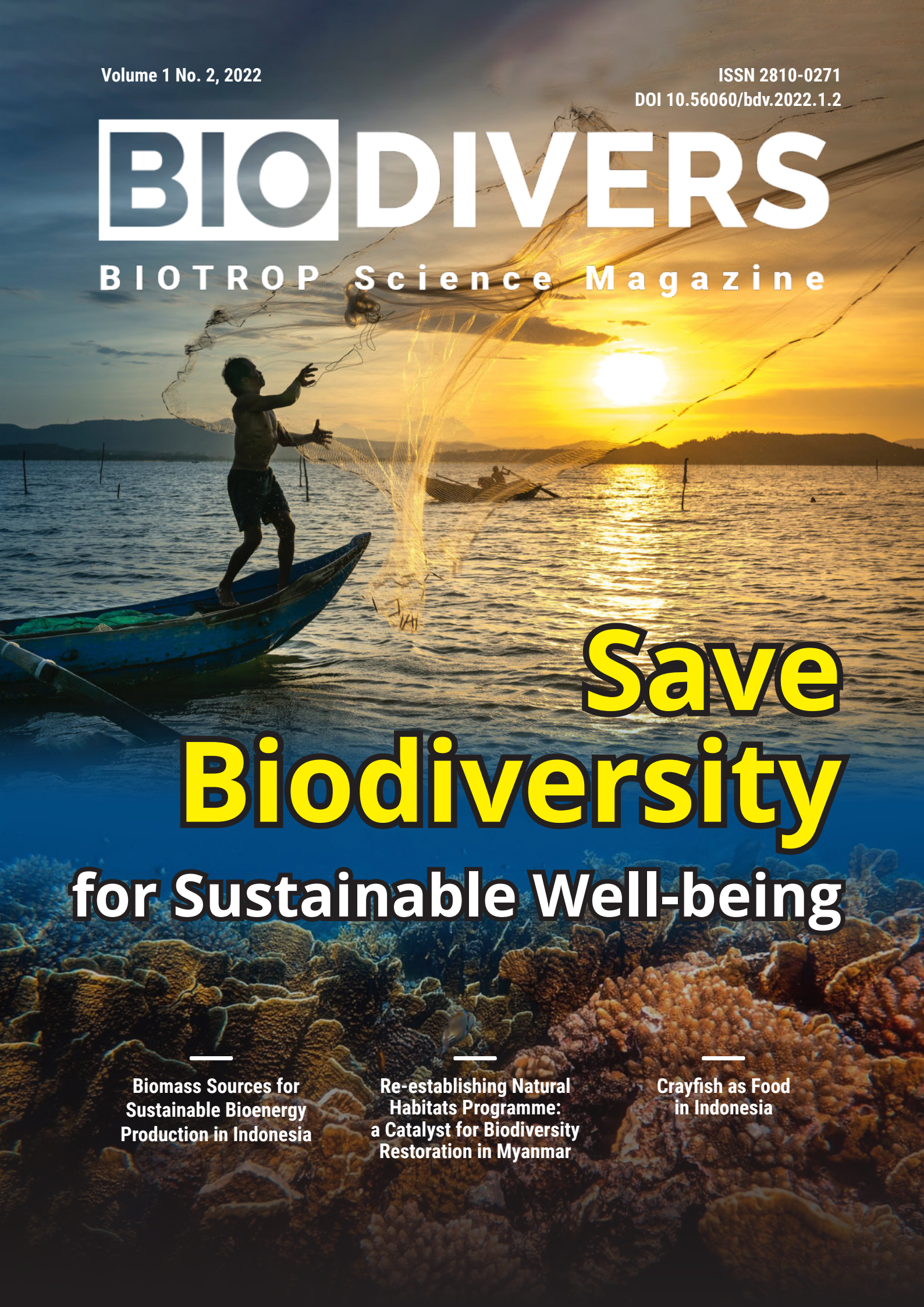
Volume 1 No. 2, 2022

ISSN 2810-0271
DOI 10.56060/bdv.2022.1.2

BIODIVERS

BIOTROP Science Magazine



Save Biodiversity for Sustainable Well-being

Biomass Sources for Sustainable Bioenergy Production in Indonesia

Re-establishing Natural Habitats Programme: a Catalyst for Biodiversity Restoration in Myanmar

Crayfish as Food in Indonesia

BIODIVERS
Vol. 1 No. 2, 2022

Source: Armaiki Yusmur

ISSN 2810-0271

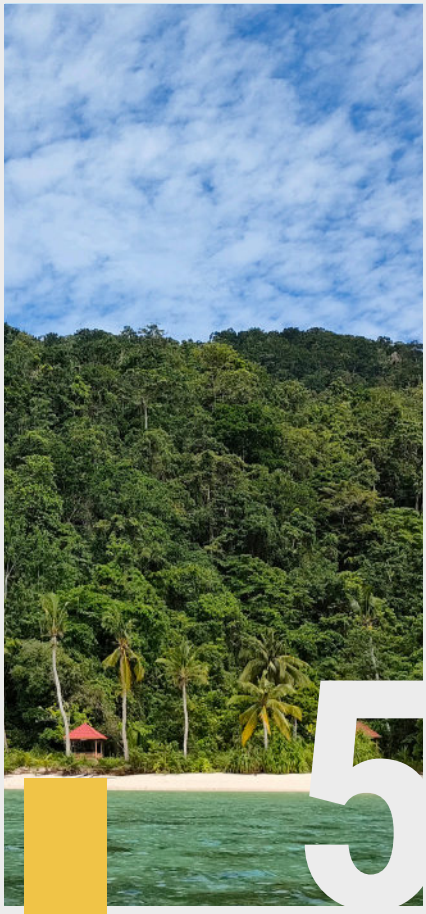
Published by:
SEAMEO BIOTROP (The Southeast Asian Regional Centre for Tropical Biology)

Cover photo taken from https://pixabay.com/, edited by Haritz Cahya Nugraha and Dani Yudi Trisna

All background photos are courtesy of Asep Saepudin, Armaiki Yusmur, Dani Yudi Trisna, Sri Widayanti, and Nijma Nurfadila (SEAMEO BIOTROP), Aditya Nugroho (IPB University), photo collection from SEAMEO BIOTROP Photo Competition Year 2015 and 2016 and other photos by mentioning their sources.

BIODIVERS Editorial Office
SEAMEO BIOTROP, Jalan Raya Tajur Km. 6, Bogor 16134
Email: biodivers@biotrop.seameo.id
Website: www.biotrop.org

Contents



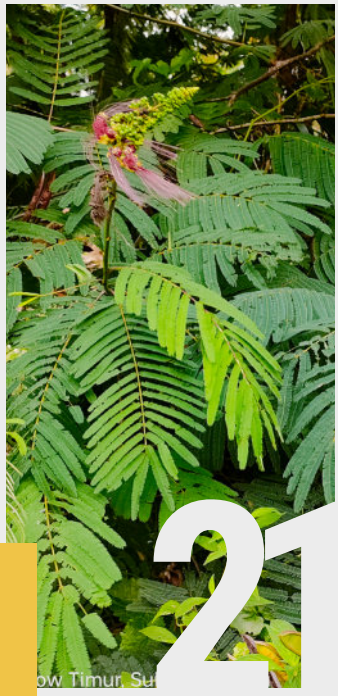
5 Overview
of BIODIVERS

9 Director's Message
Save Biodiversity for Human Well-being

11 Governing Board Member Message
Message of Commissioner Dr. Aldrin A. Darilag for the Launching of the Biodivers Collection

13 Editorial Remarks
Urgent Needs for Saving Biodiversity!

17 Interview with Ir. Laksmi Dhewanthi, M.A. IPU
Director General of Climate Change Control, Ministry of Environment and Forestry of the Republic of Indonesia



21 Biomass Sources for Sustainable Bioenergy Production in Indonesia

29 Effectivity of Signal Grass (*Brachiaria decumbens*) Enrich with Microorganism to Absorb Heavy Metals (Pb)

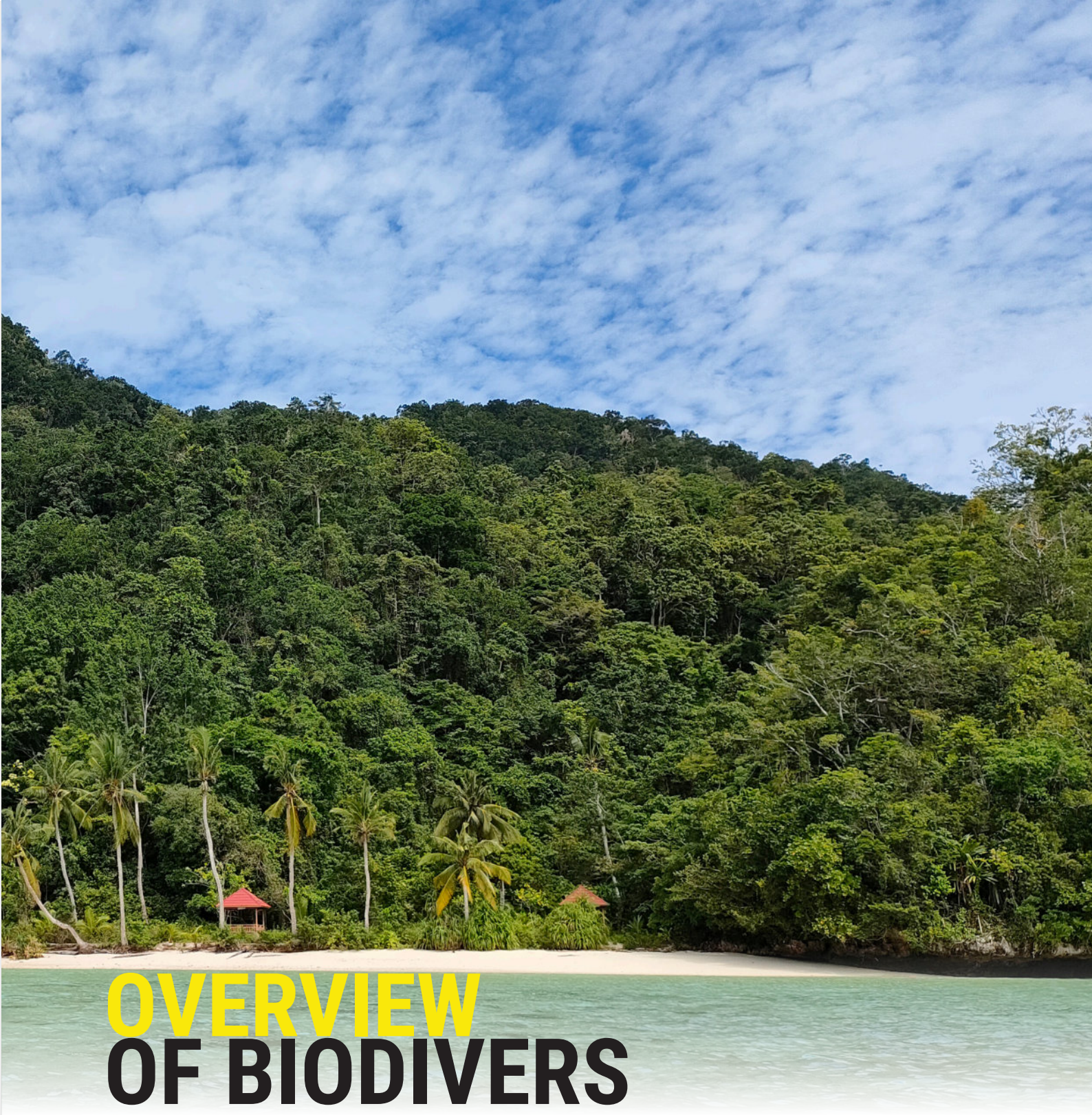
37 Re-establishing Natural Habitats Programme: a Catalyst for Biodiversity Restoration in Myanmar

45 Biotechnology for Tropical Plant Breeding in SEAMEO BIOTROP

53 The Role of Black Soldier Fly Larvae in Conserving Biodiversity

61 How Can We Get the Healthy Chocolate Products?

71 Crayfish as Food in Indonesia



OVERVIEW OF BIODIVERS

BIODIVERS is a bio-science general audience magazine launched in December 2021 by the Southeast Asian Ministers of Education Organization Regional Centre for Tropical Biology (SEAMEO BIOTROP). It is designed as a scientific publication to increase awareness on issues related to Tropical Biodiversity from the Mountain to the Ocean (MOTO) and increase biodiversity literacy.

BIODIVERS is a bi-annual publication that focuses on the Restoration and Conservation of Unique and Degraded Ecosystems, Sustainable of Management and Proper Utilization of Biodiversity, Bioenergy, Biotechnology to Support Food Security and on Strengthening Ecosystem Resilience in Facing Global Climate Change. This magazine also envisions becoming a popular-scientific magazine for promoting and publishing research findings of scientists from SEAMEO BIOTROP and overseas. The articles will come from writers worldwide.

SEAMEO BIOTROP

Southeast Asian Regional Centre for Tropical Biology

Vision

To become a reputable center for sustainable biodiversity management in Southeast Asia

Mission:

To deliver innovative products and technologies in science-education for saving biodiversity in transforming best practices for the betterment of Southeast Asia societies.

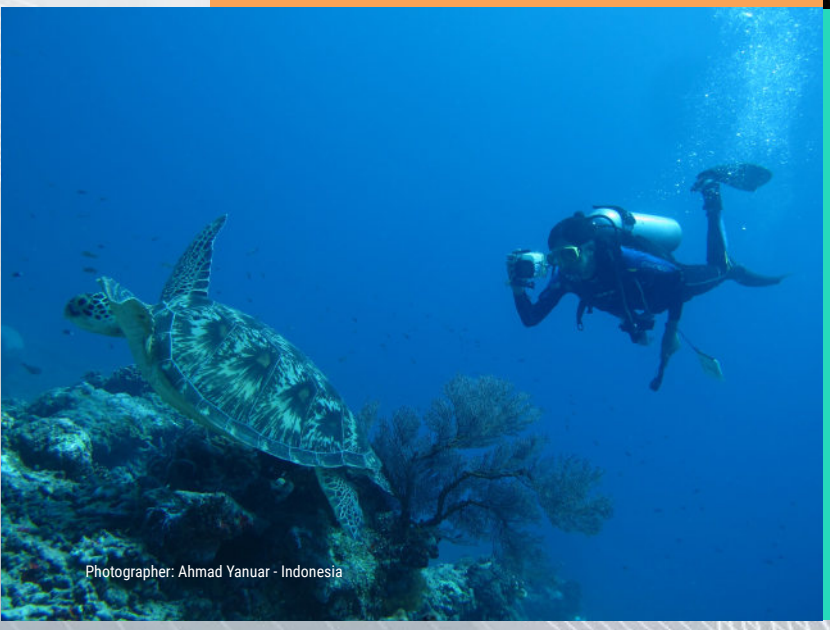
To promote applied science education on sustainable use of biodiversity for the well-being of society in Southeast Asia.

To build highly competent human resources for managing sustainable biodiversity in Southeast Asia.

SEAMEO BIOTROP Thrust Program:

Restoration and conservation of unique and degraded ecosystems

Sustainable of management and wisely utilization of biodiversity, bioenergy, biotechnology, and food security



Strengthening ecosystem resilience to global climate change

Save Biodiversity for Human Well-being

Greetings from SEAMEO BIOTROP, Indonesia!

Preceding the second semester of the year 2022, I am delighted to present the second edition of BIODIVERS, a popular scientific magazine of SEAMEO BIOTROP. This edition mainly focuses on increasing awareness of issues related to Tropical Biodiversity from Mountains to Oceans (MoTO) and increasing biodiversity conservation literacy. In saving biodiversity, it is crucial to connect the terrestrial and coastal ecosystems.

For over 50 years, SEAMEO BIOTROP has been addressing critical issues in tropical biology through various programs, projects, and activities. The Center has been dealing with nature conservation, ecological and ecosystem restoration, human development, and other areas of tropical biology to promote sustainable management of tropical biology in Southeast Asia for the welfare of human beings.

SEAMEO BIOTROP has been providing its best efforts to tackle these concerning issues for realizing the Center's vision. The acknowledgment of the Center's role as "a reputable center for sustainable biodiversity management of tropical biology in Southeast Asia", is the basic fuel of the Center to encourage the action program using the tagline "Save Biodiversity".

The action programs are framed with the target of Tropical Biodiversity from Mountains to Oceans (MoTO), which are derived into three program thrusts, namely: 1) Restoration and conservation of unique and degraded ecosystems, 2) Sustainable of management and wisely utilization of biodiversity, bioenergy, biotechnology, and food security, 3) Strengthening ecosystem resilience to global climate change.

SEAMEO BIOTROP's Tissue Culture Laboratory has been propagating superior plants' seedlings using tissue culture technology to restore and conserve rare plants having important economic value. Tissue culture technology plays a very important role in the field of conservation by reproducing endangered plants or storing germplasms by means of frozen storage or cryopreservation. The laboratory successfully reproduces 1) forestry plants: Teak, Agarwood, Saninten, Jabon, Parica, Acacia, Candle Nut, Sengon, Eucalyptus; 2) Food crops: Banana, Satoimo, Porang (elephant foot yam), Vanilla, Avocado, Jackfruit, Strawberry, Matoa, Siompu Orange; 3) Ornamental plants: Alocasia, Aglaonema, Monstera, Caladium, Anubias; and 4) Aquatic plant: Cottonii Seaweed. Seaweed is one of the marine export commodity primadonnas and significantly supports the livelihood of coastal communities.

Education on biodiversity conservation is also a prioritized program of SEAMEO BIOTROP through the Agro-Eco-Edu Tourism program. Development of the Agro-Eco-Edu Tourism program is in line with the Integrated Strategic Plan of the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia (MoECRT) for supporting the 7 SEAMEO Priority Areas, the Agenda of Sustainable Development Goals (SDGs) 2030, the Conference of the Parties of the Convention on Biological Diversity, the Intergovernmental of Science Policy Platform on Biodiversity and Ecosystem Services and the ASEAN Center for Biodiversity. This program is among the solutions in dealing with global climate change. The program also will become a model for establishing Agro-Eco-Edu Tourism in Indonesia and the Southeast Asian region.

Invasive Alien Species (IAS) are among the threats to biodiversity. Therefore, IAS management should be prioritized to save biodiversity. SEAMEO BIOTROP has been innovating sustainable financing in IAS management.

IAS can be used as a source of livelihood for some groups. IAS can also provide benefits for future economic development. Thus, IAS is not only a detrimental factor but can also benefit various stakeholders, which leads to the improvement of the socio-cultural aspects of the community.

SEAMEO BIOTROP proposed six organizational strategies to be implemented to encourage multilateral cooperation in the field of education, to support international efforts in reducing the global impact of the Covid-19 pandemic, and to support the national declaration "Recover Together, Recover Stronger" to "Save Biodiversity for Future Generations". The key to a successful program implementation is the way to engage all relevant partners through a collaborative approach.

Five strategies to save biodiversity for the welfare of human beings are: 1) produce various plant seedlings plants using tissue culture technology; 2) engage local communities to support conservation area; 3) increase capacity building of human resources through biodiversity literacy and education; 4) strengthen institutional efforts on sustainably managing biodiversity; and (5) disseminate, campaign and promote biodiversity services for the welfare of human beings.

I thank all involved parties for sharing the knowledge, resources, and commitment in the process of publishing this issue of BIODIVERS magazine. I look forward to your continuing support in taking the magazine to a greater level. I appreciate any feedback and suggestions that will help us in striving for excellence.

#SaveBiodiversity

Happy reading and have a nice day!

Dr. Zulhamsyah Imran
Director of SEAMEO BIOTROP

Dr. Aldrin A. Darilag, CHRP, RMT, RN
Commissioner of the Commission on Higher Education (CHED)

Message of Commissioner Dr. Aldrin A. Darilag for the Launching of the Biodivers Collection

As the Governing Board Member representing the Republic of the Philippines to the Southeast Asian Regional Centre for Tropical Biology (SEAMEO BIOTROP), may I warmly welcome you all to the BIODIVERS Collection!

The BIODIVERS Magazine is a bio-science general audience publication launched late last year by the SEAMEO BIOTROP aimed at becoming a medium for promotion and publication of research related to Tropical Biology from the Mountain to the Ocean (MOTO) and conduit to increase biodiversity literacy of the general public.

Highlighting the essence of inter-generational fairness, as well as to uphold the United Nations' Sustainable Development Goals 2030, I am a firm advocate of the goals and objectives of BIODIVERS in its service to experts, academicians, conservationists and policymakers as an avenue to arouse productive discourse and generate out-of-the box innovations to address global issues and concerns on biodiversity and sustainability.

The theme for Volume 1 No. 2: "Save Biodiversity for Sustainable Well-being" truly resonates with the recently concluded agreements of the 2021 United Nations Climate Change Conference. The global consensus to accelerate climate response by scaling up actions on combating climate impacts so as to attain the target limit of 1.5°C is "alive but its pulse is weak." Hence, the only way to ensure the collective survival and longevity of humankind in this planet is to keep its promises and translate commitments into rapid compliance. Thus, the BIODIVERS Collection is an embodiment of the genuine aspiration to preserve the beauty and integrity of our flora and fauna from the worsening global climate crisis.

To the contributors in this edition, may you be further inspired in dedicating yourselves in the service of humanity and its posterity. Your contribution to this magazine is an affirmation of your noble intent to ensure the preservation of a sustainable world for people, animals, and the planet.

To the readers, may you be enlightened on the great privilege you now enjoy and the responsibility you bear for the current generation and beyond. Let the articles in this edition be a wake-up call to deliver on international covenants and enact solutions to our problems.

Lastly, to the BIODIVERS Editorial Team, my commendations to this noteworthy accomplishment! You have proven to become a reliable partner in the realization of SEAMEO BIOTROP's vision and mission for the protection and conservation of Southeast Asia's biological diversity.

Dr. Aldrin A. Darilag, CHRP, RMT, RN
Commissioner of the Commission on Higher Education (CHED)

Source : https://www.pexels.com/photo/an-aerial-photography-of-a-mountain-with-green-trees-near-the-beach-8762100/

Urgent Needs for Saving Biodiversity!

Our biodiversity in our beloved one Earth is facing serious challenges as world population is increasing. It is projected that world population will reach 9.8 billion in 2050 and 11.2 billion in 2100. This growing population will put pressure to the sustainable use of natural resources in meeting the demand for human basic necessities, i.e., food, water, and energy, which encourage urgent actions for preserving the sustainable environments. Countries around the globe already paid attention to sustainably manage the environment, since the adoption of the Stockholm Conference, Sweden, 5-6 June 1972. About 20 years later, the attention to sustaining biodiversity is strengthen by issuing the Convention on Biological Diversity (CBD) directed for protecting biodiversity and restoring degraded ecosystems in 1992.

We should put efforts in ensuring environmental sustainability understanding the vital role of the environmental functions and resources in providing human needs. The environments support human lives by supplying water, food, energy, and comfortable climates. Efforts to sustain the environments require further understanding on the connection between human dimensions and environmental degradation. Balance condition is required between ecological system protection and economic development to ensure environmental sustainability. The target of sustaining the environments is the key strategy against the backdrop of the growth of human population and the rampant exploitation of the environment. The underlying concern is that the future generations are on the verge of confronting scarce natural resources and polluted environment.

This volume of BIODIVERS raises the importance of the theme "Save Biodiversity for Sustainable Well-being". The science magazine concentrates on calling for articles that elaborates focused aspects of Save Biodiversity, namely: 1) Restoration and conservation of unique and degraded ecosystems, 2) Sustainable management of biodiversity, 3) Utilization of bioenergy and biotechnology to support sustainability, 4) Strengthened ecosystem resilience, 5) Ecotourism development in promoting biodiversity conservation, and 6) Initiatives against potential risk of biodiversity loss. Responding to this call, contributed articles discuss subjects on bioenergy, contamination, conservation, biotechnology and breeding, and food nutrition. The contributed articles are mostly from case studies in tropical countries, which is blessed to have a mega-biodiversity of flora and fauna. Appreciating the efforts, this remarks briefly discusses the tropical biodiversity.

The tropics covers almost 40 percent of the Earth's surface and are home to rich areas of the most fascinating world countries such as Brazil, Panama, Colombia, Thailand, Lagos, and Indonesia. The regions are located in the center of the earth, between the Tropic of Capricorn and the Tropic of Cancer. The Tropics are also home to almost all shallow-water corals and mangroves. Among the most characteristic areas of the tropical region are the mangroves, a unique ecosystem formed by trees or shrubs that grow in saltwater and live semi-submerged in the intertidal zone of the tropical or subtropical coasts.

The tropical climates have a varied mean annual temperature but relatively minor seasonal changes in temperature. The tropical climates also have yearly high rainfall and long and severe dry seasons. Seasonality of rainfall exerts a strong influence on temporal patterns of primary and secondary processes in the ecosystem. In the warm and humid zones, live 78 percent of plants and animal species, including amphibians, terrestrial mammals, fish, ants and flowering plants. More than 91 percent of terrestrial birds can be found, live, cross or visit the tropics on their annual migrations.

Our Understanding on Biodiversity

Biodiversity is the diversity among living things, from various sources including terrestrial, coastal, marine and other aquatic ecosystems and the ecological complexities. The biodiversity includes within-species, inter-species, and ecosystem diversity. Biodiversity is an important development capital as a renewable natural resource. The more diverse the genes, species and ecosystems, the stronger the environmental carrying capacity.

Biodiversity, the variation of life on Earth, is a major factor in nature's resilience. In a biodiverse ecosystem, if the environment changes and some organisms can no longer thrive, others can take their place and fulfil essential functions. It is often the most overlooked species that are the most important in healthy ecosystems. Insects, for example, play an essential role in pollinating flowering plants - a third of the food we eat depends on animal pollinators. Healthy ecosystems, interdependent webs of living organisms and their physical environment, are vital to all life on Earth. Our ecosystems provide us with clean air, fresh water, food, resources and medicine. ***Biodiversity contains sources of life, e.g., food, feed, fuel, pharmacy and attractions!***

Tropical Biodiversity is in Danger

Despite the huge biodiversity found in the Earth's tropical regions, many of its species are endangered due to climate change, deforestation and logging, making it the area with the highest rate of biodiversity loss on the planet.

Editorial Remarks

A current study suggests that the damage to biodiversity in the tropics could even be worse than expected if we do not get a grip on the environmental problems. The megadiverse of tropical ecosystems can be disappearing. It is crucial to call for actions for a better approach to save our precious biodiversity!

Habitat destruction, pollution, over-exploitation, invasive species, agricultural intensification and ultimately global warming are changing the tropical environment into something completely different with a drastic transition. In coastal, coral reefs are replaced by fields of algae and sponges. Mangroves are highly sensitive to variations in environmental conditions, which makes climate change their main threat. These ecosystems are adapted to very special conditions of salinity, water level, substrate and climate, which are being altered, and affected by climate change. They play a fundamental role in the fight against climate change, as they are capable of absorbing up to five times more carbon dioxide than terrestrial forests. In the forests, a forest fire can result in grassy vegetation taking over, and desertification even occurs.

Our nature is under pressure as never before. Our needs for food, water and land and our demands for energy surely put more and more stuff which destroys habitats, pollutes our air and water, and drives species of animals and plants to extinction. The WWF's latest Living Planet Report estimates that we have lost 68% of all vertebrate wildlife populations since 1970 (https://www.worldwildlife.org/press-releases/68-average-decline-in-species-population-sizes-since-1970-says-new-wwf-report). That's more than half of all birds, mammals, reptiles, amphibians and fish gone in just 50 years. During that time, our population has more than doubled, increasing from 3.7 billion to over 7.9 billion today (https://populationmatters.org/biodiversity). In its landmark 2019 report, IPBES reported that one million species are now at risk of disappearing for good and according to the IUCN Red List of Threatened Species, 41% of amphibians, 25% of mammals, 34% of conifers, 13% of birds, 31% of sharks and rays, 33% of reef-building corals, and 27% of crustaceans are threatened with extinction.

Actions to Save Tropical Biodiversity

The diversity of life on Earth is essential to the health of our planet and to our well-being as human beings. For example, Coral reefs provide fish resources for the 275 million people that live within 30 kilometers from the coastal area. The forests provide timber and other products. Unfortunately, the loss of biodiversity in an ecosystem can have dramatic negative effects on humans as well. Therefore, efforts are urgently needed to Save Biodiversity.

Establishing Protected Areas

Current environmental action is not enough, but we must fight for areas' protection. Establishing protected areas is one approach to conserving biodiversity. The world has seen a huge potential action to preserve and conserve biodiversity through protected areas, both terrestrial and marine.

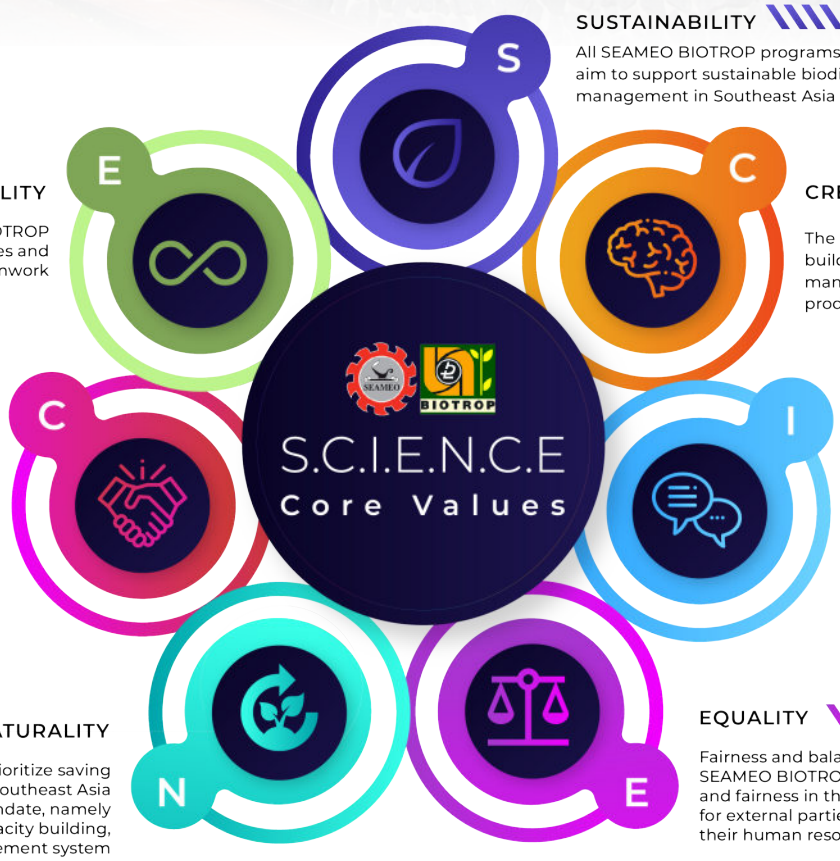
Nature reserves alone are not the solution. Protecting only what's inside the boundaries of a nature reserve, doesn't prevent biodiversity loss outside. Those drivers include population growth and deeply rooted inequalities between developed and developing countries.

Gathering Multinational Efforts

It is now a request for a joint approach to managing resources and ecosystems. We need multinational efforts that span across borders because many of these issues are not constrained within a particular country.

Let's Always Save Our Biodiversity!

Dr. Perdinan
Deputy Director for Administration of SEAMEO BIOTROP, Indonesia
Department of Geophysics and Meteorology, IPB University



SUSTAINABILITY

All SEAMEO BIOTROP programs and activities aim to support sustainable biodiversity management in Southeast Asia

EGALITY

All human elements in SEAMEO BIOTROP must have egalitarian attitudes and inclusive and solid teamwork

CREATIVITY

The innovation and creative capacity buildings, including creativity in manufacturing research and training products

CONNECTIVITY

All science education activities must have connectivity that supports and complements each other in a science-based learning system Applied Digital Science Technology

INTEGRITY

Integrity is meant consistency in the actions, values, methods, measures, principles, expectations and various outcomes for the achievement of the SEAMEO BIOTROP organization

NATURALITY

SEAMEO BIOTROP will prioritize saving natural biodiversity in Southeast Asia through its organizational mandate, namely science education, capacity building, and a knowledge management system

EQUALITY

Fairness and balance in the development of SEAMEO BIOTROP's internal human resources and fairness in the opportunities for external parties to develop their human resources at SEAMEO BIOTROP

"Every thing needs to depend to each other, with its surroundings. That's what I learned from the ecosystems. Nothing stands alone. All things are inter-related, either through food chain or recycling system. So, let's learn from the ecosystem. We can continue our lives if we commitedly conduct our respective functions and work together

Ir. Laksmi Dhewanthi, M.A. IPU
Director General of Climate Change Control, Ministry of Environment and Forestry of the Republic of Indonesia

The video of this interview can be accessed at:
https://youtu.be/IH9ijuFzqMc

Implementation of Climate Change Control Program for Saving Biodiversity

Interview with Ms. Laksmi Dhewanthi, Director General of Climate Change Control, Ministry of Environment and Forestry, Indonesia

Currently, climate change is one of the most critical problems worldwide. Many countries have been significantly affected by climate change. Indonesia, as a strategic archipelagic country located between two continents, also plays an important role in climate change. The Directorate General of Climate Change Control (DGCCC) is one of the Directorate Generals under the Ministry of Environment and Forestry of the Republic of Indonesia which is appointed as the national focal point for the United Nations Framework Convention on Climate Change (UNFCCC), as well as the coordinator of various mitigation and adaptation efforts to control climate change in Indonesia.

In a podcast session on organized by the team from BIODIVERS magazine of SEAMEO BIOTROP on 15 July 2022, the Director General of Climate Change Control Ir Laksmi Dhewanthi, MA, IPU, shared about the Implementation of Climate Change Control Program for Saving Biodiversity.

Question:

Indonesia, as an archipelagic country strategically located in a tropical region between two continents, plays an important role in mitigating global climate change. Indonesia's commitment related to global climate change is reflected in its participation in the Paris Agreement that has been ratified through the Decree Number 16 2016 of the Ministry of Environment and Forestry of the Republic of Indonesia (MoEF). The Directorate General of Climate Change (Ditjen PPI) of MoEF has conducted several actions in realizing the sustainable use of forest and environmental resources for the welfare of the community which implicitly describes the Save Biodiversity and Sustainability design. The design is constructed to support the mission of the President of the Republic of Indonesia, known as Indonesia Maju. In relation to the mission, would you share with us the role of DGCCC in supporting the mission?

Answer:

Thank you for the sharing opportunity presented to us this morning. The DGCCC of MoEF, as a part of the government, bears a constitutional mandate from the 1945 Constitution of the Republic of Indonesia, Article 33 regarding the utilization of natural resources and Article 28 letter (h), regarding the provision of clean and healthy living environment for all citizens. Sustainable biodiversity utilization and maintenance is a global agenda, while it is also a constitutional obligation and mandate from the 1945 Constitution of the Republic of Indonesia.

Based on the 1945 Constitution, the MoEF of Republic Indonesia, especially the DGCCC has the task for 1) ensuring the smooth implementation of the climate change control agenda in Indonesia; 2) ensuring the provision of clean and healthy environment; and 3) answering the triple crisis, i.e., climate change, environmental damage and pollution, and biodiversity loss. The three agendas are interrelated, and we have a role in one of the agendas, namely climate change control.

Question:

In carrying out the roles, certainly there are challenges. Which one is the biggest challenge from the climate conditions in Indonesia, considering the many changes happens nowadays? Also, which challenge has the most impact on the environment and biodiversity?

Answer:

All countries face many challenges in dealing with climate change. Why? Scientifically, the global average of Earth's surface temperature is rising faster than the previous trend. We know that climate always constantly changes. We have experienced ice ages in which ice was then melted and so on. There is going to be ice melting phenomena, as well. However, the rate of temperature rise is what's worrying. The previous temperature rise happened in one hundred years. Currently, the temperature rise is happening faster than before. Therefore, all countries agree to keep the temperature rise below 2° C.

However, the IPCC report in 2018 stated that the temperature rise should be kept below 1.5° C. Why? One of the reasons is that an increase of zero point a few degrees Celcius has caused disturbance toward sensitive living creatures threatening their lives. Humans can control air temperature by using air conditioner or air heater, depending on necessity. Therefore, it is a global effort to keep the temperature rise below 1.5° C, to keep the ecosystems from destruction for the sake of living organisms on the Earth.

Question:

Are there short- and long-term programs for tackling the climate change issue?

Answer:

The climate change agenda is one of the national programs related to disaster resilience. There are many activities carried out in the program, not only by the Ministry of Environment and Forestry. We not only need a team. We need everyone on the Earth to contribute their commitments and real actions to tackle the climate change issue. Every single contribution matters. In Indonesia, there are two approaches in dealing with the climate change issue. The first approach is actions related to climate change mitigation, while the second one is actions related to climate change adaptation. The mitigation approach includes eliminating or reducing the emissions of greenhouse gas. The adaptation approach includes increasing our resilience to the deal with the adverse impact of climate change and adapting to the climate change impact. These two approaches are the primary agendas with their respective targets.

Each country that has declared their commitments to the UNFCCC is required to establish a document called the Nationally Determined Contribution (NDC) as a form of commitment to the Paris Agreement. The Indonesia's NDC has two targets. In reaching the mitigation target we are doing our best efforts to reduce the emissions of greenhouse gas by 29% with our own resources or by 41% with the international support at the year 2030. In regards to adaptation, we are increasing resilience in three aspects: 1) socio-economic resilience, 2) ecological resilience, and 3) landscape resilience. We are committed to reach our targets in both mitigation and adaptation. They are equally important in dealing with climate change.

Question:

In monitoring the impact of climate change, which methods are used by DGCCC to observe the changes continually? Subsequently, which methods are used to collect, process and analyze the observational data? Are the data accessible by the general public?

Answer:

In regards to monitoring the impact of climate change, the DGCCC has the role as the national focal point for UNFCCC. The role demands the DGCCC to coordinate numerous efforts in mitigation and adaptation conducted by various sectors. Each sector used its respective methods for observing and monitoring the impact of climate change. The data resulted from the observations conducted by each sector are then shared with the DGCCC to be processed and analyzed. The Meteorological, Climatological and Geophysical Agency (*Badan Meteorologi, Klimatologi dan Geofisika*) observes the climatic factors and weather affecting climate change; thus, we obtain the climatic data from BMKG. Data on water resources in terms of quantity are provided by the Ministry of Public Works and Public Housing. Data on water quality are provided by the Directorate General of Environmental Pollution and Degradation Control. The Directorate General of Nature Resources and Ecosystem Conservation provides data on biodiversity.

The DGCCC oversees the greenhouse gas emissions. Firstly, we have a method for inventorying greenhouse gas and for calculating the reduction of greenhouse gas emissions. Secondly, we have an inventory system of greenhouse gas and a system for calculating the reduction of greenhouse gas emissions through the national registry system. Businesses and individual activities will report to the national registry system about the mitigation efforts that have been done and the magnitude of their contributions. The five sectors in the NDC, i.e., forestry, waste, energy, agriculture and industry, conduct inventory and report on the reduction of their greenhouse gas emissions, referring to the approved methods at the international level through the IPCC. Therefore, it is essential to closely collaborate with other units within the MoEF, with other ministries and institutions as well as local government and multi-stakeholders.

Question:

In that regard, it is clear that all parties should participate in this action of tackling the climate change issue. The impact of climate change can threaten environmental sustainability. Would you share your expectations in terms of the roles of communities in minimizing the impact of climate change?

Answer:

I have previously mentioned about a triple crisis which is already in plain sight. The triple crisis is happening right now. We have to tackle the triple crisis with immediate measured efforts, done with deep concern, tight commitment and mutual collaboration. We do hope that everyone has full comprehension that the triple crisis we are now facing is our collective responsibility. For instance, the issue of climate change is not solely the responsibility of the DGCCC. Also, the water crisis in not the responsibility of one institution. We are all have our own respective responsibility for dealing with climate change issue. So, let's join hands and collaborate to face the challenges and tackle the issues. I believe that no living thing can survive by itself. Every thing needs to depend to each other, with its surroundings. That's what I learned from the ecosystems. Nothing stands alone. All things are inter-related, either through food chain or recycling system. So, let's learn from the ecosystem. We can continue our lives if we commitedly conduct our respective functions and work together.

Question:

It is a very comprehensive discussion. As a closing statement, would you like to deliver a message or two?

Answer:

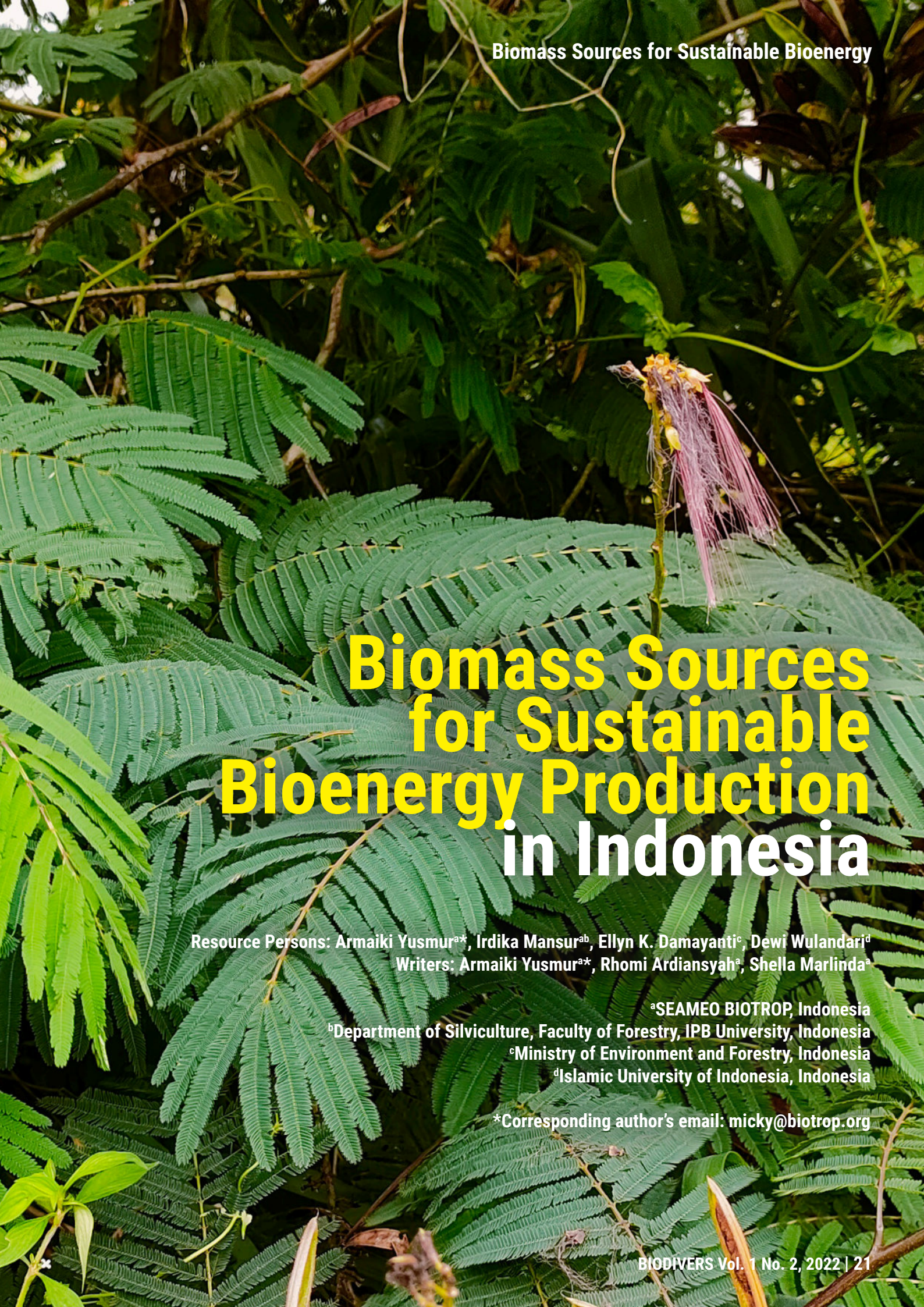
Yes, thank you. I would like to reiterate our hope that in dealing with the current crisis, it is essential for us to work together, to mutually encourage each other in elevating the efforts and real actions for the continuance of our lives.

Closing:

Thank you very much for having this comprehensive discussion with us. We look forward to having collaborations with the DGCCC in supporting the programs to achieve the visions and missions of the Government of Indonesia in tackling the climate change issues.

Transcriber: Anidah
Interviewer: Armaiki Yusmur
Cameraman and Video Editor: Asep Saepudin

Source: Armaiki Yusmur, 2021



Biomass Sources for Sustainable Bioenergy Production in Indonesia

Resource Persons: Armaiki Yusmur[a]*, Irdika Mansur[ab], Ellyn K. Damayanti[c], Dewi Wulandari[d]
Writers: Armaiki Yusmur[a]*, Rhomi Ardiansyah[a], Shella Marlinda[a]

[a]SEAMEO BIOTROP, Indonesia
[b]Department of Silviculture, Faculty of Forestry, IPB University, Indonesia
[c]Ministry of Environment and Forestry, Indonesia
[d]Islamic University of Indonesia, Indonesia

*Corresponding author's email: micky@biotrop.org

Biomass Sources for Sustainable Bioenergy

Global Commitment to Energy Transition

The energy sector is currently dominated by fossil fuels that accounts for 73% of greenhouse gas emissions. A report prepared to support the High-Level Dialogue on Energy organized by the Secretary-General under the auspices of the United Nations General Assembly in September 2021 emphasized a need to accelerate the energy transition toward achieving SDG 7 (Affordable and Clean Energy) and Net Zero Emissions. Global CO2 emissions are targeted to be halved by 2030 to avoid an unprecedented increase in the frequency and severity of dangerous weather extremes, including devastating heat waves, floods, and droughts, risks to food and water security, population displacement, and loss of livelihoods.

The proposed recommendations include accelerated energy transition to reach 8,000 Gigawatt (GW) produced from renewable energy sources by 2030 considering the different contributions of every country. The utilization of renewable energy becomes an important de-carbonization option due to its abundance and cost-effective potential. For many countries, this is both a challenge and an opportunity to develop investment strategies, regulations, and socio-economic aspects. Over the next decade, every aspect of the national energy system will be affected by changes in climate and energy policies, financing, sustainable advanced technology, and shifts in energy supply and demand. The rapidly declining costs of renewable technologies are opening previously unimaginable opportunities around the world. The global commitment above could be a "market-driven" biomass based energy (bioenergy) for industries.

Wood pellet is one of the fastest-growing renewable bioenergy sources in the world. In 2019, around 38.9 million tons of pellets were produced globally[1]. Over the past 7 years, this source has reached an annual growth rate of 11.6% (Figure 1). Asia has the highest rate of 49% followed by Oceania at 30%. On the other hand, Europe dominated wood pellet production with a 55% share globally followed by America at 32% (Table 1).

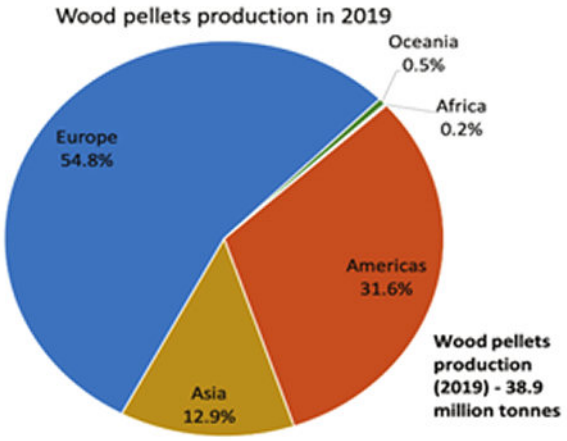


Figure 1. World wood pellet production in 2019 (%)

Table 1 Global Wood Pellet Production

Year	World	Africa	America	Asia	Europe	Oceania	EU-28
2012	18.1	0	5.1	0.3	12.5	0.03	11
2013	21.2	0	6.65	0.62	13.9	0.03	12.3
2014	25.1	0.04	7.96	1.72	15.2	0.14	13.3
2015	27.4	0.03	8.76	2.04	16.4	0.15	14.1
2016	29.3	0.04	9.49	2.59	17	0.16	14.3
2017	33.4	0.06	10.4	3.52	19.2	0.25	15.9
2018	36.6	0.07	11.2	5.01	20.1	0.21	16.9
2019	38.9	0.07	12.3	5.01	21.3	0.21	17.8
Growth	11.549413	-	13,401625	49.511219	7.91134	32.04692	7.117652

Source: Global Bioenergy Statistics, 2020

Opportunity and Challenge for Indonesia

The global market is widely opened for biomass, especially in the form of pellets. For Indonesia as a tropical country, where biomass can be produced throughout the year, the opportunity for producing bioenergy in the future is very prospective.

Indonesia consists of numerous islands with some areas still under-developed. To meet the targeted electrification ratio in the frontier, the outermost, and the least developed areas, often referred to as 3T (*Terdepan, Terluar, Tertinggal*) areas, the State Electricity Company (PLN) proposes that 23% of the supply must originate from renewable energy sources (Electricity Supply Business Plan (RUPTL) 2019-2028). The Indonesia Power Enterprise, a subsidiary of PLN, strives to fulfill the target through the development of Hybrid Power Plants (PLTH) among Biomass Power Plants (PLTBm), Solar Power Plant (PLTS), and Battery Energy Storage Systems (BESS) with the Minigrid concept spreading over the 3T islands. By implementing this concept, energy in the 3T Islands could be more affordable, reliable, sustainable, and available for 24 hours. In addition, this concept could also be a

solution to implement de-dieselization, decarbonization, and digitization of power plants.

Some advantages of wood biomass as the energy source, compared to fossil energy sources, are the following; wood is numerically abundant, available throughout the year, emits lower carbon quantity, and environmentally friendly because CO_2 released during combustion/oxidation will be compensated by the photosynthesis process[2]. Thus, the bioenergy from biomass sources will contribute less carbon emissions to the atmosphere.

Biomass Plantation Species as an Alternative Sustainable Bioenergy in Indonesia

Indonesia has numerous potential sources as raw materials for bioenergy from biomass with a high productivity level. These are tropical tree species having a short-time production age or rotation. Those trees with faster growth rates, and having many branches tend to have higher energy contents (Cahyono et al)[3]. Considering growth characteristics, the trees producing biomass sources for bioenergy should have the following characteristics:

1. Fast growth with a dense branching.
2. Considerable weight.
3. Easy to grow in various conditions.
4. Quickly sprout after pruning.

While the tree species to be planted must have the following characteristics:

1. Adaptable to various soil and climatic conditions.
2. Grows fast (high increment) and can compete with reeds.
3. Fast-growing after pruning.
4. Wood has a high calorific value.
5. Possess other economic values.

There are 147 forest tree species are potential for bioenergy production[4]. Meanwhile, seven species are highly recommended by the Forestry Research and Development Agency (FORDA) of the Ministry of Forestry Republic of Indonesia for biomass plantations, i.e., *Acacia auriculiformis* (akasia kuning)[5], *Acacia mangium* (akasia) [6], *Albizia procera* (waru)[7], *Calliandra calothyrsus* (kaliandra)[8], *Gliricidia sepium* (Gamal)[9], *Leucaena leucocephala* (lamtorogung)[10] and *Sesbania grandiflora* (turi)[11,12].

Potential Species for Biomass Plantation

Among the species, *Gliricidia sepium* has the most potential, with the remaining 6 species as alternatives, for biomass plantation. Among the 6 species, two have been domesticated, namely, (*Calliandra calothyrsus* and *Leucaena leucocephala*) and the other 4 grow naturally

Figure 2. Gamal (*Gliricidia sepium*) (Source: Armaiki Yusmur, 2021)

(*Auliculiformis acacia, Acacia mangium, Albizia procera,* and *Sesbania grandiflora*). These species have been planted widely for commercial and industrial plantations or for commercial and traditional agroforestry farms/ plantations, and utilized for various purposes[13].

Among the fast-growing tree species, Gamal (Figure 2) and Kaliandra (Figure 3) meet closely the above criteria. These trees are not endemic but adaptable to various conditions. These trees do not tolerate soils with poor drainage and frequent flooding but grow well in acidic and infertile soils[14]. Gamal does not grow well under other plant canopies but Kaliandra can live under the shade with moderate to high-intensity sunlight. In the highlands, Kaliandra that originated from Central America, can grow well in an elevation of up to 1,400 m above sea level with high and low rainfall in a long dry season of up to 6 months[15]. On its native place in Mexico and Central America, Kaliandra grows at elevations up to 1860 m above sea level, especially on areas where the annual rainfall ranges from 1,000 to 4,000 mm with a dry season lasting 2-4 months. This species can also grow at a minimum temperature of 18–22° C. In contrast, Gamal requires warmer conditions for its growth around 25–30° C for its optimal growth. Therefore, Kaliandra is preferably planted on a higher land.

Besides being fast growing, these species also have high calories and productivity. The productivity of Kaliandra is between 30-54 tons/ha/year with an average calorific value of 4,423 kcal/kg while Gamal trees produce 40-50 tons/ha/year with an average calory value of 4,529 kcal/kg. Considering the physical conditions in Indonesia and the characteristics of wood as a raw material for energy, Gamal wood is more suitable for production because of its high calorific value., low ash content (0.74%), and high melting point (1,400oC). Gamal plants have considerable ability to survive in areas with long dry periods. Nursery management of Gamal plants is relatively easy compared to Kaliandra. Quality analysis of the chips and wood pellets from Gamal trees are also very promising (Table 2).

Table 2. Gamal wood pellet and chips quality analysis result

Parameters	Chips Gamal Wood	Pellet Gamal Wood Without Adhesive	Molasses Adhesive Gamal Wood Pellet	SNI 8951-2020		
				Premium	Standard	Utilities
Density (g/cm^3)	0.69	0.86	1.00	0.5	0.5	0.5
Moisture content (%)	1.94	1.19	1.07	9.5	10	12
Flaying matters (%)	78.44	76.97	76.16	72	71	70
Ash content (%)	2.19	1.44	1.48	1.5	3	4
Fixed Carbon (%)	19.37	21.59	22.36	17	16	14
Ash (%, adb)	0.94	1.08	1.81	1.5	3	4
Gross Calorific Value (Cal/g, adb)	4,242	4,500	4,526	4,300	4,300	4,040
Total Sulfur (%, adb)	0.087	0.022	0.078	0.05	0.05	0.1
Carbon (%, adb)	46.74	48.77	48.78	17	16	14
Hydrogen (%, adb)	6.57	6.42	6.32			
Nitrogen (%, adb)	0.47	0.42	0.42			
Oxygen (%, adb)	45.19	43.29	42.59			
Chlorine (%, adb)	0.020	0.017	0.11			
HGI	19	25	33	32	32	32

Source: Prima Kelola IPB, 2021

Figure 3 Kaliandra (*Calliandra callothyrsus*)
(Source: Armaiki Yusmur, 2021)

SEAMEO BIOTROP assessment on the suitability and adaptability of Gamal in Indonesia show that this species can grow well in Java and Kalimantan Islands[16]. An ecological feasibility study has been conducted using literature and spatial data to support the recommendation on suitable areas for Gamal plantation in Indonesia. The study concluded that about 7.716,65 km^2 are suitable and expandable for Gamal plantation on Java Island (Figure 4), while 4.064,59 km^2 are on Kalimantan Island (Figure 5).

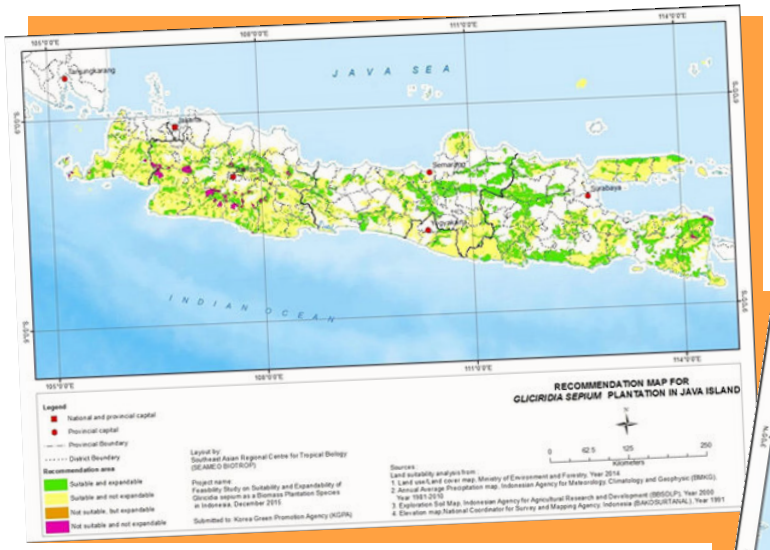


Figure 4. Suitable and expandable areas for Gamal plantation in Java Island

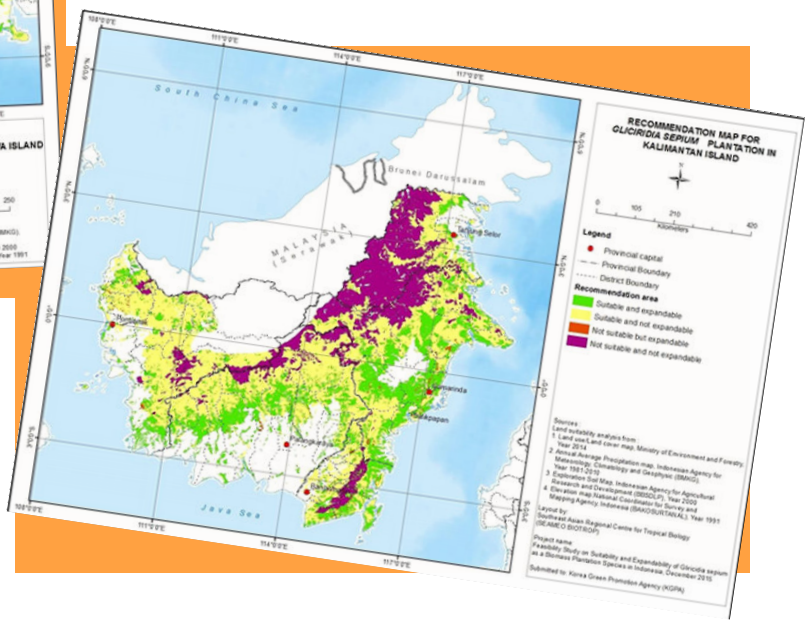


Figure 5. Suitable and expandable areas for Gamal plantation in Kalimantan Island.

Indonesian Action Plan for Bioenergy Policy on Climate Change Mitigation

The government, as a policy maker, tries to encourage the increase in the use of New and Renewable Energy (NRE). This National Energy Policy targets the NRE mix of 23% in 2025 based on PP Number 79 of 2014. On the other hand, PT PLN in the 7th Business Plan for Power Supply (RUPTL) in 2021-2030 estimates the need for electricity to reach 55,000 MW, where the average increase in electricity demand per year is 5,500 MW. Meanwhile, the Ministry of Energy and Mineral Resources also projects the next five-year EBT plant development plan for the construction of Geothermal PLT worth USD 17.45 billion, Water or Microhydro PLT worth USD 14.58 billion, PLT Solar and PLT Bayu worth USD 1.69 billion, PLT Waste is worth USD 1.6 billion, PLT Bioenergy is worth USD 1.37 billion and PLT Hybird is worth USD 0.26 billion. Based on these conditions, the development of energy plant biomass as a raw material supply for PLTU co-firing is a huge opportunity, especially for energy biomass that has been converted into the form of chips, sawdust and wood pellets.

With the high demand for biomass energy, it is necessary to identify potential areas for garden development and industrial support. In addition to utilizing non-forestry areas with agroforestry and monoculture schemes, industry can also open energy plant plantations through forestry multi-enterprise schemes utilizing forest areas. This policy is regulated in the Regulation of the Minister of Environment and Forestry No. 3 of 2021 Regarding Business Activity Standards in the Implementation of Risk-Based Business Permits in the Environment and Forestry Sector and the Regulation of the Minister of Environment and Forestry No. 8 of 2021 Regarding Forest Management and the Preparation of Forest Management Plans, and Utilization of Protected Forests and Production Forests.

Currently, the industry of wood energy, especially wood pellets, is still relatively small in Indonesia. Some wood energy producers who have produced in Indonesia are generally export-oriented (to South Korea and Japan), and only a small part is sold in the domestic market. This happens because the price of wood pellets in the international market is much higher than in the local market. By setting a maximum tariff of 85% of the price of coal, it is expected that the domestic production of wood

pellets will be encouraging enough for the industry to be able to supply domestic needs. By creating investment in the green industry and green energy, it is hoped that the development of biomass potential in Indonesia can contribute to the movement of reducing emissions and the impact of climate change.

The main challenge for most of these industries is how to replace the current use of fossil fuels with renewable energy sources, both in the production process and in the supply of energy. Available technology options include:

a. Electricity generation from cleaner and renewable energy sources.
b. Renewable energy sources from the heat of the sun, geothermal, or sustainable biomass.
c. Production of hydrogen, ammonia, and other synthetic fuels from renewable energy (green hydrogen).
d. Reduction of carbon dioxide emission, through biomass production and carbon capture with Storage/ Utilization.

References

[1] Global Bioenergy Statistical, 2020.

[2] Amirta R, Anwar T, Sudarajat, Yuliansyah, Suwinarti W. 2018. Trial production of fuel pellet from Acacia mangium bark waste biomass. *IOP Conf. Ser.: Earth Environ. Sci. 144(1)*, Article 012040. doi: 10.1088/1755-1315/144/1/012040

[3] Cahyono TD, Coto Z, Febrianto F. (2008). Analisis nilai kalor dan kelayakan ekonomis kayu sebagai bahan bakar substitusi batu bara di pabrik semen. *Forum Pascasarjana 31(2)*: 105-116.

[4] Hartono, BT. 2015. National energy related policy. Presentation for International Symposium on Wood Biomass in Indonesia "Current Status and Perspectives of Wood Biomass Business". Semarang, Indonesia, October 28, 2015.

[5] Hendrati, RL, Nurrohmah, SH, Susilawati, S. and Budi, S. 2014. Budidaya Acacia auriculiformis untuk Kayu Energi. Badan Penelitian dan Pengembangan Kehutanan, Balai Besar Penelitian Bioteknologi dan Pemuliaan Tanaman Hutan dan Direktorat Jenderal Bina Usaha Kehutanan. IPB Press. Jakarta, Indonesia.

[6] Jøker, D. 2000. Acacia mangium Willd. Seed Leaflet No. 3. Danida Forest Seed Centre. Humlebaek, Denmark. 2p.

[7] Van Valkenburg, JLCH. 1997. Albizia procera (Roxb.) Benth. In Faridah Hanum, and van der Maesen, LJG. Plant Resources of South-East Asia No. 11: Auxiliary plants. PROSEA (Plant Resources of Southeast Asia) Foundation. Bogor, Indonesia. Retrieved from http://www.proseanet.org on 7 December 2015.

[8] Hendrawan, I, Fanindi A. and Semali, A.2005. Karakteristik dan Pemanfaatan Kaliandra (Calliandra calothyrsus). Lokakarya Nasional Tanaman Pakan Ternak. Pusat Penelitian dan Pengembangan Peternakan, Kementerian Pertanian. Bogor, Indonesia. p.141-148.

[9] Simons, AJ. and Steward JL. 1994. Gliricidia sepium – a multipurpose forage tree legume. Retrieved from http:// www.fao.org/ag/agp/agpc/doc/publicat/ guttshel/x5556e07.htm on October 29, 2015.

[10] Jones, RJ, Brewbaker, JL. and Sorensson, CT. 1992. Leucaena leucocephala (Lamk) de Wit. In Mannetje, L't and Jones, RM. Plant Resources of Southeast Asia No. 4: Forages. PROSEA (Plant Resources of Southeast Asia) Foundation. Bogor, Indonesia. Retrieved from http://www.proseanet.org on 2 November 2015.

[11] Ahmad NR. 2013. Bioenergy industry based on forest biomass. Presentation for Panel Discussion Forum of Biomass Inductry in Indonesia. Embassy of South Korea and Ministry of Forestry Republic of Indonesia, on Septemer 5, 2013 at Grand Melia Hotel, Jakarta Indonesia.

[12] Heering, JH. and Gutteridge, RC. 1992. Sesbania grandiflora (L.) Poiret. In Mannetje, L't and Jones, RM. Plant Resources of South East Asia No. 4: Forages. PROSEA (Plant Resources of Southeast Asia) Foundation. Bogor, Indonesia. Retrieved from http://www.proseanet.org on 7 December 2015.

[13] Wawo, AH, Utami, NW. and Syarif, F. 2013. Konservasi Tumbuhan Bernilai Ekonomi Tinggi Melalui Pengembangan Model Agroforestri. Prosiding Seminar Nasional Agroforestri. p.104.

[14] Simons, AJ. and Steward JL. 1994. Gliricidia sepium – a multipurpose forage tree legume. Retrieved from http:// www.fao.org/ag/agp/agpc/doc/publicat/ guttshel/x5556e07.htm on October 29, 2015

[15] Jøker, D. 2003. Calliandra calothyrsus Meissner. Seed Leaflet No. 76. Danida Forest Seed Centre. Humlebaek, Denmark. 2p.

[16] Ellyn KD, Dewi W, Armaiki Y. 2015. Feasibility Study on Suitability and Expandability of Gliricidia sepium as a Biomass Plantation Species in Indonesia. Research Report, SEAMEO BIOTROP - Korea Green Promotion Agency (KGPA) Collaboration.

SEAMEO BIOTROP'S PRIORITY PROGRAMS

SEAMEO BIOTROP's program to become reputable centre in promoting "Save Biodiversity"

Source: Sri Widayanti SEAMEO BIOTROP, 2019

01 Save Biodiversity for Future Generations

02 Biodiversity Ranking and Database from Mountain to Ocean

03 Agro-eco-edu Tourism

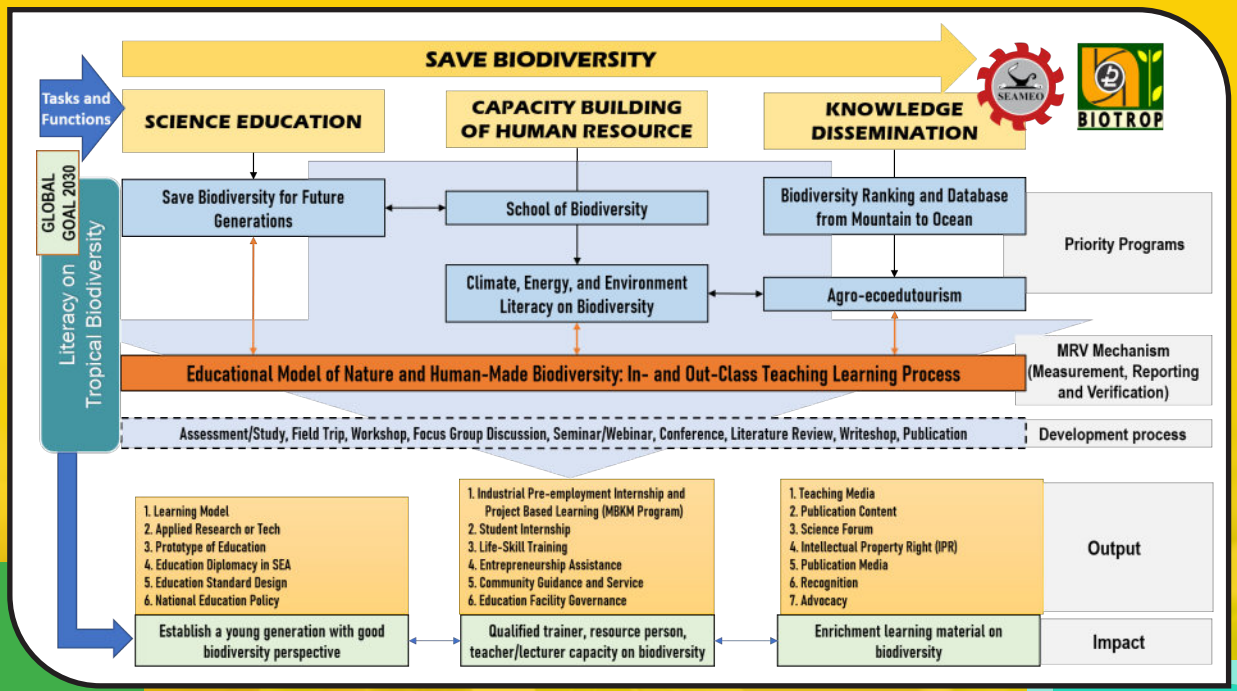
04 School of Biodiversity

05 Climate, Energy, and Environment Literacy on Biodiversity

06 Educational Model for Nature and Human Made Biodiversity In- and Out-of-Classroom Teaching and Learning Processes

07 Development of Biological Engineering for Sustainable Use of Biodiversity

08 Supporting Program: Institutional Governance and Human Resources Development



Program Design of SEAMEO BIOTROP's Priority Programs

Contact Person:

Sri Widayanti, M.Si
s_widayanti@biotrop.org
+62 811-110-093

Dewi Suryani, MM
dewisuryani@biotrop.org
+62 813-1444-3117

Source: https://www.pexels.com/photo/macro-shot-of-grass-field-580900/

Effectivity of Signal Grass (*Brachiaria decumbens*) Enrich with Microorganism to Absorb Heavy Metals (Pb)

Resource persons: Risa Rosita[a], Irdika Mansur[ab], Rahayu Widyastuti[c], Evelyn Bigcas[d]
Writer: Risa Rosita[a]

[a]SEAMEO BIOTROP, Indonesia
[b]Department of Silviculture, IPB University, Indonesia
[c]Department of Soil Science and Land Resources, IPB University, Indonesia
[d]College of Forestry & Environmental Studies, Mindanao State University, Philippines

*Coresponding author: risa@biotrop.org

Effectivity of Signal Grass (*Brachiaria decumbens*)

Introduction

Forest destruction, or deforestation, is four-pronged; it affects the biological, physical, chemical and social environments [1]. When a forest is destroyed, many organisms lose their habitats, climate regime is altered with the loss of carbon sequestering organisms, the consequent soil erosion affects the availability of soil nutrients, and the loss of habitat may also lead to the displacement of the indigenous people whose livelihood depends much on the forest.

Depletion of soil nutrients due to soil erosion is a serious consequence as it affects food security (availability, quality, quantity, access, utilization and stability). Hence, the replenishment of soil nutrients is of equal importance and a priority for human survival.

When left alone, nature may be able to fend for itself. However, the slow natural recovery process may not be able to cope with the rate of forest destruction, particularly the intrusion of heavy metals into the soil. Thus, some forms of soil intervention regime is necessary.

Like other fertile soils, the soils in Java, Bangka, Papua, Sulawesi, and East Nusa Tenggara islands are rich in minerals and nutrients that benefits many organisms [2,3,4,5,6]. However, due to improper management, human development activities had polluted these fertile lands.

Soil pollution, either intentional or unintentional, is the introduction of substances into the soil resulting in soil disturbances or damages by changing its initial condition [7]. These human activities causing soil pollution include mining and industrial development that introduce wastes and pollutants into the soil, water and air.

Heavy metals are one type of these soil pollutants. Naturally, soil contains the elements Si, Al, Fe, Ca, Na, K, and Mg derived from the weathering of parent

Source: Dani Yudi Trisna SEAMEO BIOTROP

materials [8]. The excessive presence of metals affects the soil properties and impacts the ecosystem balance. Contaminated soil can decrease soil quality, resulting in unhealthy soil and ultimately, in soil inability to support plant life. One of the heavy metal pollutants is lead (Pb). This metallic element can come from industrial waste and improper mining activities such as excessive use of agricultural and hazardous materials (B3), which can seep into the soil through air currents and settle in the soil layers. Lead waste in high amounts can be toxic and can endanger the health of plants, animals and humans. Based on its toxicity, Pb is a heavy metal classified under the highly toxic category.

As pollutants, heavy metals are difficult to remove naturally from the ecosystems. Hence, soil or chemical burning is necessary but this activity requires high costs and poses potential damage to the environment. Consequently, eco-friendly alternatives need to be carried out. One biological alternative to alleviate the impact of pollutant substances is soil remediation which involves the improvement of contaminated land using bioremediation and phytoremediation [9].

Risa Rosita, M.Si.
Head Section of Environmental Technology and Security (ETS), SEAMEO BIOTROP

Effectivity of Signal Grass (*Brachiaria decumbens*)

Bioremediation is carried out by utilizing the role of microorganisms in restoring contaminated soil [10]. Microorganisms are the first life forms that were highly adaptive to rapid changes brought about by critical environmental conditions. Microbes are everywhere and they literally impact the entire biosphere; starting from their major role in regulating biogeochemical cycles, extreme environmental conditions such as frozen environments, acid lakes, hydrothermal vents, and deep ocean floors, to the small intestines of animals [10]. Meanwhile, phytoremediation involves the use of symbiotic plants with microbes that have great potential to remedy contaminated soil [11].

Signal Grass Enrichment (*Brachiaria decumbens*)

Biological approaches using microorganisms and heavy metal resistant plants are a possible solution that is economical and environment-friendly in overcoming soil pollution by heavy metals, one of which is through enrichment planting with Signal grass (*Brachiaria decumbens*). In the efforts to improve the environment, researchers in Indonesia have tested several grass species in their abilities as phytoremediation agents such as *Chrysopongon zizanoides* L., *Scirpus grossus*, *Brachiaria humidicola, Eleusine indica, Paspalum notatum, Setaria splendida*, and *Panicum maximum* Jacq. However, Signal grass' potential as a phytoremediation agent in post-coal mining soil contaminated with Pb has not yet been reported.

Therefore, this study tried to determine the phytoremediation ability of Signal grass planted on ex-coal mine soil after enrichment by *Claroideoglomus etunicatum* and *Bacillus subtilis*. Available information about plants as phytoremediation agents are deemed necessary to help restore the fertility and productivity of post-mining soil.

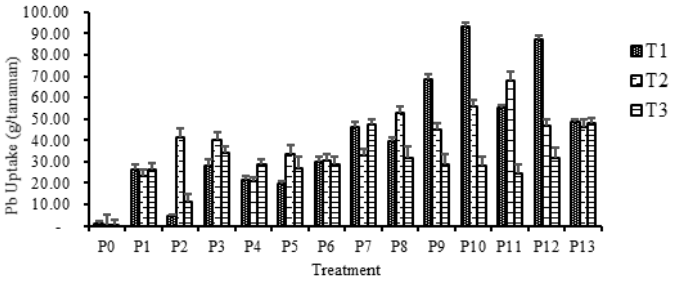


Figure 1. Comparison of Pb metal uptake in Signal Grass after 12 weeks of treatment from left to right: T1 = teak garden soil media, T2 = ex-mining soil media, T3 = ex-mining soil media, P0 = no treatment, P1 = 100% NPK, P2= 100% dolomite, P3= 50% NPK + 50% dolomite, P4= *C. etunicatum*, P5= *Bacillus* sp., P6 = *C. etunicatum* + *Bacillus subtilis*, P7= 50% NPK + *C. etunicatum*, P8 = NPK 50% + *Bacillus subtilis*, P9= NPK 50% + *C. etunicatum* + *Bacillus subtilis*, P10= Dolomite 50% + *C. etunicatum*, P11 = Dolomite 50% + *Bacillus subtilis*, P12= Dolomite 50% + *C. etunicatum* + *Bacillus subtilis*, P13 = 50% NPK + 50% dolomite + *C. etunicatum* + *Bacillus subtilis*.

Source: Dani Yudi Trisna SEAMEO BIOTROP

Effectivity of Signal Grass (*Brachiaria decumbens*)

The soil sample is the post-mining soil in the form of revegetation soil (T2) and overburden (T3) obtained from Bukit Asam, coal mining company, while the land for comparison is teak garden soil (T1) which was taken from SEAMEO BIOTROP teak gardens. Signal Grass enriched with *C. etunicatum* and *Bacillus* sp. (P4, P5, P6, P7, P8, P9, P10, P11, P12, P13) showing phytoremediation abilities, had absorbed large amounts of Pb pollutant compared to control (P0) and unenriched Signal grasses (P1, P2, P3) without damaging plant growth. The highest Pb pollutant absorption value in Signal grass enriched with *C. etunicatum* and *Bacillus subtilis* reached 93 g/plant. Phytoremediation ability arises because *C. etunicatum* and *Bacillus subtilis* help in increasing the total dry biomass of the plant, thereby increasing the metal uptake ability of the plant (Figure 1).

Before being treated, the Signal grass did not show phytoremediation abilities, but after being enriched with C. etunicatum and Bacillus subtilis it manifested phytoremediation capacity. The plants absorb the metal Pb pollutant in large quantities (93 g/plant). As such, research becomes really useful in supporting activities that help protect, restore, and promote the sustainable use of the earth's ecosystem, that sustainably manage the forests, that combat desertification, that revoke land degradation rights and eventually, implement biodiversity conservation.

Future Research Innovation Connectivity

This information on post-mining land resource management technology, particularly using plant as potential agents of phytoremediation and microorganisms as bioremediation agents are needed to guide policy formulation, decision making and implementation. This relates to the mission of Indonesia and other countries to stop deforestation during the decade 2021-2030 particularly, the agreement on the climate-related Summit (COP26) in Glasgow [12]. In addition, the research were carried out to support the international agreement of the UN Global Goals or the Sustainable Development Goals (SDGs) # 15 "Mining and Life on Land" [13] where the research activities were aimed to help promote sustainable forests and other terrestrial ecosystems by addressing human-induced land degradation.

Acknowledgements

The authors acknowledge the support of SEAMEO BIOTROP through the provision of research grants DIPA 2019 and Bukit Asam, coal mining company in Palembang for allowing the use of a post-mined land. The authors also express their gratitude to the BIODIVERS committee and DPIS IPB who were involved in the Workshop on Writing Popular Scientific Articles for BIODIVERS Magazine as a medium for disseminating research results.

References

[1] Manik, K. E. S. 2018. *Pengelolaan lingkungan hidup. Kencana.*

[2] Iskandar, J., Iskandar, B. S., & Partasasmita, R. 2018. Site selection and soil fertility management by the Outer Baduy People (Banten, Indonesia) in maintaining swidden cultivation productivity. *Biodiversitas Journal of Biological Diversity, 19*(4), 1334-1346.

[3] Sari, F. I. P., & Andini, D. E. 2020. Karakterisasi Mineral dan Geokimia Tailing Tambang Timah Pulau Bangka Bagian Utara. Jurnal GEOSAPTA Vol, 6(2), 73.

[4] Fauzan, A., Rosana, M. F., Yuningsih, E. T., Saputra, D. H., & Meiriyanto, F. 2020. Karakteristik Batuan Tambang Bawah Tanah Big Gossan Kabupaten Mimika, Provinsi Papua. Geoscience Journal, 4(1), 52-60.

[5] Haryati, E., Dahlan, K., Mantiri, S. Y. Y., & Singir, B. 2021. Profil dan Karakteristik Mineral Nikel Laterit di Daerah Angkasapura, Kota Jayapura, Papua, Indonesia. Jurnal Fisika, 11(2), 95-104.

[6] Putra, Y. S., & Hermawan, R. 2022. Identifikasi Potensi Sebaran Mineral Mangan (Mn) Berdasarkan Anomali Medan Magnetik Pada Lembar Kupang, Nusa Tenggara Timur. Bulletin of Geology, 5(4), 820-832. [1]

[7] Muslimah, M. S., & Si, S. 2017. Dampak pencemaran tanah dan langkah pencegahan. J. Penelit. Agrisamudra, 2(1), 11-20.

[8] Strahler, A. N., & Strahler, A. H. 1973. Environmental Geoscience : Interaction Between Natural System and Man. Hamilton Publishing Company.

[9] Purwani, J. 2010. Remediasi tanah dengan menggunakan tanaman akumulator logam berat akar wangi (*Vetiveria zizanioides* L.). Balai Penelitian Tanah. Bogor, 287-298..

[10] Seigle–Murandi, F., Guiraud, P., Croize, J., Falsen, E., Erikson,.K.L. 1996. Bacteria are omnipresent on Phanerochaete chrysosporium Burdsall. Applied and environmental microbiology, 62(7), 2477-2481

[11] Pilon-Smits, E. 2005. Phytoremediation. Annu. Rev. Plant Biol. 56, 15-39.

[12] Lennan, M., & Morgera, E. 2022. The Glasgow Climate Conference (COP26). *The International Journal of Marine and Coastal Law, 37*(1), 137-151.

[13] Parra, C., Lewis, B., & Ali, S. H. (Eds.). 2020. *Mining, materials, and the Sustainable Development Goals (SDGs): 2030 and beyond.* CRC Press.

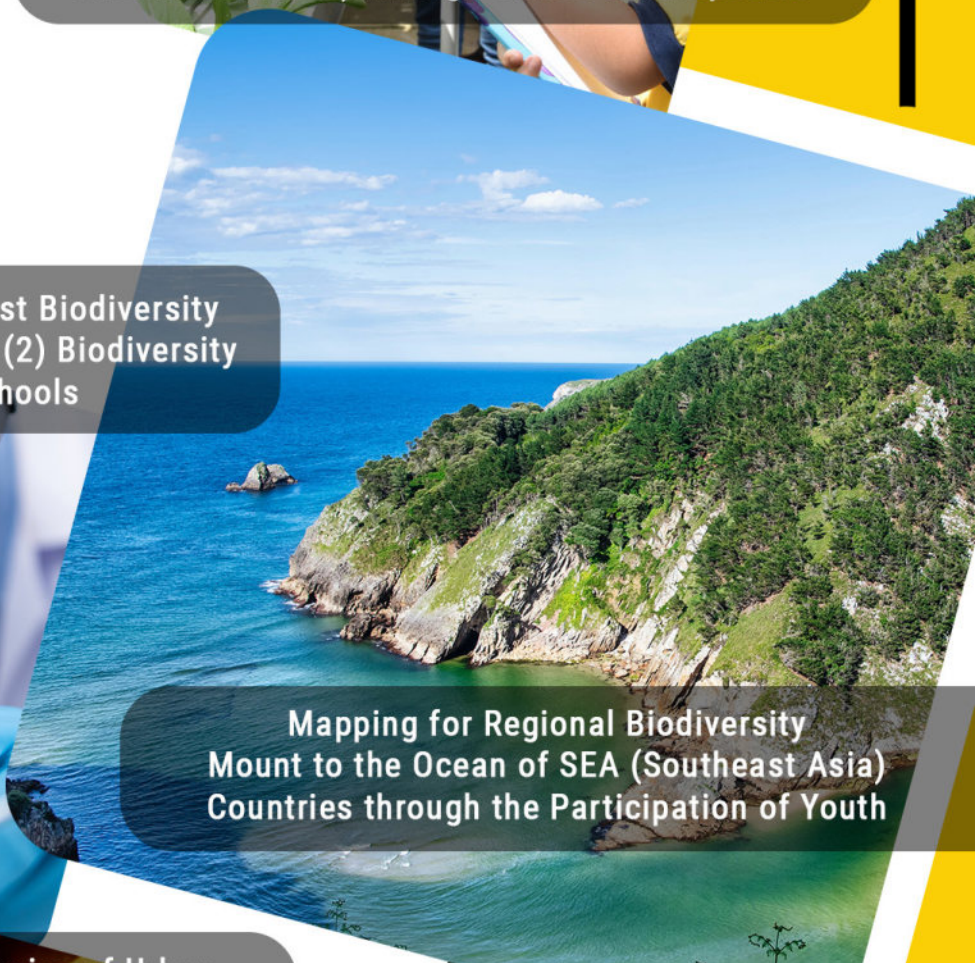
SEAMEO BIOTROP'S Priority Programs

SAVE BIODIVERSITY FOR FUTURE GENERATION

Contact Person
Risa Rosita, S.Si, M.Si.
risa@biotrop.org

Production of Organic Pesticide Prototypes to Conserve School Garden Commodity (Supporting BIONIK Activities) through School Participation

SEA Level Competition: (1) Best Biodiversity School SEA (Southeast Asia) & (2) Biodiversity Scientific SEA for Schools



Mapping for Regional Biodiversity Mount to the Ocean of SEA (Southeast Asia) Countries through the Participation of Youth

CPRN Project 1: "Coping Strategies of Urban Households to Ensure Food Security During the COVID Pandemic: a Case Study of 3 Communities in Indonesia and the Philippines (Sampling Area: South Bogor, Indonesia)

Project CPRN Project 2: Saving Biodiversity Through Environmental Education Among High School Students in SEA (Southeast Asia)

Re-establishing Natural Habitats Programme: A Catalyst for Biodiversity Restoration in Myanmar

Tluang Hmung Thang[a*] and Nay Yu[a]

[a]Nature and Wildlife Conservation Division, Forest Department, Ministry of Natural Resources and Environmental Conservation, Nay Pyi Taw 15011, Myanmar

*Corresponding author: tluanghmungthang@gmail.com

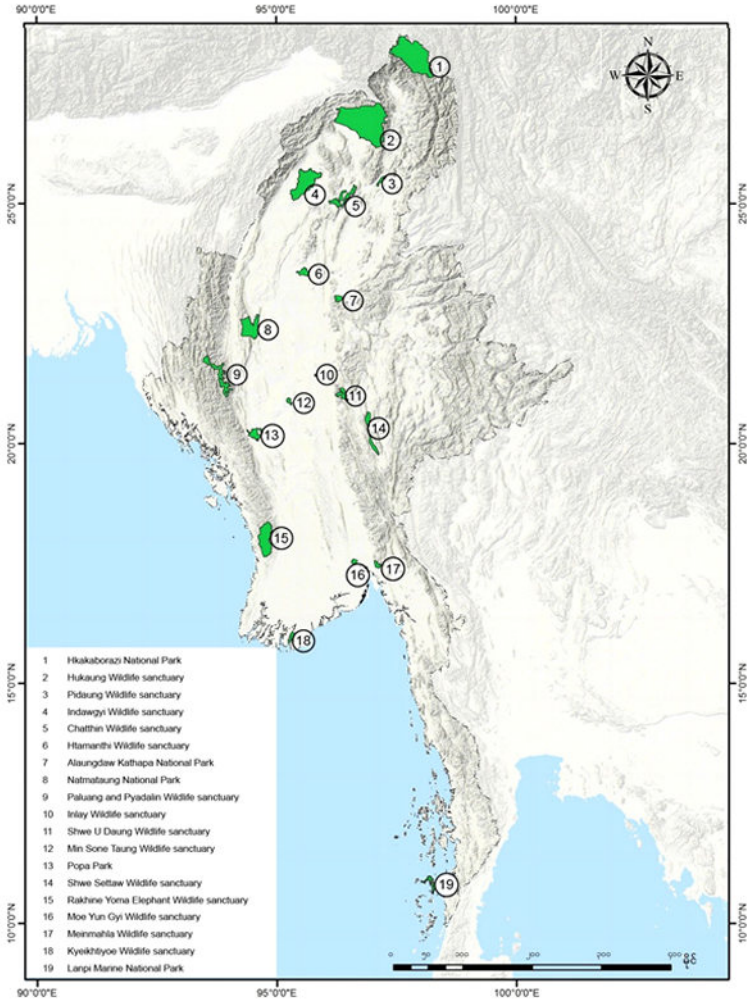


Figure 1. Location map of RNH implemented PAs

Introduction

Protected areas (PAs) play a pivotal role in the conservation of biological diversity, as these are homes to thousands of species, provide ecosystem services and help alleviate poverty [1]. Within a limited small-scale landscape, protected areas receive a high proportion of species and facilitate species' suitable range extension [2]. Consequently, countries aimed to expand their protected areas to conserve species and protect ecosystems. However, the effectiveness is being undermined by the lack of funding sources [1]. Just as small grant programs could fill the gaps in capacity building, research, and conservation agenda settings [3], governments and donors must take responsibility to upscale the management of PAs to prevent further declines of biodiversity in limited fragmented landscapes and the restoration of natural habitats.

Myanmar, located in the Indo-Burma biodiversity hotspot, is endowed with diverse ecosystems and precious biodiversity which are being conserved by the establishment of protected areas. Ongoing climate change, socio-economic development, urbanization and increasing human population negatively impacts the already declining ecosystem services. Thus, it is crucial to restore the natural habitats for effective biodiversity conservation and sustainable utilization of the ecosystem services [2,4]. Habitat restoration is a global priority in maintaining ecosystem services, conserving biodiversity, and combating climate change. United Nations declared the "UN Decade on Ecosystem Restoration 2021-2030" to implement ecosystem restoration as it is crucial in achieving the sustainable development goals. Thus, Myanmar government launched the Re-establishing Natural Habitat Programme (RNH) (2019-2020 to 2028-2029), to achieve its objectives to protect the ecosystems and biodiversity, and to fulfill its commitments to international conventions and programs such as the Convention of Biological Diversity (CBD), Paris Agreement and Sustainable Development Goals (SDG), and the Myanmar Sustainable Development Plan of 2018-2030 [5].

The long-term goals extend to the restoration of ecosystems which ensures the sustainable supply of ecosystem services, climate change mitigation, and which promotes public and stakeholder participation in ecosystem resiliency and biodiversity conservation. The main objectives of the RNH include developing effective protected areas management plans, sustaining the natural resources, ensuring that the conservation of ecosystems and biodiversity results in community development, enhancing community participation and fulfilling commitments to international agreement, programs, and conventions. Findings and outputs from surveys and activities obtained from the RNH will provide baseline data to upscale the effective management of PAs, and enhance restoration strategies and planning. The RNH is being implemented in 19 protected areas of Myanmar namely; Hkakaborazi National Park, Hukaung Wildlife Sanctuary, Pidaung Wildlife Sanctuary, Htamanthi Wildlife Sanctuary, Indawgyi Wildlife Sanctuary, Chatthin Wildlife

Sanctuary, Shwe U Daung Wildlife Sanctuary, Alaungdaw Kathapa National Park, Natmataung National Park, Min Sone Taung Wildlife Sanctuary, Panlaung and Pyadalin Wildlife Sanctuary, Popa Park, Shwesettaw Wildlife Sanctuary, Inlay Wildlife Sanctuary, Rakhine Yoma Wildlife Sanctuary, Moe Yun Gyi Wildlife Sanctuary, Kyeikhtiyoe Wildlife Sanctuary, Meinmahla Wildlife Sanctuary and Lanpi Marine National Park, respectively (Figure 1).

Implementation

The RNH is to be implemented according to conceptual model developed for each protected area (Figure 2).

The 10-year RNH invested about 5,188 million Myanmar kyats, and the evidence of progress and effectiveness are to be assessed through the department standard operating procedures on a monthly, quarterly, and annual basis. Under the umbrella of RNH, 13 main activities for the re-establishment (Table 1) and 15 main activities for the protection were set up to achieve the objectives (Table 2) [6,7].

Figure 2. Conceptual model of RNH

Table 1. Main activities for the re-establishment in RNH

No.	Activity
1	Improving wildlife corridors
2	Establishing gap plantations (Mangrove and animal food plant)
3	Establishing gap plantations (Mangrove and animal food plant)
4	Cleaning of weed and Eichhornia
5	Creating artificial salt licks for wild animals
6	Restoring pastureland for elephant, deer, hog deer, gaur, banteng, sambar, Myanmar star tortoise, birds
7	Building artificial resting places for birds
8	Conserving pastureland and nesting sites for birds
9	Establishing protected zones for fish breeding
10	Cleaning of *Mimosa pigra*
11	Measuring water depth and water quality
12	Soft release of Myanmar star tortoise
13	Establishing protected zones for coral reef

Table 2. Main activities for the protection in RNH

No.	Activity
1	Construction of patrol station (camp)
2	Patrolling
3	Boundary pillar construction
4	Installation of signboards
5	Education and awareness raising
6	Creating pamphlets, brochures and posters
7	Measuring and protection of springs and water headways
8	Construction of fire lines
9	Star tortoise inventory and survey
10	Fauna and flora inventory and surveys (wild elephant, tiger, bird, mammal, white browed nuthatch, Popa langur, crocodile, Eld's deer, insect, plant, marine species, amphibian and reptile, fish, tiger, takin and red panda, Ayeyarwady dolphin)
11	Shore protection for turtle
12	Distribution of fuel efficient cooking stove
13	Ecotourism enhancement
14	Archiving of plant and insect samples
15	Capacity building and training on surveys and sampling techniques

https://www.pexels.com/id-id/foto/tampilan-jarak-dekat-dari-tiger-247615/

Current major outcomes

The RNH has been implemented for two years and some of the main outcomes of the re-establishment activities include 76 ha of improving wildlife corridors, 60 ha of gap plantations (mangroves), 180 ha of gap plantations (forests and animal food plant), 104 ha of restoring wildlife pasturelands, and creating salt lick of 281 sites. The main protection activities include the construction of 1918 boundary pillars, 19 patrol stations, and distribution of 8232 fuel efficient cooking stoves (Figure 3).

Species surveys and recording were also conducted in all targeted PAs by park rangers and staff of Nature and Wildlife Conservation Division (Figure 3 and Supplementary). The Eld's deer (*Rucervus eldi thamin*) which is endemic to Myanmar was monitored in Shwesattaw Wildlife Sanctuary (SWS). Results showed that the population of Eld's deer was 952±440 (mean±SE) in 2019, 1106±359 in 2020, 653±244 in 2021, and 1368±359 in 2022. While in Popa Mountain Wildlife Sanctuary the estimated population of Popa langur (*Trachypithecus popa*) was 98 in 2020, 87 in 2021, and 90 in 2022. In Meinmahla Wildlife Sanctuary the recorded number of Crocodile (*Crocodylus porosus*) was 107 in 2019, 119 in 2020 and, 115 in 2021. From 2019 October to 2022 March, environmental education and awareness raising was conducted 326 times and the training was 16 times.

Although most of the activities contributed to better understanding of the species' habitat and their status, the government cannot afford to successfully operate such activities due to limited availability of funds for conservation. Nevertheless, in the current implementation of RNH, several effectiveness and weakness also emerged (Figure 4). The SWOT analysis suggested that strength and opportunities found in the analysis can be incorporated in future activities and related strategies. Significant weakness and threats indicate that the implementation of RNH still needs to consider some potential and unprecedented causes of climatic and anthropogenic factors. In addition, those weaknesses pointed out the need for further inputs in such activities.

Figure 3. Implemented activities of RNH

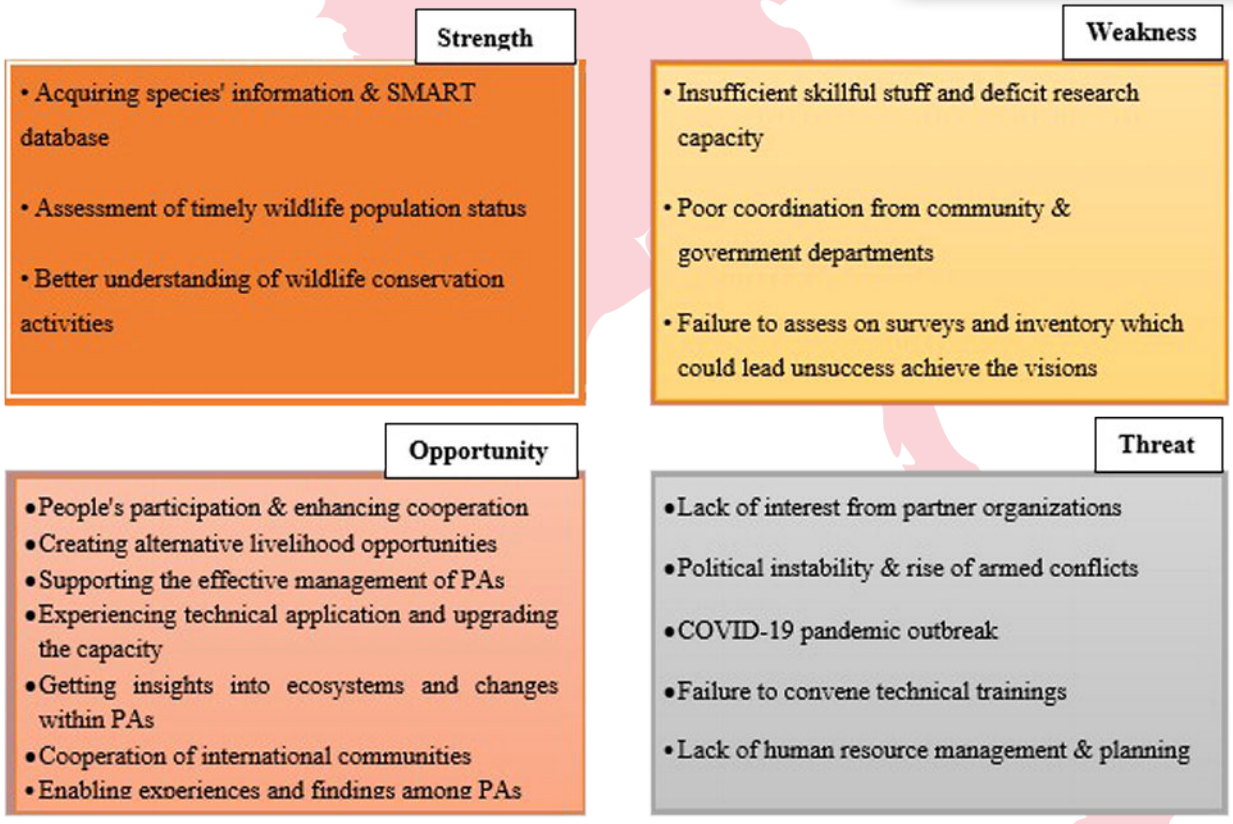


Figure 4. SWOT analysis on RNH

Conclusion

Conserving protected areas (PAs) are of utmost importance in maintaining biological diversity, and sustaining diverse ecosystems. Hence, effective management of PAs is crucial in this age of species extinction. Investing in the restoration and management activities of PAs is a wise move in saving the biodiversity and nature, as a whole. The RNH program highlights the contribution of grants and investments that can leverage the re-establishment and rehabilitation of habitats, and protection activities in PAs.

Although the RNH is a grant-oriented program, some weaknesses are detectable. To implement the activities successfully and achieve the goals, program should emphasize the need for skillful and efficient staff, and for enhancing cooperation of local community, concerned entities and related departments. The authors, therefore, recommend for the consideration of potential threats and weakness in the implementation operations to facilitate the effective and efficient achievement of the targeted goals. The role of protected areas reaches far more than the conservation of biodiversity and ecosystems, as PAs also contribute in carbon trade off and the Nationally Determined Contribution-NDC and Sustainable Development Goals. Therefore, effectively managing and restoring the natural habitats not only achieve the goals of conserving biological diversity and ecosystems, but also help in combating other environmental problems and menaces.

Reference

[1] Lindsey, P.A., Millera, J.R.B., Petracca, L.S., et al. 2018. More than $1 billion needed annually to secure Africa's protected areas with lions. *Proc Natl Acad Sci USA*. 115:45, 10788–10796. https://doi.org/10.1073/pnas.1805048115

[2] Thomas, C.D., Gillingham, P.K., Bradbury, R.B., et al. 2012. Protected areas facilitate species' range expansions. *Proc Natl Acad Sci USA*. l. 109:35, 14063–14068. https://doi.org/10.1073/pnas.1210251109

[3] Báez, S., Mazzarino, M., Peralvo, M., & Sears, R.R. 2020. Evaluating the impacts of a small-grants program on sustainable development and biodiversity conservation in Andean Forest landscapes. Mountain Research and Development. 40:2, D1–D7. https://doi.org/10.1659/MRD-JOURNAL-D-19-00066.1

[4] Thu, A.M., Li, G.G., Zhang, M., et al. 2019. Group size and social organization of the endangered Eld's deer (*Rucervus eldii thamin*): Results from a long-term study in Myanmar. *Glob. Ecol. Conserv.* 18:e00618. https://doi.org/10.1016/j.gecco.2019.e00618

[5] RNH, 2019a. The Re-establishing Natural Habitat Programme (RNH) (2019-2020 to 2028-2029), Forest Department, Ministry of Natural Resources and Environmental Conservation, Nay Pyi Taw, Myanmar.

[6] RNH, 2019b. The Re-establishing Natural Habitat Programme (RNH) Annual Report. Forest Department, Ministry of Natural Resources and Environmental Conservation, Nay Pyi Taw, Myanmar.

[7] RNH, 2020. The Re-establishing Natural Habitat Programme (RNH) Annual Report. Forest Department, Ministry of Natural Resources and Environmental Conservation, Nay Pyi Taw, Myanmar.

SAVE BIODIVERSITY

THE USE OF BIODIVERSITY RANKING AND DATABASE FROM MOUNTAIN TO OCEAN

Development of tropical biodiversity database as a source of data and information in the context of saving tropical biodiversity

Activities to be performed as part of the "Biodiversity Ranking and Database from MOTO" program include:

- **Development of biodiversity database portal**
- **Study of biodiversity ranking of national parks and geoparks**
- **Development of virtual science park for biodiversity collection**
- **Development of a competency-based training system in herbarium management**
- **Development of IAS risk management system and technology**
- **Development of scientific publication for policy**

Contact person : Dr Harry Imantho, M.Sc (harry@biotrop.org)

TIMELINE 2022 - 2026

Biodiversity Database from Mountain to Ocean

Tropical Biodiversity Ranking from Mountain to Ocean

	2022	2023	2024	2025	2026
Activity	• Framework Development of Tropical biodiversity database • Study on Tropical Biodiversity Ranking: *Dev. concept and indicators of biodiversity ranking* • Developing Learning material and publication	• Development of Tropical biodiversity database from Mountain to Ocean • Study on Tropical Biodiversity Ranking: *Scooping indicators and validation* • Developing Learning material and publication	• Development of Tropical biodiversity database from Mountain to Ocean • Study on Tropical Biodiversity Ranking: *Developing biodiversity ranking technique/tools* • Developing Learning material and publication	• Promotion and operationalization of Tropical biodiversity database • Study on Tropical Biodiversity Ranking: *Validation biodiversity ranking technique/tools* • Developing Learning material and publication	• Impact Assessment of Tropical biodiversity database from Mountain to Ocean • Study on Tropical Biodiversity Ranking: *Promoting biodiversity ranking technique/tools into policy study* • Developing Learning material and publication
Output	• Framework of tropical biodiversity database • Concept and key indicators of biodiversity ranking • Publication	• Portal of Tropical Biodiversity Database for Kingdom Plantae • Validated indicators of biodiversity ranking • Scientific publication, learning materials	• Updated Portal of Tropical Biodiversity Database for Kingdom Plantae and Animalia • Biodiversity ranking technique/tools • Scientific publication, learning materials • Document for IPR proposal	• Updated Portal of Tropical Biodiversity Database for Kingdom Plantae and Animalia • Validated biodiversity ranking technique/tools • Scientific publication, learning materials • IPR	• Strategy for enhancing Tropical Biodiversity Database • Biodiversity ranking technique/tools adopted/widely-used by stakeholders • Scientific publication, learning materials

DNA Amplification using Real-Time PCR machine

Source: Asep Saepudin SEAMEO BIOTROP

Biotechnology for Tropical Plant Breeding in SEAMEO BIOTROP

Dewi Rahmawati[a] and Ulfah J. Siregar[ab]*

[a]SEAMEO BIOTROP, Indonesia
[b]Department of Silviculture, Faculty of Forestry and Environment, IPB University, Indonesia

*Corresponding author: ulfahjs@apps.ipb.ac.id

Source: Aditya Nugroho (IPB University)

Introduction

Tropical biodiversity is the world's very valuable asset. Tropical plant biodiversity provides food, feed, clothing and shelter for a large portion of the world's population. The sustainability of biodiversity, therefore, is very important for life sustainability. Considering environmental degradation and the subsequent increasing number of endangered endemic plant species, strengthening our efforts toward saving biodiversity is indeed essential. The environmental degradation that is mostly caused by anthropogenic activities is derived from the ever-growing population, namely; deforestation, mining, expanding tourism, settlement and many others. The declining environmental condition affects the sustainability of biodiversity. Thus, collecting and assessment of the richness of tropical genetic resources are very critical for conservation and sustainable utilization. Biotechnology and plant breeding, through the production of superior plant seedlings with high productivity, must augment conservation efforts to sustain biodiversity.

Nowadays, agriculture production is pushed further toward marginal land as more fertile land is occupied by settlement. This situation juxtaposed the requirements for new agricultural varieties and clones which are adaptable to harsh environments. However, the seeds market often consists of traditional non-certified seeds with uncertain availability. The very limited availability of certified seeds with new adaptive potential has resulted in their exorbitant prices. The increasing need for certified new seeds often calls for a breakthrough technology supported by genomic breeding techniques, discovered through research on the nursery-raised selected superior clones [1]. Plant breeding programs include the development of clone banks for genetic conservation, clone seed gardens and propagation of important plants resulting from controlled gene crosses. The superior clones are then raised to develop seed gardens as seed sources to produce high-quality plant varieties. The first phase is to identify the parent trees as genetic resources. The second phase is to select superior seeds to achieve high-quality plants.

New Molecular Techniques for Plant Breeding

Selection is the first important technique during the plant domestication process leading to a successful plant breeding program. Selection is a choosing process of plants with the most desirable properties in accordance with the objectives of the plant breeding program from a set of existing plant populations. The primary purpose of the selection is to improve the plant's genetic traits by increasing the targeted gene pools in a population. Nowadays, selection could be done either *in-vivo* or *in-vitro*. *In-vitro* selection is often preferred due to its

Figure 1. Utilization of biotechnology: a). *In-vitro* selection; b). *In-vitro* micrografting; c).
Note: Results of breeding by using mutation technology in *Acacia mangium*.

several advantages such as requiring only a smaller area and having more homogenous controlled conditions compared to field conditions, which make selection highly effective. *In-vitro* selection is usually done to study the relationship between phenotypes and genotypes as well as to implement non-controversial biotechnology approaches for obtaining superior plant cultivars, i.e., by genetic engineering. *In-vitro* plant breeding includes micropropagation techniques for obtaining large quantities of seeds, induction of somaclonal diversity, *in-vitro* tubing and obtaining secondary metabolites [2].

Plants produce various types of secondary metabolites in their tissues, however, their concentrations are very low and their formation depends on the stage of plant development. Extraction of plant secondary metabolites often faces obstacles due to the limited amount of plant supply and the high cost of purification. *In-vitro* culture is an efficient alternative for producing secondary metabolites with various advantages, including independence from varied environmental conditions (geographic location, climate and season), careful selection of multiplied cells that contain certain secondary metabolites, observable cell growth and observable cell metabolic processes [3, 4]. The metabolic processes can be rationally regulated to form bio-active compounds under controlled conditions in a relatively shorter period in a free-microbial-contaminated environment. One example is the production of agarwood employing the *in-vitro* dual culture interaction technique, in which several selected potential fungi are applied to cultured agarwood plant tissue to induce the formation of agarwood compounds as secondary metabolites (Fig. 1a). *In-vitro* micrografting is a vegetative propagation technique carried out in an aseptic environment using *in-vitro* culture techniques aimed at combining the superior characteristics of rootstock and scion (Fig. 1b).

The advantages of using the *in-vitro* micrografting technique include rejuvenating tissue from old plants, allowing a year-round seed production, shortening the production time in providing grafted seeds and disease-free plants, increasing studies on the compatibility and correlation between rootstock and scion, making desired specific combination among genotypes, reducing environmental impacts, shortening the breeding cycle, increasing resistance to diseases and parasites originating from the soil, increasing nutrient uptake, increasing plant's vigor, providing multiple production periods with uniform quality, increasing production and having knowledge of the compatible and incompatible micrografting techniques. In a compatible micrografting, the reciprocal relationship between rootstock and scion occurs normally, which will affect the variability in nutrients distribution patterns, the nutrients movement across the joint junction and the regulation of hormone transport.

Another in vitro breeding technique is the use of mutation technology to bring out new characters. The mutation was induced in *Acacia mangium* tissue culture having high cellulose content, which otherwise is limited in nature. The micropropagation of *Acacia mangium* generation M1 is obtained by mutation breeding technique (Fig. 1c).

The success of plant breeding depends on several factors, namely genetic

diversity, expected inheritance and potential genetic advantages. So far, morphological identification is used to distinguish new varieties from the existing ones. However, morphological

identification can provide biased results due to similar parental characteristics from which the varieties are derived, especially for plants having narrow genetic diversity. Morphological evaluation is subjective. The appearance of plant morphology is controlled by genetic traits that are influenced by environmental factors. Stronger environmental factors can cause variations in plant morphology and responses to a certain condition, such as soil fertility, pest and disease attacks. Molecular techniques could help in distinguishing plant accessions.

Molecular markers have a very broad potential to shorten the breeding duration and increase the efficiency of breeding programs. Their development allows plant breeders to assess genes almost directly, providing ways to select genes responsible for the desired traits, such as pest and disease-resistant genes in plants. PCR-based markers, such as RAPD, microsatellites or SSR, PCR-RFLP and AFLP, which are relatively easy and cheap to develop have been used frequently to tag genes involved in economically important traits using QTL mapping.

Microsatellite markers were utilized in studying the Sengon (*Falcataria moluccana*) resistance to gall rust disease [5]. Previous RAPD markers could not differentiate accessions showing different resistance and susceptibility against gall rust disease [6]. SSR markers which usually give higher polymorphisms than RAPD and more stable results could be used to evaluate the germplasm diversity. Through the SSR markers a high level of heterozygosity was found in a Sengon population (Fig. 2). The SSR markers were able to genetically differentiate some resistant accessions of Sengon from some susceptible ones. However, some other accessions remained clustered together forming separate groups with intermediate reactions toward the gall rust disease (Fig. 3).

Further investigation on the resistance and susceptibility of Sengon accessions was done using phytochemical screening, which is a technique to determine secondary metabolite presence in the accessions. Different secondary metabolites which are resistant and susceptible to the gall rust disease were found on substances extracted from sengon trees. The susceptible Sengon trunk contained flavonoid, saponin, phenolic, hydroquinone, tannin, triterpenoid and steroid, but did not contain alkaloids. On the contrary, the trunk of Sengon trees which are resistant to the gall rust disease contained flavonoids, saponin, triterpenoid and stronger ssteroids compared to the susceptible ones [7].

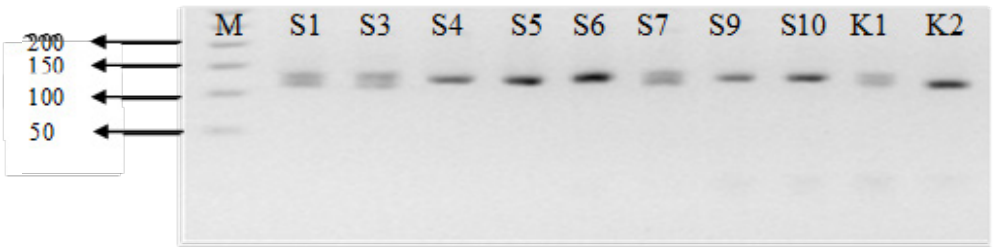


Figure 2. The use of microsatellite molecular markers on *Falcataria moluccana* which is resistant and susceptible to gall rust disease
Notes: M = Marker, bp); S1-S10 (Sengon is resistant against Kediri), K1-K2 (Sengon is susceptible to Kediri).

Dewi Rahmawati S.Si, M.Si
Staff of Environmental Technology
and Security (ETS), SEAMEO BIOTROP

Source: Asep Saepudin SEAMEO BIOTROP

The generation of previous molecular markers is often inadequate to differentiate accessions clearly as explained above. The coming of the next-generation sequencing era opens the possibility of generating more powerful markers based on genomic or transcriptomic sequences from relatively cheap sequencing processes. Transcriptomic sequences from Sengon having resistance and susceptibility against stem borer pest and gall rust disease have been published recently [8, 9]. From the available sequences, it is easy to detect single nucleotide polymorphisms (SNPs) among the sequenced accessions. Now SNPs are becoming the choice markers to tackle complicated traits with complicated inheritance patterns. Genome-wide association study (GWAS) is often performed to dissect complicated traits using the association between phenotypes influenced by environmental factors with markers scattered throughout the genome. The use of SNPs and GWAS would accelerate the breeding program of tropical plant species with more precision.

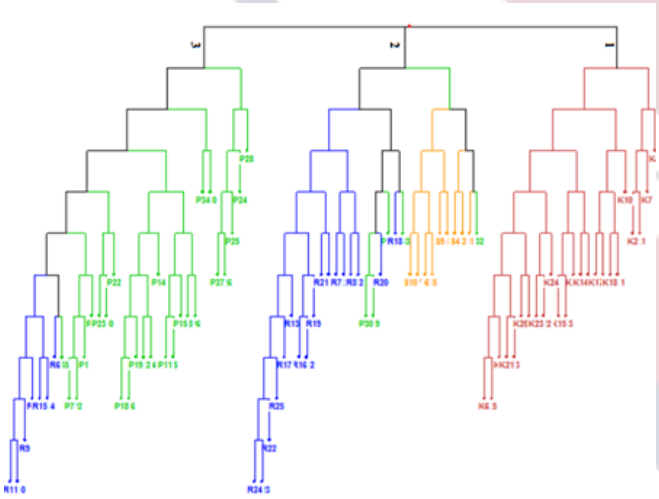


Figure 3. Dendrogram showing clustering of Sengon accessions from two populations of Kediri and Sukabumi into three main groups with different resistance and susceptibility against gall rust disease

References

[1] Tasma MI. 2015. Pemanfaatan Teknologi Sekuensing Genom untuk Mempercepat Program Pemuliaan Tanaman. J Litbang Pert 34(4):159-68.

[2] Rahmawati D. 2021. Teknologi Kultur Jaringan di Laboratorium Bioteknologi. Penerbit SEAMEO BIOTROP.

[3] Dias MI, Sousa, João M, Alves, Rita C, Ferreira, Isabel CFR. 2016. Exploring Plant Tissue Culture to Improve the Production of Phenolic Compounds: A Review. Industrial Crops and Products 82:9-22.

[4] Toungos MD. 2018. Plant Growth Substances in Crop Production: A Review Int Innovative Agric & Bio Res 6(3):1-8.

[5] Siregar UJ, Rahmawati D, Damayanti A. 2019. Fingerprinting Sengon (*Falcatria moluccana*) accessions resistant to boktor pest and gall rust disease using microsatellite markers. Biodiversitas 20(9):1698-706.

[6] Dwiyanti FG, Siregar IZ, Siregar UJ. 2019. Phenotypic and Genetic Diversity Evaluation of Sengon (*Falcataria moluccana* (Miq.) Barneby & JW Grimes, Editors from Solomon Provenance on Progeny Trial in Cirangsad Experimental Forest, West Java. Jurnal Manajemen Hutan Tropika, 27(3):174-83.

[7] Rahmawati D, Khumaida N, Siregar UJ. 2019. The Morphological, Wood Anatomical and Phytochemical Characterization of Susceptible and Resistant Sengon (*Falcataria moluccana*) Tree to Gall Rust Disease. Biodiversitas 20(3):907-13.

[8] Shabrina H, Siregar UJ, Matra DD, Siregar IZ. 2019. The dataset of de novo transcriptome assembly of *Falcataria moluccana* cambium from gall-rust (*Uromycladium falcatarium*) infected and non-infected tree. Data in brief 26:104489.

[9] Siregar UJ, Nugroho A, Shabrina H, Indriani F, Damayanti A, Matra DD. 2021. De novo transcriptome assembly data for Sengon (*Falcataria moluccana*) trees displaying resistance and susceptibility to boktor stem borers (*Xystrocera festiva Pascoe*). BMC Res Notes 14:261.

Agro-Eco-Edu-Tourism Program
in Supporting Biodiversity Conservation

SEAMEO BIOTROP'S Program to enhance the continuation of tropical biodiversity conservation program in Southeast Asia through agricultural and ecosystem based education and tourism activities

Contact Person: Rhomi Ardiansyah (rhomi@biotrop.seameo.id)

Develop Process | Strategi Direction

FGD
- Strategic Plan
- Growth/Demographic
- Community Issues
- Expectations
- Aspiration

Identify Facilitie Needs

WORKSHOP
- Program Needs
- Building and Space Needs
- Site Needs
- Infrastructure
- Aspiration

Planning Parameters

PLANNING AND PUBLIC REVIEW
- Core Principle/Value
- Goals and Objectives
- Planning Frameworks
- Future Vision
- Campus Design

Document

DEVELOPMENT
- Graphic
- Maps
- Drawings
- Writings
- Processes

Implementation

IMPLEMENTATION STRATEGIES
- Priorities
- Funding
- Capital Planning
- Strategies

- Design and Concept Agro-Eco-Edu-Tourism (AEET)
- Disseminating innovation product and knowledge development

Becoming the Centre of Tropical Fruit and Ornamental Fish Biodiversity Conservation through Agro -Eco-Edu-Tourism

AEET Model for Southeast Asia

	2022	2023	2024	2025	2026
Activity	- Development of Masterplan - Study on the implementation Criteria and Indicator	- Feasibility Study and Site plan - Detail Engineering Design (DED) Development - Study on Tropical Fruit and Ornamental Fish Cultivation and Technology	- Establishing AEET at SEAMEO BIOTROP - Establishing Entrepreneurship One Stop Shop Technology Centre	- Establishment of AEET at SEAMEO BIOTROP - Integrated Traveller Camp Information System	- Study on Learning Model Development of Agro -Eco-Edu - Tourism for Tropical Biodiversity Conservation
Output	- Document Master Plan of AEET at SEAMEO BIOTROP - Implemented Criteria and Indicators of AEET in VHS	- Document of Feasibility Study and Site plan - DED and cost analysis - Collaboration partners - Learning Modul - Research and review paper	- Construction - Research Product Dissemination	- AEET model - Traveller Camp prototype	Learning Model

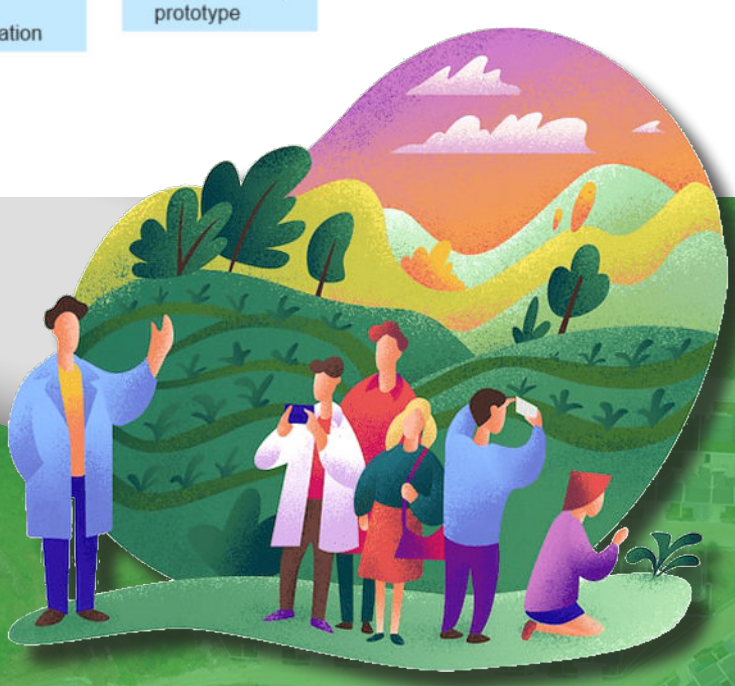


Photo by Hadura Abu Hasan

The Role of Black Soldier Fly Larvae in Conserving Biodiversity

Hadura Abu Hasan[a]*

[a]Vector Control Research Unit, School of Biological Sciences, Universiti Sains Malaysia, 11800 Penang, Malaysia.

*Corresponding author: hadura@usm.my

Introduction

Conserving biodiversity can be accomplished through programs that involve public policies, communities, and ecosystems. Biodiversity keeps ecosystems in balance so they can continue to function and regulate themselves. It maintains our existence in innumerable ways by supplying us with food, fuel, shelter, and medications. One such activity that protects and maintains the diversity of the declining ecosystem is composting. In such natural technology, a wide range of fungi, bacteria, and other invertebrates including insects convert the available nutrients from the organic matter to develop and reproduce. Insects, such as flies, beetles, termites, ants, and other arthropods, all make substantial contributions to the transformation of organic matter into valuable materials.

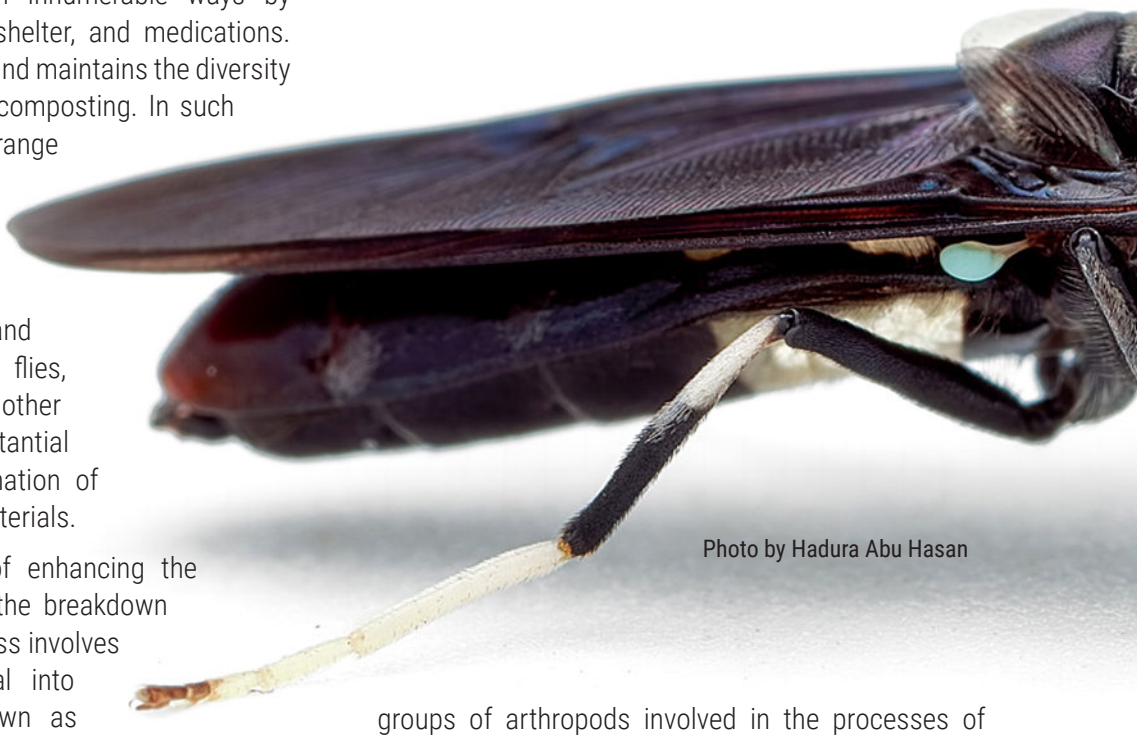


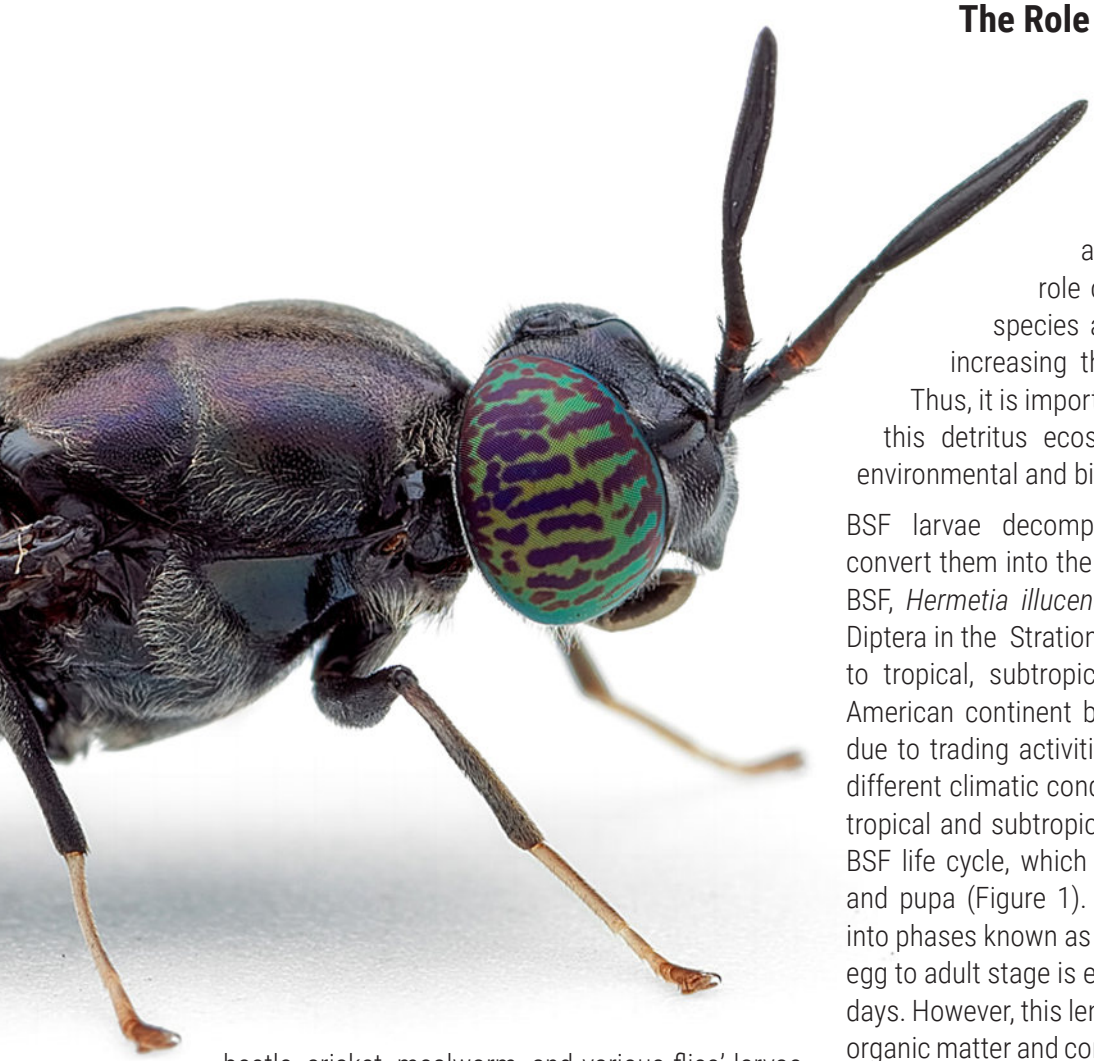
Photo by Hadura Abu Hasan

Composting is the process of enhancing the nutrient content produced by the breakdown of organic materials. The process involves decomposing organic material into a humus-like substance, known as compost. Generally, composting heaps require a constant supply of organic materials from the surrounding environment. The air and moisture around the composting areas are greatly responsible for the conversion of organic matter. Compounds formed throughout the various phases of decomposition attract a wide range of invertebrates whose life cycles are completed inside the compost. This activity protects and maintains the diversity of decaying ecosystems, resulting in the preservation of specific types of biodiversity in the environment. Hence, it was deemed necessary to educate the public about the variety of organisms that can be found inside it.

Decomposers

A decomposer is an organism that feeds on and decomposes dead plant or animal matter, releasing organic nutrients into the ecosystem. It is commonly classified as a bacterium, fungus, or invertebrate. Many yeasts, bacteria, and fungi contribute to the production of enzymes that degrade the cellulose, lignin, and tannins in waste. Pre-treatment by the microbial activity or the presence of lactic acid bacteria helps to improve digestibility and utilization of the nutrients in the organic substrate by the invertebrate animals [1]. The important groups of arthropods involved in the processes of decomposition of plants and animal remains belong to several taxonomies. They are responsible for eliminating dead organic matter and releasing nutrients into the soil. Mesofauna includes mites (Acari), springtails (Collembola), and small insects with sizes ranging from 100 to 200 mm. The larger size of the organisms is called macrofauna, which includes earthworms (Oligochaeta), beetles (Scarabaeidae, Geotrupidae or Silphidae), Diptera larvae (Muscidae, Sarcophagidae, Scatophagidae, Stratiomyidae or Calliphoridae), centipedes (Diplopoda), millipedes (Myriapoda) and woodlice (Isopoda) [2].

Decomposition is a natural biological process that reduces the organic materials while composting occurs under a controlled environmental condition. The natural decomposition process is time-consuming, has potential microbial contamination, produces offensive odours, and may contain insufficient nutrient content. The controlling process in composting differentiates from decomposition by requiring certain conditions such as the feed substrates, temperature, humidity, and acidity for the organisms to survive. Composting can be achieved through the enzymatic degradation of organic materials as they pass through the digestive system of the invertebrates. In recent years, an increasing number of studies are considering the use of insects such as the



beetle, cricket, mealworm, and various flies' larvae in waste management or particularly, composting [3]. Among these species, the Black Soldier Fly (BSF) larvae have become popular worldwide due to their ability to degrade a various range of organic matter [4].

The BSF larvae

The prominently labelled insect decomposer, BSF larvae, was discovered through composting; living in natural ecosystems with plentiful organic matter. They are not only reproducing but also contribute to the composting process in their unique way. Many decomposer insects were found but this species was a companion that completed its entire life cycle in the compost. Since the composting matter has become a miniature ecosystem, then it has also become essential and deemed necessary to educate the people and for them to understand the role of these larvae in biodiversity. This species accelerated the process while also increasing the nutrient value of the compost. Thus, it is important to remind the community about this detritus ecosystem, which ultimately leads to environmental and biodiversity conservation.

BSF larvae decompose various organic waste and convert them into the non-polluted, high nutrient residue. BSF, *Hermetia illucens* (Linnaeus) belongs to the order Diptera in the Stratiomyidae family. This species is native to tropical, subtropical, and temperate regions of the American continent but has been distributed worldwide due to trading activities. BSF is uncommonly tolerant to different climatic conditions apart from its preference for tropical and subtropical regions. There are five stages in BSF life cycle, which include adult, egg, larva, pre-pupa, and pupa (Figure 1). The larval stage is further divided into phases known as an instar. The life cycle of BSF from egg to adult stage is estimated to be completed within 44 days. However, this length of time depends on the types of organic matter and conditions of the present environment.

BSF larvae start to feed on a discovered organic source once it hatches from the eggs. The larvae are about 27 mm in length and 6 mm in width (Figure 2). They are pale white and have a small black head containing their mouthparts. The moisture level of the feed which is optimum for larvae feeding ranges from 60% to 90% while temperatures that are optimum for the development of this species range from 27°C to 33°C. During this stage, lower temperatures are most likely favoured due to the heat generated by the wriggling movements of the larvae as they consume organic matter. BSF larvae release enzymes to liquefy organic substrate to ensure that it is digestible prior to consumption.

Figure 1. Life stages of BSF (Photo by Hadura Abu Hasan).

The Role of Black Soldier Fly Larvae

BSF larvae are extremely efficient digesters of organic waste. They combine organic and inorganic molecules and redeposit them as frass, a powdery form of faeces. Observed in the compost, the larval stage of this species contributed to composting. The continual tunnelling of larvae transports microorganisms and air throughout the compost, while their excrement enhanced the nutrient content. This larvae species feed on leftover vegetable matter, and the fragmentation of this organic matter allows greater surface area for bacteria to interact with it. In addition, adult flies never come close to human habitation and therefore never created any nuisance. Together with bacteria in the compost, BSF larvae can be considered useful decomposers in the natural world.

Pre-pupae leave the organic substrate and search for a dry location for shelter. The pre-pupae stage requires approximately seven days to develop into the pupae stage. Time spent in the migration phase for each pre-pupae varies but it showed to be dependent on the pre-pupae ability to find an ideal pupation site. The pupae are dormant and turn into darker coloration. They are inactive and can survive without food sources. The pupation period might take two to three weeks, depending on the temperature and humidity.

Figure 2. Decomposer, BSF larvae
(Photo by Hadura Abu Hasan)

The appearance of an adult BSF is like a wasp, black, and about 15 to 20 mm in length. It has one pair of wings and three pairs of legs (Figure 3). The terminal part of the legs is white. Adult BSF does not feed as they are surviving on the body fat obtained during the larval stage and die when these fat reserves are depleted. The adults of BSF do not pose any pest-like behaviour and only live for a few days or a week [5].

Figure 3. Adult BSF, *Hermetia illucens*
(Photo by Hadura Abu Hasan)

An aerial mating process happens in adult and female BSF oviposit on a suitable organic matter. The mating process takes place two days after the emergence of the adult BSF while oviposition occurs two days after the fertilization of eggs. The instinct of female adult BSF to lay their fertilized egg near the organic source is trusted to be due to the detection of volatile chemicals from rotting wastes. Eighty percent or more egg hatching rates are achieved at an egg-laying site with a constant temperature of 27°C and an ambient relative humidity of 60% or more [6]. Female BSF prefers areas with an abundance of organic substance to lay eggs, whilst males prefer sunny spots with a lot of vegetation (Figure 4).

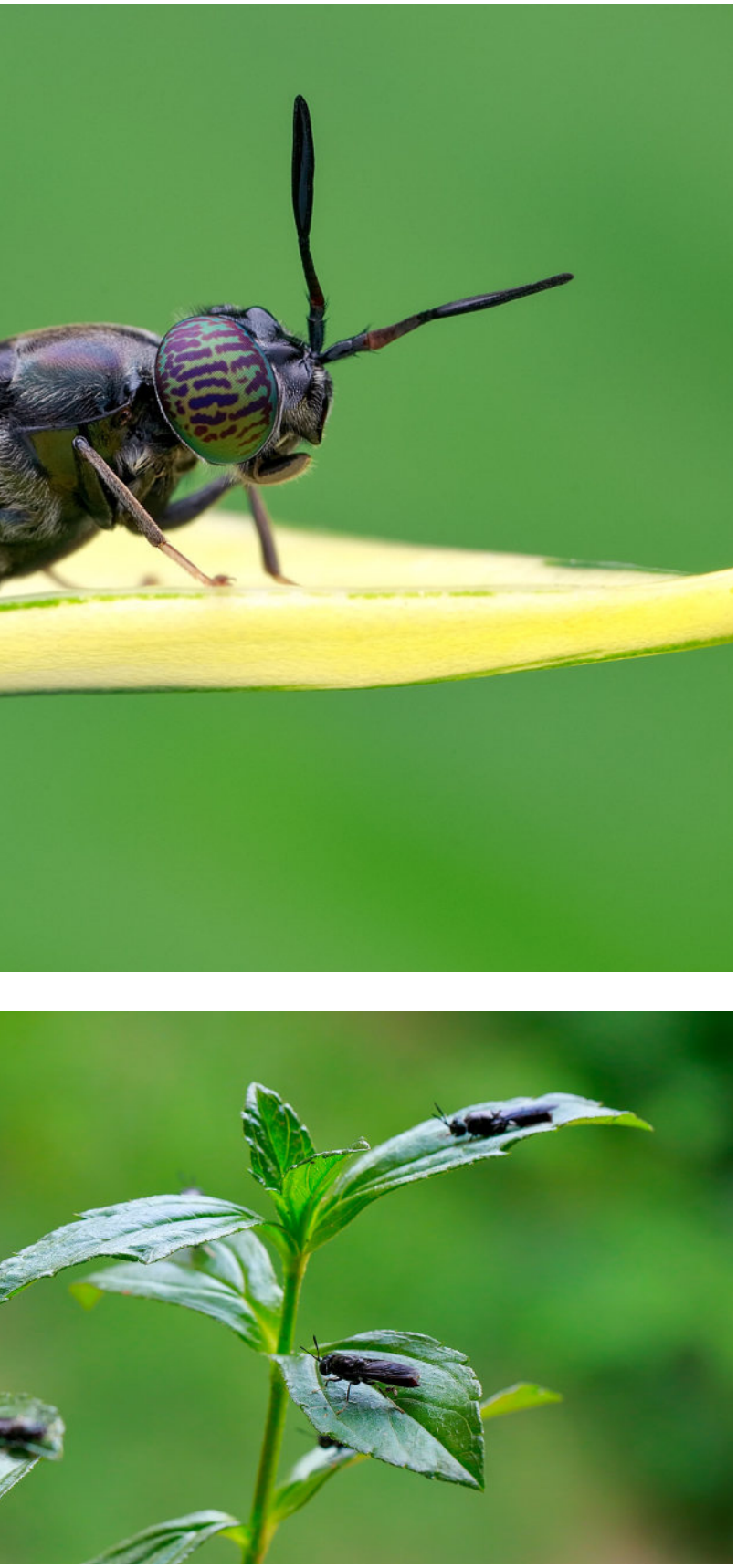


Figure 4. Black Soldier Flies resting on the plant (Photo by Hadura Abu Hasan)

Composting by BSF larvae

One of the primary causes of insect declines worldwide is habitat loss. A diverse landscape with open grasslands, shrubby areas, and forestland can encourage a diverse insect community because these different areas provide a variety of native foraging and nesting resources. Many strategies for supporting insect communities have already been devised, and these steps can also benefit pollinators and non-pollinating insects by creating ideal habitat. Insects benefit from composting because it provides them with a place to live. Because BSF larvae feed on mostly biodegradable materials in the ecosystem, they are more efficient than many other ways of composting. The larvae are photophobic, they typically hide from view. Pre-pupae harvest themselves and instantly reside under the rocks, sand, or any organic matter for protection. This behaviour makes it simple to create a clean compost site free from visible larvae.

The BSF larvae can consume organic waste double their body weight daily and efficiently convert this organic feed into valuable biomass containing high protein and lipid content. This makes them an ideal animal feed for poultry, livestock, and fish. As they prepare to pupate, they search for drier substrates until they mature as flies. This characteristic is advantageous because the mature larvae can easily be collected as they migrate out of their initial feeding substrate. The black soldier fly larvae can be introduced into a heap composting cage unit using the simple composting method. Food scraps, dry leaves, or animal manures can be used as the main components of the composting process. Composting cages constructed of wire mesh can be installed in the desired locations to keep animals out of the composting materials (Figure 5). The size of the cages is determined based on the amount of waste generated from the targeted areas. For instance, due to the large amount of green waste generated on a university campus, a larger scale composting plant is required. The unit can also be covered by a roof to protect it from rain. The collected rainwater may then be utilized to water the compost and moisten the substrate for BSF larvae development. Compost material produced can be further tested for nutrient content and quality. Enrichment of the compost nutrient is significant to generate interest in the composted product. The BSF larvae produce frass that is unpolluted, odourless, and most importantly, that provides nutrients for the plants.

Figure 5. Composting by the community (Photo by free image Pixabay)

Community participation

Various composting methods can be implemented during the early phase of the community projects. A small-scale cage composting can be set up at selected locations such as schools, universities, animal facilities, or residential areas in urban, suburban, and rural areas. Community participation at the neighbourhood or regional level results in several benefits, including increased social involvement and empowerment, improved local soils, enhanced food security, and increased local career opportunities. The composting knowledge and skills using BSF larvae among the local workforce can be passed on to subsequent generations. The innovations in composting techniques using BSF larvae are required to produce quality compost and can be conveniently practiced by the communities. To generate economic activities from BSF composting, cooperation among the relevant stakeholders, including the government, private agencies, industry, and the community promises a good economic prospective.

References:

[1] Isibika, A., Vinnerås, B., Kibazohi, O., Zurbrügg, C., & Lalander, C. (2019). Pre-treatment of banana peel to improve composting by black soldier fly (*Hermetia illucens* (L.), Diptera: Stratiomyidae) larvae. Waste Management, 100, 151-160.

[2] Galante, E., & Marcos-Garcia, M. A. (2008). Decomposer insects. Encyclopedia of Entomology, 1158-1169.

[3] Ayilara, M. S., Olanrewaju, O. S., Babalola, O. O., & Odeyemi, O. (2020). Waste management through composting: Challenges and potentials. Sustainability, 12(11), 4456.

[4] Kim, C. H., Ryu, J., Lee, J., Ko, K., Lee, J. Y., Park, K. Y., & Chung, H. (2021). Use of Black Soldier Fly Larvae for Food Waste Treatment and Energy Production in Asian Countries: A Review. Processes, 9(1), 161.

[5] Oliveira, F., Doelle, K., List, R., & O'Reilly, J. R. (2015). Assessment of Diptera: Stratiomyidae, genus *Hermetia illucens* (L., 1758) using electron microscopy. J. Entomol. Zool. Stud, 3(5), 147-152.

[6] Diclaro II, J. W., & Kaufman, P. E. (2009). Black soldier fly, *Hermetia illucens* Linnaeus (Diptera: Stratiomyidae). EDIS, 2009(7).

Author Profile

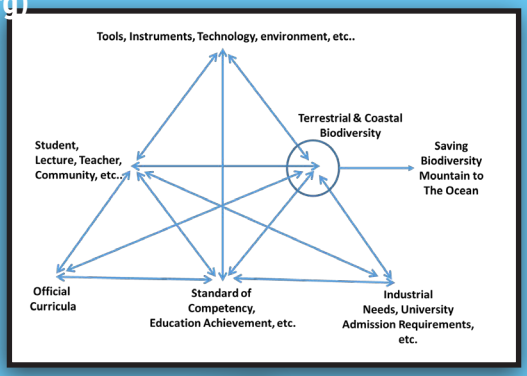
Dr Hadura Abu Hasan is a senior lecturer in Medical Entomology at the School of Biological Sciences and a fellow at Vector Control Research Unit (VCRU), Universiti Sains Malaysia. She obtained her PhD from Liverpool School of Tropical Medicine, United Kingdom in 2015. Her research background is in mosquito behaviour and vector control. She is actively involved in vector control research projects, especially on mosquitoes and other non-biting flies. Her current project on Black Soldier Fly (BSF) which was initiated in 2017, focuses on transferring the knowledge of biology, behaviour, and production of this species to the community. She has extensive experience in rearing and mass production of black soldier flies, houseflies, and mosquitoes in laboratory settings. She conducted mass rearing of insects for various scientific research such as waste management, biological control, and the production of animal feed. She conducted several knowledge transfers programs on the importance of insects especially the black soldier flies, that involve the exchange of creative and innovative ideas, research findings, skills, and experiential education between universities, research organizations, industries, government agencies, and the community.

School of Biodiversity:

Development of Biodiversity Education and Learning Ecosystem Model

EAMEO BIOTROP'S effort to build a school of biodiversity that integrates the "Saving the Biodiversity (MoTo) program into learning unit plans, learning resources, learning environments, and learning activities. The School of Biodiversity Program will utilize materials from models, modules and good practices generated from the research, training and dissemination program of activities that have been organized by SEAMEO BIOTROP.

Contact person : Slamet Widodo Sugiarto, M.Sc. (widodo@biotrop.org)



- Realization Schools Model (Green and Blue Schools of Biodiversity)
- Enriching Curriculum
- Modules Development

- Replication Learning Model
- Knowledge Dissemination

	2022	2023	2024	2025	2026
Activity	• Criteria and indicators Development & Selection Schools • Designing Thematic Learning Model • Synchronizing curriculum • Modules Development • ToT for Teachers	• Synchronizing curriculum • Thematic Landscape Development • Learning Model Application • Micro-learning Modules Series Development • Replication Model	• Best Practices Micro-learning Modules Development • Learning Models Tools Development and Application • Teacher Certification	• Synchronizing curriculum at various levels of education • Multi Language Micro-learning Modules Series Development	• Replication Learning Model to SEA
Output	• C&I Document • Thematic Learning Concept Design • Synchronized Curriculum • Modules Series • Trained Teachers	• Thematic Landscape Model • Replication Schools Model in National Level • Digital Micro-learning Modules Series	• Best Practices Modules Series • Learning Model Tool • Certified Teachers	• Adopted Curriculum • Multi Language Micro-learning Modules Series	• Adopted Curriculum in SEA • School Model in SEA

Source: https://absortech.com/moisture-magazine/desiccants-fcc-guidelines-compliance-for-shipping-cocoa-beans/

How Can We Get The Healthy Chocolate Products?

Nijma Nurfadila[a]*, Sutrisno[b], Usman Ahmad[b], Samsudin[c]

[a]SEAMEO BIOTROP, Indonesia
[b]Study Program of Postharvest Technology, Faculty of Agricultural Technology, IPB University, Indonesia
[c]National Research and Innovation Agency, Indonesia (BRIN)

*Corresponding author: nijma@biotrop.org

Fermentation starter using combination of yeast, acetic acid bacteria, and mangosteen rind extract, and combination of yeast, lactic acid bacteria, and acetic acid bacteria can increase physical quality and inhibit the mycotoxigenic fungi and their mycotoxins in cocoa beans as basic material for chocolate products.

Source: https://www.freepik.com/free-photo/blurry-man-cocoa-beans-medium-shot_19673459.htm#query=Cocoa&position=31&from_view=search

Chocolate Products And Cocoa Beans

Chocolate is a food product made from roasted and ground cocoa beans. There is three types of chocolate, i.e. dark chocolate, white chocolate, and milk chocolate. Dark chocolate contains cocoa liquor, cocoa butter, lecithin, sugar and vanilla, meanwhile white chocolate contains everything dark chocolate does (except chocolate liquor), milk fats and solids. Milk chocolate has all of the dark and white chocolates content [1]. Cocoa liquor is the paste of cocoa beans that contains non-fat cocoa solids and cocoa butter, meanwhile cocoa powder is made by removing some of the cocoa butter from liquor [2]. Lecithin is a group of fatty substances that can be found in animal and plant tissue that has a range of functions within the human body.

Chocolate products can not be already processed, if we have not many good cocoa beans. Cocoa beans are obtained from cocoa trees (Theobroma cacao). Cocoa trees are native to the Amazon and Orinoco river basins in South America [1]. Now, Indonesia is the third cocoa beans exporter countries after Ivory Coast and Ghana [3]. Cocoa beans production in exporter countries were Ivory Coast (> 2 000 000 tonnes), Ghana (883 652 tonnes), Indonesia (659 776 tonnes), Nigeria (328 263 tonnes), and Cameroon (295 028 tonnes) [4]. The highest value of Indonesian cocoa beans production in 2021 originated from Central Sulawesi (130 650 tonnes), Southeast Sulawesi (114 828 tonnes), and South Sulawesi (107 075 tonnes) [5].

There are three types of cocoa beans can be found in Indonesia, such as *criollo, forastero* and *trinitario*, but the most widely grown cocoa in Indonesia is *forastero*. Charactheristic of *criollo* or fine cocoa are 1) oval and red cocoa pods, 2) big and round kernels, 3) weight of dried kernel > 1.2 g, and 4) white cotyledon, 5) fat content is lower that 56%, 6) size and weight of kernels are similar relatively, and 7) aroma and taste are better than *forastero* and *trinitario*. The morphology of *forastero* or *lindak* are 1) round until oval and green cocoa pods, 2) flat and small kernels, 3) the average of weight of dried kernels is 1 g, 4) purple cotyledon, 5) fat content is more than 56%, 6) size and weight of kernels are heterogeny, and 7) aroma and taste are not better than *criollo*. *Trinitario* is hybrid cocoa from *criollo* and *forastero* [6]. Hybrid is the offspring of two plants or animals of different varieties or species.

Nutritional Facts And Benefits Of Cocoa Beans And Chocolate Products

Cocoa beans contains more phenolic antioxidants are called flavonoids, including catechin, epicatechin, and procryanidins [2]. Phenolic antioxidants or flavonoids are a wide group of metabolites that originate from the

secondary metabolism of plants as providing antioxidants roles. Nutritional compositions of cocoa powder are 81.6 % non-fat cocoa solids (NFCS), 15.0 % fat, 52.4 % total polyphenols, 1.9 % mg/g epicatechin, and 0.6 % mg/g catechin. Dark chocolate contains 23.4 % NFCS, 34.7 % fat, 13.0 % total polyphenols, 0.3 % epicatechin, and 0.2 % catechin; meanwhile milk chocolate contains 6.2 % NFCS, 32.6 % fat, 4.4 % total polyphenols, 0.1 % epicatechin, and 0.04 % catechin [7]. White chocolate has 12.6 % total polyphenols, while the epicatechin and catechin were below than 0.03 and 0.01 mg/ml [8]. Common nutritional composition in white chocolate are 472 cal, 2 g protein, 29.8 g fat, 62.7 g carbohydrate, 63 mg calcium, 287 mg phosphor, 2.8 g iron, 30 mg vitamin A, 0.03 vitamin B1, and 1.4 g water; meanwhile dark chocolate contains 504 cal, 5.5 g protein, 52.9 g fat, 29.2 g carbohydrate, 98 mg calcium, 446 mg phosphor, 4.4 mg iron, 60 mg vitamin A, 0.05 mg vitamin B1, 2.30 g water. Milk chocolate has 381 cal, 9 g protein, 35 g fat, 53.6 g carbohydrate, 200 mg calcium, 2 mg iron, 30 mg vitamin A, 0.08 mg vitamin B1, and 1 g water [6].

Nutritional composition in cocoa beans has many benefits for human health. Chocolate consumption can reduce risk of diabetes, because the antioxidant effect of cocoa beans may directly influence insulin resistance. Insulin is a hormone produced by pancreas that controls the amount of glucose in the bloodstream. Not only that, chocolate also may stimulate changes in redox sensitive signaling pathway involved in gene expression and the immune response, can protect nerves from injury and inflammation, protect the skin from UV radiation, cognitive function and mood [7].

Problems In Cocoa Beans And Chocolate Products

Chocolate products come from cocoa beans are processed through several stages of processing, i.e. preharvesting, harvesting, postharvesting, manufacturing, and distribution. In fact, many farmers has been guided by instructors from Ministry of Agriculture and some private companies to conduct good agricultural practices, but some farmers and collectors are still ignoring good handling practices after the cocoa beans are harvested. This condition may cause decreasing of cocoa beans postharvest quality, especially during harvesting, fermentation, drying, storing, and packaging process that facilitates fungal contamination.

The international standard for cocoa beans based on the Food and Drug Administration (FDA) requires the cocoa beans such as: 1) should be fermented and had moisture content of 7%, 2) have no insects, and 3) had uniform quality without foreign materials such as pods or pulp [4]. Physical quality of cocoa beans can be detected from grade of cocoa beans based on total kernels, slaty kernels, and moldy kernels. Grade of cocoa beans based on total kernels in 100 g of cocoa beans are : 1) AA (maximum 85 kernels), 2) A (maximum 86 – 100 kernels), 3) B (maximum 101 – 110 kernels), 4) C (maximum 111 – 120 kernels), and 5) S (maximum > 120 kernels) [5]. Grade of *lindak* cocoa beans based on slaty kernels are : 1) I – B (maximum 3%), 2) II – B (maximum 8%), and 3) III – B (maximum 20%) [9]. Grade of *lindak* cocoa beans based on moldy kernels are : 1) I – B (maximum 2%), 2) II – B (maximum 4%), and 3) III – B (maximum 4%), while the moisture content of cocoa beans should be lower than 7.5% [9]. Dried cocoa beans during storage can be infested by insect and contaminated by fungi. Some postharvest fungi can produce mycotoxins, such as *Aspergillus flavus, A. niger, A. ochraceus, A. parasiticus* and *Penicillium citrinum*. Fungal infection may cause decreasing of germinability, discoloration, decreasing of physical quality and nutritional content, heating of cocoa beans, and mycotoxin production.

Some fungi were isolated from unfermented cocoa beans in Central Sulawesi, i.e. *A. flavus, A. niger, A. fumigatus, Fusarium* sp., *Geotrichum* sp., *Mucor* sp., *Penicillium* sp., *Rhizopus* sp., *Trichoderma* sp., *T. viride*, dan *Verticillium* sp.. *Aspergillus flavus* population was isolated in cocoa beans at farmer, collector, and exporter levels were 7.2 x 108, 4.5 x 105, and 4.1 x 103 cfu/ml. Aflatoxin B1 (AFB1) content in cocoa beans were collected from farmers (104.80 ppb), collectors (61.31 ppb) and exporters (47.74 ppb) [10]. Aflatoxigenic fungi also were found in 226 cocoa beans were collected from Brazillian farms, i.e. *A. flavus, A. parasiticus*, and *A. nomius* [11]. Mycotoxigenic fungi were also found in cocoa beans were collected from Flores, such as *A. flavus, A. fumigatus*, and *A. niger*. The range of AFB1 content in fermented cocoa beans were collected from Flores was 2.21 – 3.65 ppb, while the range of ochratoxin A (OTA) was not detected – 0.38 ppb [12].

There are three kinds of mycotoxins are usually found in foodstuff, i.e.

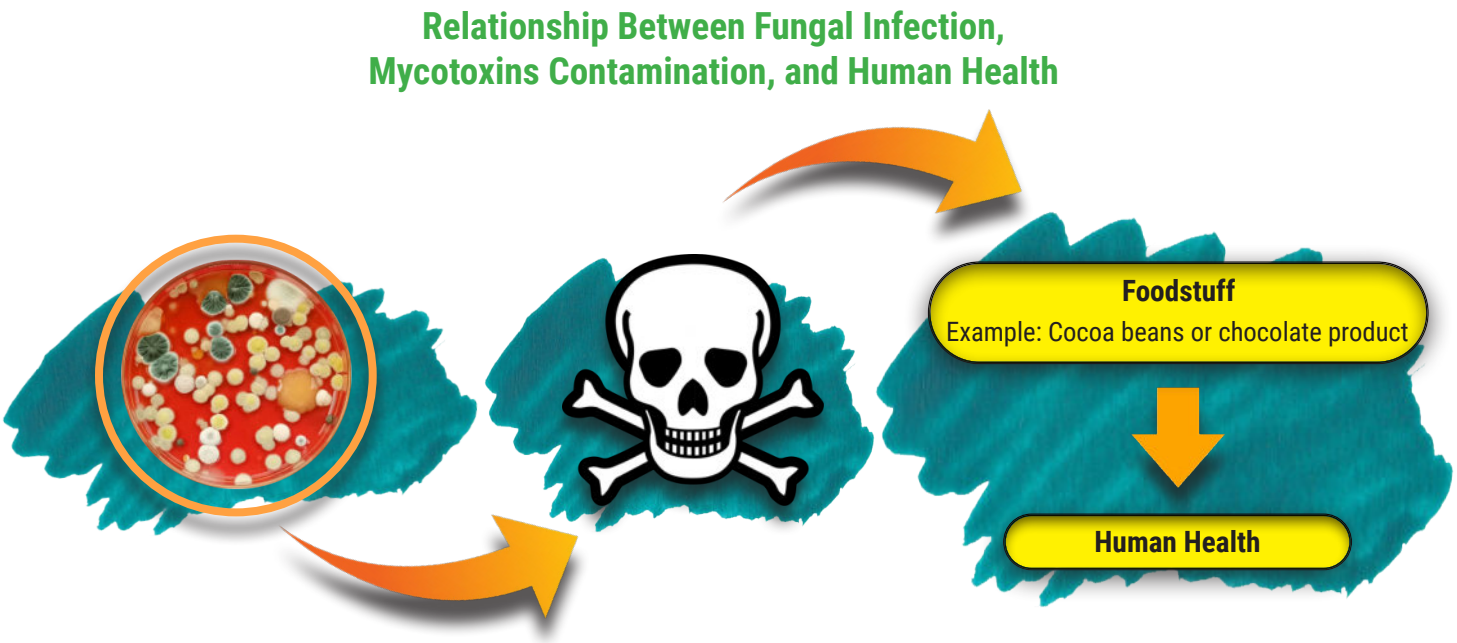


Figure 1. Mechanisms of mycotoxins contamination in foodstuff influence to human and animal health (Source : Nijma Nurfadila)

aflatoxins, fumonisin, and ochratoxin A [13], but aflatoxins and ochratoxin A are commonly found in cocoa beans. Mycotoxins are toxins produced by some fungal species or fungal strains, meanwhile the mycotoxigenic fungi is a kind of fungal species or fungal strains that can produce mycotoxins. Aflatoxin is a kind of mycotoxins produced by *A. flavus* and *A. parasiticus* that causes liver cancer in human and animal. There are four types of aflatoxins, i.e. B1, B2, G1, and G2, but the most dangerous for human health is aflatoxin B1 (AFB1) [13]. The maximum tolerable limit (MTL) for aflatoxin in cocoa beans, cocoa butter, and cocoa powder in Bulgaria are 5 ppb, while the MTL in Uruguay and Malaysia are 10 ppb [14]. Ochratoxin A (OTA) is a potent nephrotoxic mycotoxin that has been linked to kidney problems in both livestocks and human [13]. The MTL of ochratoxin A in cocoa beans in Brazil is 10 ppb [15]. Mechanisms of mycotoxins contamination in cocoa beans influence to human health is initiated by fungal infection in foodstuff, for example cocoa beans. Some mycotoxigenic fungi contaminated in foodstuff (example : cocoa beans), then the fungi produce the mycotoxins in available condition. Then, the contaminated foodstuff (example : cocoa beans or chocolate products) are consumed by human or animal that will give negative effect to human or animal health, such as cancer, indigestion, and etc (Fig. 1).

Fungi and mycotoxins contamination in cocoa beans can be prevented using conventional biotechnology is called fermentation. Fermentation is also useful for omitting the pulp and forming of the delicious taste as well as reducing bitter taste. The physicochemical properties of dried cocoa beans also can be improved using fermentation.

Appropriate Fermentation Starters and Their Advantages for Cocoa Beans

There are two processing of cocoa beans in Indonesia, i.e cocoa beans within fermentation and without fermentation. Fermentation is divided into three stages, i.e.: 1) anaerobic stage, 2) lactic acid bacteria stage, and 3) acetic acid bacteria stage. In aerobic stage, yeast will convert glucose into alcohol in low oxygen condition and pH value <4 at 24 – 36 first hours. In lactic acid bacteria (LAB) stage, the LAB will convert glucose and organic acid into lactic acid at 48 and 96 hours. In acetic acid bacteria (AAB) stage, AAB will convert alcohol into acetic acid as the effect of wide exothermic during temperature increase.

As much as 90% unfermented cocoa beans were exported with lower price compared to the fermented cocoa beans. The quality of unfermented dried cocoa beans can be improved by artificial fermentation. Artificial fermentation is carried out using useful microorganisms to increase the quality of cocoa beans. It means that fermentation is one of important processes for cocoa beans. Cocoa beans fermentation process involved some microorganisms, i.e. yeast, AAB, LAB, Bacillus and several other bacteria, as well as filamentous fungi [16]. Combination of microorganisms are used for fermentation process is called fermentation starter.

The addition of *Saccharomyces cerevisiae, Acetobacter aceti* and *Lactobacillus lactis* [17] and the combination of *S. cerevisiae, Lactobacillus plantarum, A. aceti* [18] had been processed as fermentation starter, but the quality of cocoa beans were still not increased. *Saccaharomyces cerevisiae* is a kind of yeasts, meanwhile *A. aceti* is a

https://agrigoldmagazine.com/2022/02/23/bank-of-ghana-forecasts-weak-cocoa-prices-sales/

kind of acetic acid bacteria (AAB) and L. lactis is a kind of lactic acid bacteria (LAB). Therefore, formulating and concocting combination treatment to increase quality of cocoa beans, specially physical quality and to inhibit the mycotoxigenic fungi in cocoa beans is necessary.

As much as 75% samples were included into grade B based on total kernels, except controls and I*ssatchenkia orientalis* BIO 211291 + *A. aceti* (grade B into grade C). Mean of total kernels in 1st and 3rd day after fermentation was 107 kernels, while the mean of those in 6th and 11th day after fermentation was 110 kernels per 100 g. Based on the percentage of slaty kernels, as many as 58% samples were included into grade II-B. Based on the percentage of moldy kernels in Indonesian National Standard 2008, all treatments were included into grade I-B (total maximum of moldy kernels is 2%). The differences of slaty, fermented and moldy kernels were shown in Fig. 2 [19]. Slaty kernel is a kind of cocoa kernels that has not been fermented.

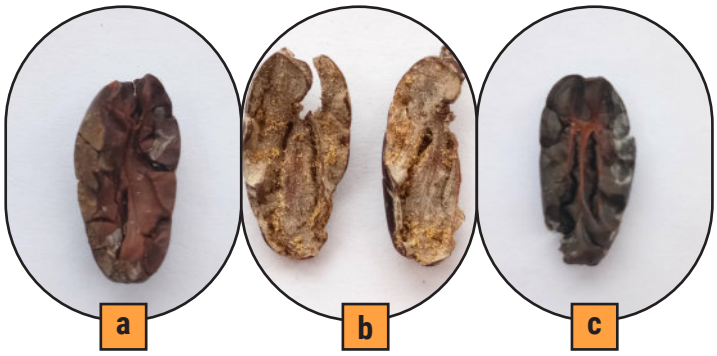


Figure 2. (a) Slaty kernel, (b) fermented kernel, and (c) moldy kernels of cocoa beans
(Source : Nijma Nurfadila)

The lowest population of aflatoxigenic *A. flavus* at the beginning of inoculation until 11 days after inoculation was found in treatment with *Issatchenkia orientalis* BIO 211288 + *Acetobacter aceti* + mangosteen rind extract (MRE) (0.48 log cfu/g into not detected) and *I. orientalis* BIO 211291 + *I. orientalis* BIO 211288 + *A. aceti* + MRE (3.75 log cfu/g into not detected), while the aflatoxins could not be detected in all treatments, because their aflatoxin were still lower than limit of detection [20]. It means that the appropriate fermentation starter to increase physical quality and inhibit aflatoxigenic *A. flavus* and aflatoxins are *I. orientalis* BIO 211291 + *I. orientalis* BIO 211288 + *A. aceti* + MRE and *I. orientalis* BIO 211288 + *A. aceti* + MRE. Mangosteen rind extract (MRE) as addition of fermentation starter is used for antioxidant and anticancer, thus two appropriate fermentation starters are very important for human health.

In other research, there is microorganisms combination can be used as fermentation starter to inhibit ochratoxigenic *A. niger* YAC-9 and ochratoxin A (OTA) synthesis, i.e. indigenous *Lactobacillus plantarum* HL-15 either

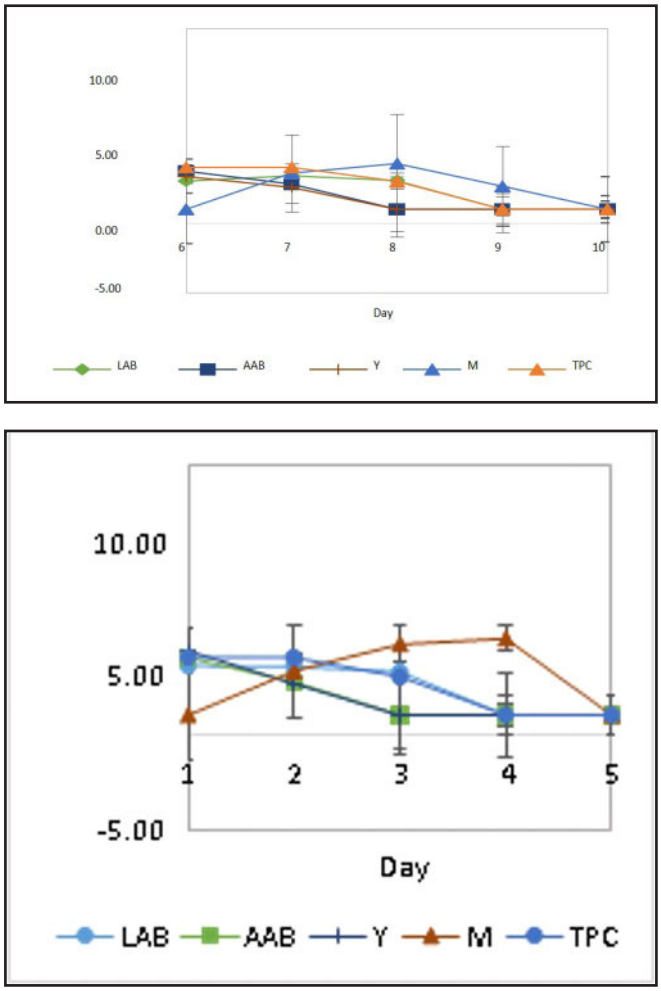


Figure 3. Growth of yeast, LAB, AAB, and mold during the course of drying in : (a) cocoa beans were inoculated by *L. plantarum* HL-15 and *A. niger* YAC-9; and (b) cocoa beans were inoculated by *L. plantarum* HL-15, C. famata HY-37, *Acetobacter* spp. HA-37, and *A. niger* YAC-9 (Source : Rahayu et al. 2021).

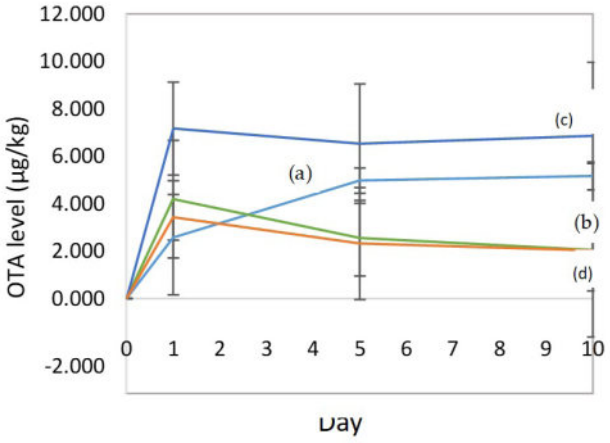


Figure 4. The OTA concentration during fermentation (0, 1st and 5th day) and drying (10th day) in cocoa beans with: (a) natural fermentation, (b) fermentation starter (*L.plantarum* HL-15) + *A. niger* YAC-9, (c) natural fermentation + *A. niger* YAC-9, (d) fermentation starter (*L.plantarum* HL-15 + *C. famata* HY-37 + *Acetobacter* spp. HA-37) + *A. niger* YAC-9 (Rahayu et al. 2021)

individually or in combination with *Candida famata* HY-37 and *Acetobacter* spp. HA-37. Population of ochratoxigenic *A.niger* YAC-9 decreased in cocoa beans were inoculated by *Lactobacillus plantarum* HL-15 as starter culture during fermentation and drying (Fig.3a). *Aspergillus niger* population also decreased during fermentation and drying in cocoa beans were inoculated by *L. plantarum* HL-15 + *C. famata* HY-37 + *Acetobacter* spp. HA-37 (Fig. 3b) [21]. Not only ochratoxigenic *A. niger,* but also ochratoxin was inhibited by those (Fig.4).

Way Forward Strategies

Fermentation starter using combination of *I. orientalis* BIO 211288 + *I. orientalis* BIO 211290 + acetic acid bacteria (*Acetobacter aceti*) + mangosteen rind extract (MRE); and *I. orientalis* BIO 211288 + *A. aceti* + MRE can be used as appropriate postharvest handling of dried cocoa beans in exporter countries to increase the physical quality and inhibit aflatoxigenic *A. flavus* and aflatoxins, especially in Indonesia. Other microorganisms combination of *L. plantarum* HL-15 + *C. famata* HY-37 + *Acetobacter* spp. HA-37 also can be used as fermentation starter to inhibit ochratoxigenic *A. niger* and OTA. These appropriate fermentation starters should be introduced to farmer, collector and exporter levels of cocoa beans through the campaign, thus they will be applied in the fermentation process of cocoa beans. The collaboration of all stakeholders, such as scientists, government, lecturers, economic agents (farmers, collectors, traders, exporters, and customers) should be built to solve many problems in cocoa beans. Campaign of fermented cocoa beans is one of methods to keep our quality of cocoa beans and cocoa products from upstream (farmers) to downstreams (customers), thus the customers health will also be maintained.

References

[1] Szalay J. 2018. Chocolate facts, effect, and history. https://www.livescience.com/61754-chocolate-facts.html. Accessed on 25th June 2022.

[2] Katz DL, Dughty K, Ali A. 2011. Cocoa and chocolate in human health and disease. *Antioxid Redox Signal*. 15(10): 2779 – 2811.

[3] Dickson. 2017. *Sepuluh negara penghasil kakao terbesar di dunia* (The biggest of ten producing cocoa beans countries in the world). https://ilmupengetahuanumum.com/10-negara-penghasil-kakao-terbesar-di-dunia/. Accessed on 14th March 2018.

[4] Worldatlas. 2021. *Lima negara penghasil kakao terbesar: Indonesia urutan ke berapa?* (Five biggest of producing cocoa beans countries : How Indonesia's ranking?).https://databoks.katadata.co.id/datapublish/2021/10/04/5-negara-penghasil-kakao-terbesar-indonesia-urutan-berapa. Accessed on 11th May 2022.

[5] Directorate General of Estate. 2021. Cocoa production by Province in Indonesia 2018-2022. https://www.pertanian.go.id. Accessed on 11th May 2022.

[6] Rukmana R, Yudirachman H. 2016. Untung selangit dari agribisnis kakao. Yogyakarta (ID): Lily Publisher.

[7] Miller KB, Hurst WJ, Flannigan N, Ou B, Lee CY, Smith N, Stuart DA. Survey of commercially available chocolate- and cocoa containing products in the United States. 2. Comparison of flavan-3-ol content with nonfat cocoa solids, total polyphenols, and percent cacao. *J Agric Food Chem*. 57 : 9169 – 9180.

[8] Meng CC, Jalil AMM, Ismail A. 2009. Phenolic and theobromine contents of commercial dark, milk and white chocolates on the Malaysian market. *Molecules*. 14 : 200 – 209.

[9] Indonesian National Standard. 2008. *Biji kakao* (Cocoa beans) SNI 2323:2008. Jakarta(ID): INS Company.

[10] Asrul. 2009. *Populasi jamur mikotoksigenik dan kandungan aflatoksin pada beberapa contoh biji kakao* (*Theobromae* cocoa) (Mycotoxigenic fungal population and aflatoxin content in several examples of cocoa beans) (*Theobromae* cocoa). *J Agroland*. 16(3): 258-267.

[11] Copetti MV, Iamanaka BT, Pereira JL, Fungaro MH, Taniwaki MH. 2011. Aflatoxigenic fungi and aflatoxin in cocoa. *Int J of Food Microbiol*. 148(2): 141 – 144.

[12] Wangge ESA, Suprapta DN, Wirya GNAS. 2012. *Isolasi dan identifikasi jamur penghasil mikotoksin pada biji kakao kering yang dihasilkan di Flores* (Mycotoxigenic fungal isolation and identification in dried nutmeg were collected in Flores). *J Agric Scie Biotechnol*. 1(1): 39 – 47.

[13] Dharmaputra OS, Nurfadila N, Ambarwati S, Retnowati I. 2021. *Serangan Cendawan dan Kontaminasi Mikotoksin pada Kacang Tanah, Jagung dan Sorgum, serta Pencegahan dan Pengendaliannya* (The Occurrence of Fungi and Mycotoxins Contamination in Peanuts, Maize and Sorghum, and Its Prevention and Control). Bogor (ID): SEAMEO BIOTROP.

[14] Mazumder PM, Sasmal D. 2001. Mycotoxins-limit and regulations. *Ancient Sci of Life*. 20(1):1-19.

[15] [ANVISA] Agencia Nacional de Vigilencia Sanitária. 2011. Resoluçeo RDC No.7, de 18 de fevereiro de 2011-dispôe sobre limites máximos tolerados para micotoxinas em alimentos. Httpa://bvsms.saude.gov.br/bvs/saudelegis/anvisa/2011/res0007_18_02_2011_rep.html/. Accessed on 18th May 2022.

[16] Thompson SS, Miller KB, Lopez A, Camu N. 2013. Cocoa and coffee. In : Doyle MP, Buchanan RL, editor.

Source: Nijma Nurfadila

Food Microbiology : Fundamentals and Frontiers. ASM Press Washington DC (US), 4th Edition. p. 881 – 889.

[17] Apriyanto M, Sutardi S, Harmayani E, Supriyanto S. 2016. *Perbaikan proses fermentasi biji kakao non fermentasi dengan penambahan biakan murni Saccharomyces cerevisiae, Lactobacillus lactis,* dan *Acetobacter aceti* (Improvement of the nonfermented cocoa bean femrmentation process with the addition of pure culture *Saccharomyces cerevisiae, Lactobacillus lactis*, and *Acetobacter aceti*). *Agritech*. 36(4): 410-415.

[18] Mulyawanti I, Hidayat T, Risfaheri. 2018. *Pengaruh jenis fermentor terhadap mutu biji kakao* (Influence of fermentation types on the quality of cocoa beans). *Jurnal Penelitian Pascapanen Pertanian*. 5(2): 91-98.

[19] Nurfadila N, Sutrisno, Ahmad U, Samsudin. 2020. Effectiveness of yeast, *Acetobacter aceti* and mangosteen rind extract on physicochemical properties in dried cocoa beans. In : The 6th FiA Conference "Food Science, Nutrition, and Health", Bogor (ID), 14 – 16 October 2020.

[20] Nurfadila N, Sutrisno, Ahmad U, Samsudin. 2021. Antagonistic effect of yeast, acetic acid bacteria, and mangosteen rind extract on aflatoxigenic *Aspergillus flavus* in unfermented cocoa beans. *Biotropia*. 28(3): 239-252.

[21] Rahayu ES, Triyadi R, Khusna RNB, Djaafar TF, Utami T, Marwati T, Hatmi RU. 2021. Indigenous yeast, lactic acid bacteria, and acetic acid bacteria from cocoa bean fermentation in Indonesia can inhibit fungal growth producing mycotoxins. *Fermentation*. 7(192): 1-11.

Increasing the Literacy on Climate, Energy, and Environment to Promote Biodiversity

SEAMEO BIOTROP'S program to improve students literacy skills in order to develop the understanding and comprehension of biodiversity as a science, especially on the topic of climate, energy and environmental subject.

Contact person : **Indah Wahyuni, MSi. (indah@biotrop.org);**
Deda Annasia Yuliastri, MSi. (deda@biotrop.org)

- Certified Internship MBKM Program
- Environment Risk Management

Innovation on Biodiversity Science Literacy Learning Strategy

National Literacy Movement through the Provision of Literacy Media and Week of Literacy

INCREASING THE LITERACY ON CLIMATE, ENERGY, AND ENVIRONMENT TO PROMOTE BIODIVERSITY

	2022	2023	2024	2025	2026
Activity	• The Implementation of Certified MBKM Program • The Study of Risk Management for GMO • Competition / FGD / Webinar on Literacy Learning Strategies	• The Implementation of Certified MBKM Program • Risk Analysis and Economic Valuation of IAPS at Urban Area • FGD / Webinar on Literacy Learning Strategies	• The Implementation of Certified MBKM Program • Risk Analysis and Economic Valuation of IAPS at Urban Area • Training and Competition on Writing of Popular Article on Tropical Biodiversity	• The Implementation of Certified MBKM Program • Genetic Diversity of SEAMEO BIOTROP Herbarium Specimens • Talk show on Biodiversity Literacy from the point of view of Millennials	• The Implementation of Certified MBKM Program • Development of Tissue Culture Techniques using Arbuscular Mycorrhizal Fungi • Webinar/Information Dissemination
Output	• Concept of Biodiversity Learning • Document of Biodiversity Curriculum Development	• Learning Modul • Data base of Urban IAPS • Book of Innovation Learning Strategies	• Learning Modul • Data base of Urban IAPS • Literacy Media on Biodiversity	• Learning Modul • Data base of genetic diversity of SEAMEO BIOTROP Herbarium Specimens • Literacy Media on Biodiversity	• Learning Modul • Prototype of FMA Tissue Culture • Implementation of Biodiversity Curriculum Development

Source: Asep Saepudin SEAMEO BIOTROP
Edited: Dani Yudi Trisna SEAMEO BIOTROP

Crayfish as Food in Indonesia

*Ichsan Achmad Fauzi[ab], Shella Marlinda[b], and Zulhamsyah Imran[bc]

[a]Technology and Management of Aquaculture, Faculty of Fisheries and Marine Science, IPB University, Indonesia
[b]SEAMEO BIOTROP, Indonesia
[c]Department of Aquatic Resources Management Faculty of Fisheries and Marine Science, IPB University, Indonesia

*Corresponding author: shella@biotrop.org

Crayfish as Food in Indonesia

Introduction

Fish and shellfish consumption per capita per year has been reported to increase around the globe, especially in developing countries. The increasing consumption per capita suggests that the fisheries sector provides a pivotal role in providing aquatic-based foods. In recent years, captured fisheries production has decrease due to overfishing and climate change, thereby seriously impacting the fish stock [1,2] Currently, the contribution between the fish culture sector and captured fisheries to the production of aquatic commodities is almost equal [3]. It is estimated that production from the aquaculture sector will surpass captured fish production for human consumption in the following years. Therefore, to meet the demand for aquatic commodities, aspects of aquaculture need to be evaluated thoroughly to improve efficiency and alleviate potential harmful impacts.

Indonesia is one of the top aquaculture producers, worldwide [3]. Referring to the "business as usual" scenario, aquaculture production in Indonesia, both for export and domestic consumption, is projected to continue with impressive growth [4]. Currently, the prioritized commodities include vannamei shrimp (*Litopenaeus vannamei*), Nile tilapia (*Oreochromis niloticus*), catfish (*Clarias* sp.), striped catfish (*Pangasianodon hypophthalmus*), gourami (*Osphronemus goramy*), common carp (*Cyprinus carpio*) and milkfish (*Chanos* sp.). Considering the diversity of commodity types, aquaculture production in Indonesia heavily depends on a limited number of species, especially in the case of freshwater finfish except for vannamei shrimp, which is considered the most valuable aquaculture product in this country. The development of potential commodities from freshwater crustaceans and mollusks seems to be hindered by technical and non-technical barriers. Therefore, it is crucial to foster more diverse aquaculture industries by identifying and promoting other promising aquaculture commodities.

Freshwater crustaceans can be a prospective item for human consumption among aquaculture commodities in Indonesia. Popularly known as crayfish, crawfish, or yabby, this crustacean is important as a food source in the United States [5]. Crayfish is reared in the earthen pond in both countries under either extensive or semi-intensive culture systems. In the United States, crayfishes are usually found seasonally during spring or early summer from February through May. Crayfishes are commonly cultured extensively in large areas of ponds or swamps. In this extensive system, feeding is rarely

Source: Asep Saepudin SEAMEO BIOTROP

conducted thus the crayfishes depend on natural feed that is available in the pond. The crayfish is usually sold as boiled crayfish dishes with herbs and spices (Cajun or Louisiana styled spices) at the grocery stores at a relatively low price.

Development of intensive crayfish culture system

In Indonesia, freshwater crayfish is popular as ornamental fish, cultured in concrete ponds and aquaria with lower density. The density is low to avoid physical contacts between crayfish that possibly cause broken claws leading to economic loss. The use of concrete pond and aquaria is essential to maintain water clarity; the opaque water is an indicator of low crayfish quality, causing lower price. A low-density system applied in ornamental crayfish culture is economically impractical when applied in consumption crayfish culture since it raises production cost. Despite its potential as high-protein food for humans, several underlying problems can offset the development of crayfish in an intensive culture system. Firstly, the crayfish culture requires tremendous effort due to subsequent cannibalism when reared at high density in an intensive system. Cannibalistic behavior of the fish is also common among other crustaceans such as crabs and marine lobster [6,7]. Besides, crayfish culture under high density system in concrete cages or aquariums can be difficult without proper feeding management to overcome the territorial traits of crayfish. Crayfish showed territorial feeding activities and protected their feed against other crayfish [7]. Therefore, crayfish growth may differ greatly from each other, though reared in the same pond; resulting in their different sizes when harvested. To deal with these challenges, crayfish culture using the cellular system, wherein the crayfish is placed individually (or isolated), is proposed to be a better alternative solution. The system has been adopted to culture solitary species such as marine lobster and mud crab [8]. The use of cellular system in aquaculture focuses on how to determine system productivity and optimum density [9]. To fill the gap, this current study aimed to investigate the feeding aspects of the crayfish culture under the cellular system, while also considering interaction among crayfish. The cellular system allows to limit or eliminate social interaction visually or physically among the fish, and the impact of such system on growth and survival rate was investigated.

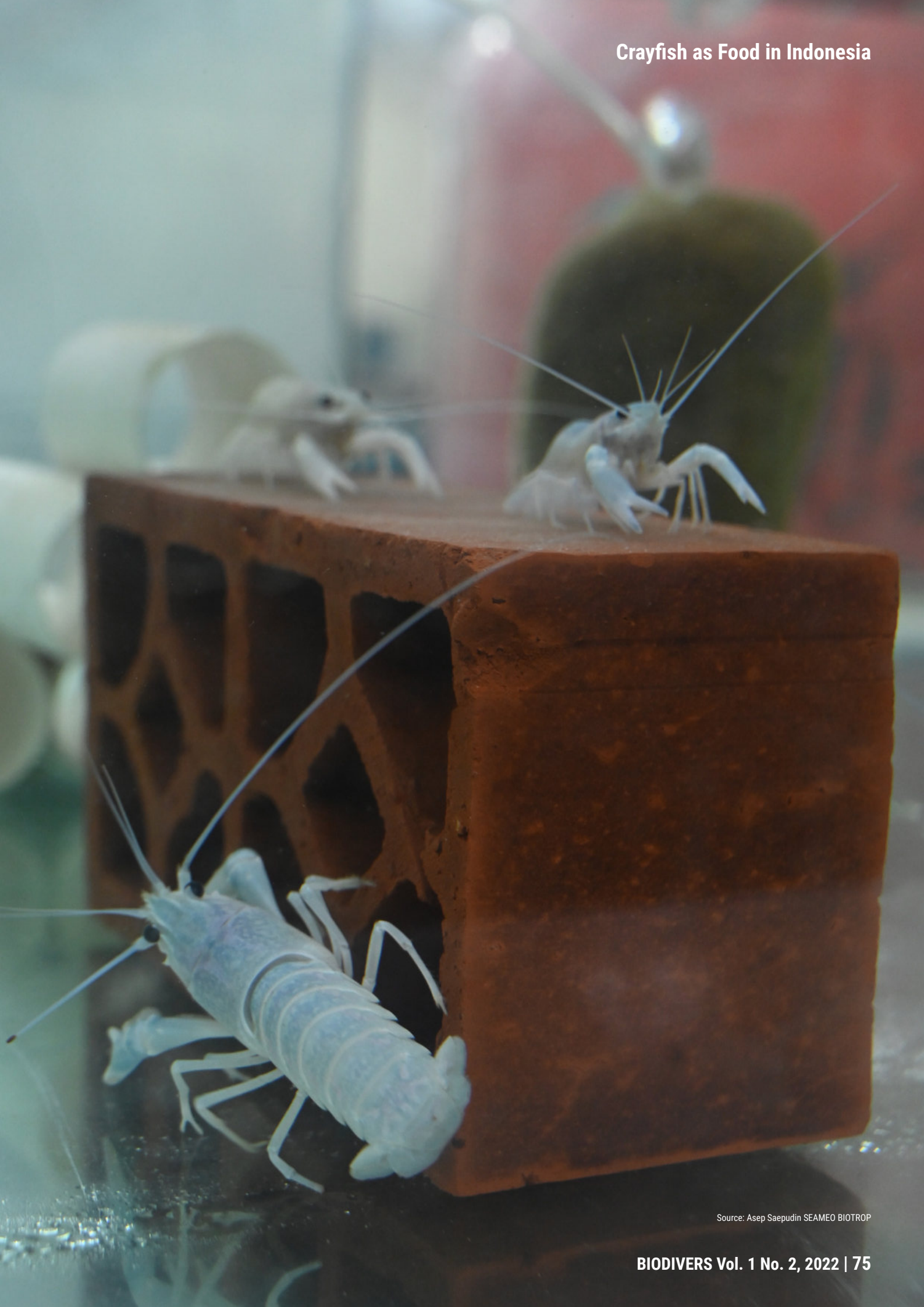
To cope with the above problems, the cellular system was proposed to culture crayfish without provoking economic loss [8,9]. It was previously applied for mud crab, and often combined with recirculating aquaculture system or placed beside rivers [8]. The use of cellular system has altered the social interaction of the cultured fishes [10]. The isolation due to the application of cellular system potentially hindered their growth rate. Hence, in this work, the growth and survival rate of freshwater crayfish cultured in cellular system were also investigated.

Providing quality feed for crayfish

Another problem that can hinder the development of cultured crayfish is the availability of feed in the intensive culture system. Among the important characteristics of an intensive culture system, as opposed to an extensive culture system in the aquaculture field, is high stocking density, high dependency on commercial feed to support optimum growth, and technology intervention to ensure optimal growing conditions. Thus, the production cost of intensive culture will be significantly higher than extensive or semi-intensive culture. One factor that contributes to the increase of production cost is the feeds cost. It is common in intensive aquaculture systems to have feed cost up to 60% of production costs. The total feed cost can even reach 80% of the total production cost in some freshwater species. The high amount of feed cost in the intensive aquaculture system is unavoidable since the principal aim of intensive culture system is to maximize the weight gain of the species in a short time. However, the pond natural productivity will not be enough to provide feed for all the crayfish that are reared.

In its natural habitat, crayfish is considered as an omnivore that can utilize various food sources such as macrophytes, detritus, small invertebrates, and fishes. In the culture condition, crayfish can be fed using commercial or homemade fed with protein content at around 25% and lipid content of 8% [11]. Specific commercial feed that is intended for crayfish is not available in Indonesia. Thus, farmers may use commercial shrimp feed that contains protein at 25-28%. Shrimp feed is the most appropriate amount since crayfish and shrimp have similar feeding behavior; nibbling the feed little by little using their modified appendages, thus, the feed needs very high stability under water to minimize leaching that may affect nutrients intake by the crustaceans and also to minimize pollution of the surrounding water.

In the development of suitable feed for crayfish, one common obstacle is the availability of locally based ingredients for the fish and shellfish feed. Currently, most of the ingredients needed for aquaculture feed are imported from other countries. Soybean meal, wheat, meat and bone meal are not available at the local source or at least not available at sufficient amount to fulfill requirements for aquatic and terrestrial feed. Thus, to overcome this dependency on imported ingredients, local feed raw material should be further explored. Some local alternative feed ingredients that have already been



Source: Asep Saepudin SEAMEO BIOTROP

Source: Asep Saepudin SEAMEO BIOTROP

evaluated and known to be suitable for use as the feed ingredients are palm kernel meal [12], cassava meal [13], rice bran [14], and rubber seed meal [15, 16]. Furthermore, in its aquatic laboratory, SEAMEO BIOTROP tried to utilize the local byproduct ingredients such as watermelon rind for crayfish feed and the preliminary results demonstrated that there was no growth difference when this ingredient was used in the feed.

The use of solitary system along with development of commercial feed for crayfish can be a solution to diversify a long-established crayfish aquaculture as ornamental commodities into food commodities. Furthermore, off-farm aspects such as a thorough market evaluation and a comprehensive marketing strategy could also support this diversification. Finally, it is of utmost importance to further elevate the aquaculture industries in Indonesia into more diversified products so that the need to import fish or shellfish commodities from abroad, is minimized if not totally stopped.

Refference

[1] Brander, K. 2010. Impacts of climate change on fisheries. *Journal of Marine Systems*, 79(3), 389–402.

[2] Brander, K., Cochrane, K., Barange, M., & Soto, D. 2017. Climate Change Implications for Fisheries and Aquaculture. In B. F. Phillips & M. Pérez-Ramírez (Eds.), *Climate Change Impacts on Fisheries and Aquaculture* (pp. 45–62). John Wiley & Sons, Ltd.

[3] FAO. 2020. *The State of World Fisheries and Aquaculture 2020*. FAO.

[4] Tran, N., Rodriguez, U.-P., Chan, C. Y., Phillips, M. J., Mohan, C. V., Henriksson, P. J. G., Koeshendrajana, S., Suri, S., & Hall, S. 2017. Indonesian aquaculture futures: An analysis of fish supply and demand in Indonesia to 2030 and role of aquaculture using the AsiaFish model. *Marine Policy*, 79, 25–32.

[5] Liddel, M., & Yencho, M. 2022. *Fisheries of the United States 2020*.

[6] Mirera, D. O., & Moksnes, P.-O. 2015. Comparative performance of wild juvenile mud crab (*Scylla serrata*) in different culture systems in East Africa: effect of shelter, crab size and stocking density. *Aquaculture International: Journal of the European Aquaculture Society,* 23(1), 155–173.

[7] Romano, N., Zeng, C., Noordin, N. M., & Ng, W.-K. 4/2012. Improving the survival, growth and hemolymph ion maintenance of early juvenile blue swimmer crabs, Portunus pelagicus, at hypo- and hyper-osmotic conditions through dietary long chain PUFA supplementation. *Aquaculture*, 342–343, 24–30.

[8] Shelley, C., & Lovatelli, A. 2011. Mud crab aquaculture: a practical manual. *FAO Fisheries and Aquaculture Technical Paper*, 567, I.

Source: Asep Saepudin SEAMEO BIOTROP

[9] Manor, R., Segev, R., Leibovitz, M. P., Aflalo, E. D., & Sagi, A. 2002. Intensification of redclaw crayfish Cherax quadricarinatus culture: II. Growout in a separate cell system. *Aquacultural Engineering*, 26(4), 263–276.

[10] Barki, A., Karplus, I., Manor, R., Parnes, S., Aflalo, E. D., & Sagi, A. 2006. Growth of redclaw crayfish (Cherax quadricarinatus) in a three-dimensional compartments system: Does a neighbor matter? *Aquaculture*, 252(2), 348–355.

[11] *FAO Fisheries & Aquaculture*. (n.d.). Retrieved April 28, 2022, from https://www.fao.org/fishery/en/culturedspecies/cherax_quadricarinatus/en

[12] Ng, W.-K. 2003. The potential use of palm kernel meal in aquaculture feeds. *Aquaculture Asia*, 8(1), 38–39.

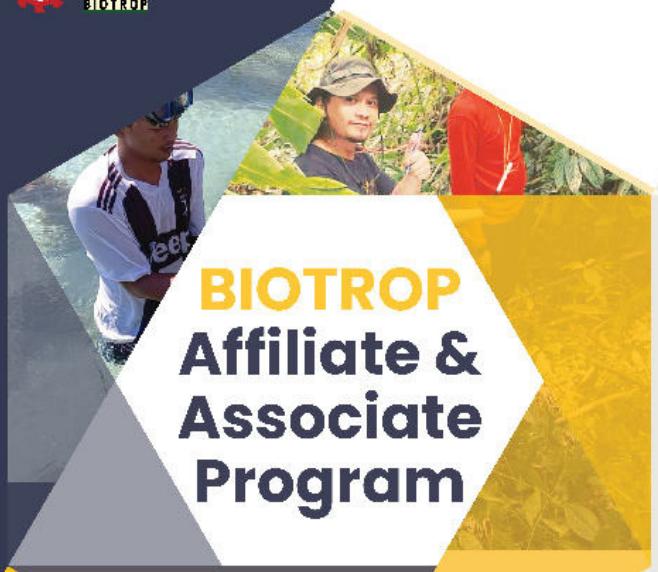
[13] Lukuyu, B., Okike, I., Duncan, A. J., Beveridge, M., & Blummel, M. 2014. *Use of cassava in livestock and aquaculture feeding programs* (Vol. 25). ILRI (aka ILCA and ILRAD).

[14] Ranjan, A., Kumar, S., Sahu, N. P., Jain, K. K., & Deo, A. D. 2022. Strategies for maximizing utilization of de-oiled rice bran (DORB) in the fish feed. *Aquaculture International: Journal of the European Aquaculture Society,* 30(1), 99–114.

[15] Komariyah, S., Suprayudi, M. A., & Jusadi, D. 2014. Preliminary study of rubber seed Hevea brasiliensis oil utilization for tilapia diet. *Jurnal Akuakultur Indonesia*, 13(1), 61–67.

[16] Suprayudi, M. A., Alim, S., Fauzi, I. A., Ekasari, J., Setiawati, M., Junior, M. Z., & Tacon, A. G. J. 2017. Evaluation of hydrolysed rubber seed meal as a dietary protein source for Nile tilapia Oreochromis niloticus L. *Aquaculture Research*, 48(7), 3801–3808.

Category and Requirements for joining the BIOTROP Affiliate Scientist



BIOTROP Affiliate & Associate Program

Senior
Affiliate Scientist

- Having a Doctoral degree for at least 8-10 years;
- Mastering scientific knowledge on tropical biology and any of the Program Thrusts of SEAMEO BIOTROP;
- Having at least 10 years of experiences in research fields relevant to Tropical Biology or any of the Program Thrusts of SEAMEO BIOTROP;
- Having published scientific articles in a Scopus indexed international journal with Q3 SJR status;
- Having a minimum of h-index score of 3;
- Having recognized as reputable in the research field;
- Having experience in collaboration or community service projects;
- Having an extensive network of potential collaborators;
- Having work experiences in reputable institutions, such as government agencies, research institutions, universities, private sectors;
- Having commitments in conducting and contributing to at least one activity in SEAMEO BIOTROP.

Young
Affiliate Scientist

- Maximum age is 40 years old
- Having at least 5 years of experiences in research fields relevant to Tropical Biology or any of the Program Thrusts of SEAMEO BIOTROP;
- Having published at least one scientific publication, such as journal article, book, scientific popular article;
- Having the ability to bring in collaboration to SEAMEO BIOTROP, including network, funding and research opportunities other than DIPA BIOTROP funds;
- Having work experiences in reputable institutions, such as government agencies, research institutions, universities, private sectors;
- Having commitments in supporting and contributing to SEAMEO BIOTROP's activities and programs.

Junior
Affiliate Scientist

- Maximum age is 45 years old;
- Having a Doctoral degree for at least 5years;
- Having at least 7 years of experiences in research fields relevant to Tropical Biology or any of the Program Thrusts of SEAMEO BIOTROP;
- Having published at least 5 scientific publication, such as journal article, book, scientific popular article;
- Having the ability to bring in collaboration to SEAMEO BIOTROP, including network, funding and research opportunities other than DIPA BIOTROP funds;
- Having work experiences in reputable institutions, such as government agencies, research institutions, universities, private sectors;
- Having commitments in supporting and contributing to SEAMEO BIOTROP's activities and programs.

Graduate
Students

- Maximum age is 40 years old;
- Being an active student of the Masters or Doctoral degree study program;
- Having priority status in the process of writing Masters thesis or Doctoral dissertation;
- Having an extensive network of potential collaborators;
- Having work experiences in reputable institutions, such as government agencies, research institutions, universities, private sectors;
- Having commitments in supporting and contributing to SEAMEO BIOTROP's activities and programs;
- Having an interest in futuristic science relevant to Tropical Biology or any of the Program Thrusts of SEAMEO BIOTROP;

Address
SEAMEO BIOTROP
Jalan Raya Tajur Km. 6
Bogor 16134, Jawa Barat

Contact
Phone: +62-251-8323848
Fax: +62-251-8326851
Email: hrm@biotrop.org
Website: www.biotrop.org

https://link.biotrop.org/BAARegistration2022

BIOTROP Affiliate and Associate (BAA) Program

The BIOTROP Affiliate and Associate (BAA) Program aims to enhance the collaboration of SEAMEO BIOTROP with researchers and practitioners in the field of Tropical Biology in Southeast Asia. The membership of the BAA program is 3 years, with extended possibility.

BAA Registration Link

https://link.biotrop.org/BAARegistration2022

BIOTROP Affiliate Scientist Program provides vast opportunities for me to share my experiences and knowledge for the younger generations and future leaders. SEAMEO BIOTROP significantly contributes to solutions on tropical biology issues in Southeast Asia through its facilities, human resources and funding as well as toward the advancements of science education activities.

Dr Supriyanto
SEAMEO BIOTROP Senior Affiliate Scientist

General Requirements for Joining the BIOTROP Affiliate Scientist (BAS)

- Having a Doctoral Degree;
- Having interest in the fields relevant to Tropical Biology or any of the Program Thrusts of SEAMEO BIOTROP;
- Having proficiency in English or any other international languages;
- Being a citizen of one of the 11 ASEAN countries;
- Willing to be the Principal Researcher or Research Group Leader.

Benefits of Joining the BIOTROP Affiliate and Associate Program

- Having priorities in research, training and information dissemination activities organized by SEAMEO BIOTROP;
- Utilizing the facilities and infrastructure of SEAMEO BIOTROP for research and training in accordance with applicable regulations;
- Receiving compensation as a resource person in activities and programs organized by SEAMEO BIOTROP;
- Publishing articles on printed and online media of SEAMEO BIOTROP;
- Having opportunities to be a keynote speaker, resource person and external reviewer for scientific events organized by SEAMEO BIOTROP;
- Networking opportunities in national, regional and international levels;
- Having opportunities for obtaining research funding from SEAMEO BIOTROP through competitive mechanism;
- Enjoying project-based honorarium;
- Being introduced to many research opportunities in national, regional and international scopes.

General Requirements for Joining the BIOTROP Associate Member (BAM)

- Being a practitioner having a certain expertise related to Tropical Biology;
- Having interest in the fields relevant to Tropical Biology or any of the Program Thrusts of SEAMEO BIOTROP;
- Having a patented product or technology which is traceable and proven;
- Willing to assist in developing SEAMEO BIOTROP's program advancement in communities;
- Being able to realize research results in a form of applicable tools or instruments.

ISSN 2810-0271