2%, and 4%. In terms of melt flow, the enzymatical CNF masterbatches (2% - 10%) were 38 g/10 mins – 8 g/10 mins, respectively, while the CNF mechanic and blended masterbatches ranged from 30 to 60 g/10 mins. Therefore, the mechanical properties of film made from masterbatch dispersed with 2% CNF enzyme provided a good result.

**Keywords:** nanocellulose fibers, composites, biodegradable, film, polylactic acid

**RD-15-09**

# Development Directions and Challenges of Climate Change Measures in Paddy Agriculture in South-Eastern Asia

**Hiromichi KITADA[a], Taro IZUMI[b], Sarvesh MASKEY[c], and Hiromu OKAZAWA[c]***

*[a]Japan International Cooperation Agency, Japan*
*[b]Japan International Research Center for Agricultural Sciences, Japan*
*[c]Tokyo University of Agriculture, Japan*
**Corresponding email: h1okazaw@nodai.ac.jp*

## Abstract

The world's population is growing rapidly. Ensuring global food security is becoming increasingly urgent. Especially in Southeast Asia, where paddy farming is the main source of water consumption, it is essential to improve agricultural productivity to meet food demand, but climate change poses several challenges to water use in rice production. Adapting to changes caused by climate change while maintaining food security is difficult, and inter-state conflicts, together with energy and value chain issues, complicate food issues. There are synergies and trade-offs between agriculture and climate change: with the world population expected to exceed 9 billion by 2050, rice consumption is expected to increase significantly. Paddy farming is essential to meet demand in Southeast Asian countries where rice is the staple food, but its expansion can cause environmental problems due to methane emissions from paddy fields and the large amounts of water required for cultivation, additionally, it can exacerbate water scarcity in some regions due to competition for water with other sectors. This study focuses on synergies and trade-offs related to improving paddy farming in Southeast Asia. Improving rice production requires adaptation to climate change (drought and flooding), availability of water resources, fertilizer management, and smarter labor, and synergies among these items can increase productivity. On the other hand, these items also involve numerous trade-offs, such as increased greenhouse gas emissions ($N_2$, $CH_4$) and labor. Therefore, we reviewed the literature on the relationship between these synergies and trade-offs to examine how sustainable rice production should be. The results indicate that considering the effects of natural disasters that may occur in various regions of Southeast Asia, such as droughts and floods, in conventional water use is necessary to maintain a favorable balance between synergies and trade-offs in promoting appropriate water use in paddy fields in the future.

**Keywords:** synergies, trade-offs, climate change, water management

**RD-15-11**

# Changes of Local Government Expectations for Local Vitalization Cooperators in Japan

**Tomoyuki OHASHI[a], Yoshiki KUWABARA[a]*, and Masahide HAYASHI[a]**

*[a]Yamagata University, Japan*
**Corresponding email: kuwayoshi@tds1.tr.yamagata-u.ac.jp*

**Abstract**

This study aims to elucidate the expectations of local governments for Local Vitalization Cooperators (LVC), a rural regeneration supporters project in Japan. LVC was established by the Ministry of Public Management in FY 2009 and required to prevent mismatches in expectations between local governments and the cooperators during the recruitment phase. The research methodology involved collecting 5443 pieces of recruitment information, which 1086 local governments recruited from FY 2009 to 2024, from a portal site where LVC's recruitment information is posted. Subsequently, we categorized the activities described in the recruitment information, created an activity database, and analyzed the annual changes in activities. Additionally, we used a cluster analysis to classify activity combinations and analyzed their annual changes. The key findings are as follows: combinations were classified into 7 clusters. Cluster 1 expected a broad range of activities related to rural communities, while Clusters 2-7 predominantly expected public relations, migration support, agriculture, urban-rural interchanges, tourist facilities management, and others. Cluster 1 exhibited a decreasing trend, with its percentage dropping from 40% in 2009 to 16% in FY 2024. Conversely, Clusters 2 and 7 showed an increasing trend, reaching the highest percentages at 41% in FY 2024, despite being 20% and 0% in FY 2009, respectively. The decrease in local governments associated with Cluster 1 is attributed to the identified ambiguity in their expectations regarding a broad range of activities related to the rural community. In such local governments, a trial period is suggested to effectively align the community and cooperators. To enhance expectation clarity, an upswing was observed in local governments specifying narrow activities. In these local governments, it is crucial to avoid recruiting applicants lacking suitable skills for the expectations, even when the number of applicants is limited.

**Keywords:** local vitalization cooperators, mismatch, recruitment information, activities, cluster analysis

**RD-15-12**

# Implications of the Transition from Subsistence to Cash Crops on the Livelihood of Soliga Tribe in India

**Iman Raj CHONGTHAM[a]*, Sneha SHAHI[b], Madegowda CHIKKANANJEGOUDA[b], Obaiah BORAIAH[b], and Shrinivas M BADIGER[b]**

*[a]Department of Biosystems and Technology*
*Swedish University of Agricultural Sciences*
*P.O Box 190, 234 22 Lomma, Sweden*
*[b]Ashoka Trust for Research in Ecology and the Environment*
*P.O Royal Enclave, Srirampura, Jakkur, Bangalore – 560064, India*
**Corresponding email: raj.chongtham@slu.se*

## Abstract

Efforts are necessary for the protection and conservation of nature in many parts of the world. However, in most protected and reserved forest areas, local people have been living for centuries and they depend their livelihood on the surrounding environment for various services such as food, income, shelter and continuation of culture and traditions. Introducing new regulations in the pursuit of conservation goals often has implications on locals' way of living. The present study attempts to acquire knowledge about the challenges and opportunities for sustaining livelihood among farmers of Soliga tribe in Biligiri Ranganatha Swamy Temple (BRT) Tiger Reserve in South India. The workshop attended by five researchers and 25 heterogeneous farmers consisting of both male, female, young and old age participants discussed in a participatory approach about: a) management of current agricultural and livelihood practices; b) key drivers for changes in land-use, and c) possible needs and actions required to promote sustainable livelihood. Findings revealed that the shift from traditional farming based on growing a variety of subsistence crops to the current practice focused strongly on growing few cash crops such as coffee (*Coffea arabica*), pepper (*Piper nigrum*) and floriculture had reduced households' food availability and increased dependence of food from outside, but with higher family cash income. Alongside farming, non-timber forest products, *e.g*. honey, berries, nuts, firewood *etc*. contributed greatly to household income and needs, and access to them were crucial. Low coffee yield due to disease and low soil fertility, changing rainfall patterns, limited agricultural land area, and wildlife crop damage were important bio-physical challenges affecting agricultural productivity. There is a need for continued research and support to enhance farmer's knowledge and skills for sustainable farming techniques such as mulching, composting, intercropping, integrated pest management and effective control of *Lantana* spp for achieving sustainable and resilient farming systems.

**Keywords:** cash crop, conservation, anture reserve, livelihood, resilient, wildlife conflict

**RD-15-14**

# Determinants Influencing Technology Adoption among Vegetable Producers in Svay Rieng Province, Cambodia

**Hong CHHUN[a], Buntong BORARIN[b]*, Serey MARDY[a], Sao VIBOL[c], Chan BUNYETH[a], Tum SARAVUTH[a], and Chun NIMUL[a]**

*[a]Svay Rieng University, Cambodia*
*[b]Royal University of Agriculture, Cambodia*
*[c]Royal University of Phnom Penh, Cambodia*
**Corresponding email:* bborarin@rua.edu.kh

## Abstract

Efforts by extension workers to facilitate technology adoption among farmers are crucial. Document analysis reveals that vegetable producers adjust their production techniques based on the availability of technologies, influenced by two key determinants: External Force Factors (EFF) and Perceptual Force Factors (PFF) towards these technologies. Ten parameters were identified within EFF and eleven within PFF. This study aims to assess the impact of these factors on technology adoption levels among 302 vegetable growers who are members of agricultural cooperatives in Svay Rieng Province. Utilizing Linear Multiple Regression Modeling, this research identifies four significant EFF factors—water shortage, resource scarcity, market competition, and excessive water—and three key PFF factors—demonstration outcomes, anxiety, and perceived image. These seven factors collectively contribute to the predictive model with an R-value of 0.612, explaining 36% of the variance in adoption levels. The findings suggest that successful technology adoption is influenced by both external challenges faced by farmers and their positive perceptions towards these technologies. Effective extension strategies should be tailored to contextual realities and aim to present technologies in a compelling and favorable light.

**Keywords:** agricultural extension, farmer technology adoption, rural development

**RD-15-25**

# Evaluate the Local Livelihood of Upland Farmers in Northwestern Cambodia Through the Livelihood Asset Approach

**Dyna CHIN[abd], Hitoshi SHINJO[d], Soksan SENG[a], Sophak POK[a], Lyhour HIN[c], Nuch SEK[a], and Sanara HOR[a]***

*[a]Faculty of Land Management and Land Administration, Royal University of Agriculture, Phnom Penh, Cambodia*
*[b]Graduate School, Royal University of Agriculture, Phnom Penh, Cambodia*
*[c]Faculty of Agricultural Engineering, Royal University of Agriculture, Phnom Penh, Cambodia*
*[d]Laboratory of Soil Science, Graduate School of Agriculture, Kyoto University, Kyoto, Japan;*
**Corresponding author email: hsanara@rua.edu.kh*

## Abstract

Battambang province, the second-largest agricultural province with a population of approximately 1 million people, has become a hub for high agricultural productivity. The landscape, enriched with mountainous and floodplain environments, has witnessed a shift from subsistence agriculture to commercial farming. This transformation has made agriculture a cornerstone of the provincial economy. After the civil war, livelihood improvement has gained interest from various scholars. Many say that their livelihood depends on agriculture greatly and commercial agriculture plays the most significant for livelihood improvement. The previous finding describes livelihood trajectories related to livelihood evaluation which led to a series of questions that remain not addressed. The study seeks to improve an understanding of local livelihood among the different groups, shedding light on the dynamics of rural livelihoods in the region through evaluating local livelihoods by way of comparing livelihood capital across three groups of villagers (Old settlers, New settlers, and New generation of Old settlers and New settlers) in Dei Kraham (DK) and Ou Tuek Thla (OT) villages, Kamrieng district, with 123 interviewees. The village formation of the selected village has different characteristics, and the two villages were established after political integration. We adopted a structured questionnaire to gather in-situ information which is the study adopted measurement and monitoring livelihood capitals: natural, human, physical, financial, and social using weighting methods and non-parametric data analysis. SPSS was adopted for data mining and analysis. Livelihood improvement of the local people realized on land resources while formal education is paid less attention. Local people in DK village, the villagers acquired larger agricultural land (on average 5 ha/family) for commercial cropping compared to OT villagers. As a result, DK villagers could earn better profit for improving their livelihood assets, but formal education pays less attention to questing the future of their young generation.

**Keywords:** livelihood assets and measurement, commercial agriculture, livelihood improvement, Battambang Province, Cambodia