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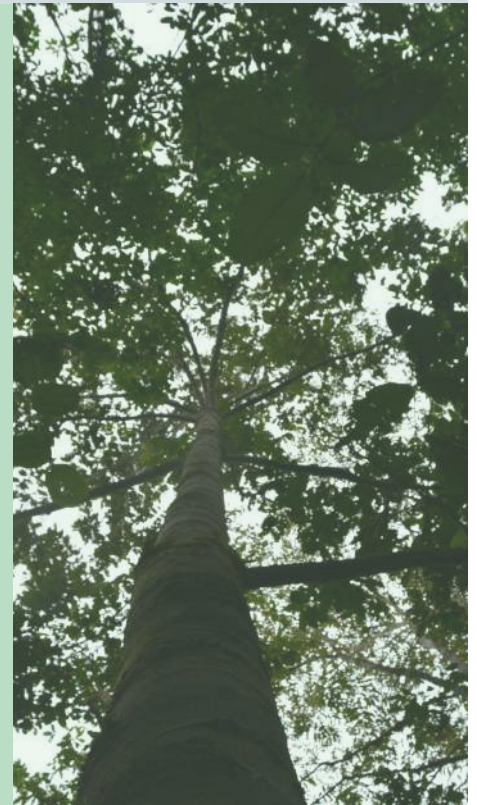
# **BULLETIN**

# **INSTITUT EKOSAINS BORNEO**

(Institute of Ecosystem Science Borneo)

**Universiti Putra Malaysia Bintulu Sarawak Campus**

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**INAUGURAL  
EDITION**

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Universiti Putra Malaysia Bintulu Sarawak Campus**

**Editors:**

**Ellie Teo Yi Lih, Omar Faruqi Marzuki, Mark Lee Wun Fui, Latifah Omar,  
Tunung Robin, Anita Rosli, Adrian Daud and Mugunthan Perumal**

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**PROF. DATIN DR.  
FARIDAH HANUM  
IBRAHIM FASc**

**DIRECTOR,  
INSTITUT EKOSAINS BORNEO (IEB)**

## **FOREWORD BY THE DIRECTOR**

It gives me a great honour and pleasure to write an inaugural foreword for Institut EkoSains Borneo's (Institute of Ecosystem Science Borneo) Bulletin. Since its establishment almost two years ago on 15th March 2020, the Institute has begun to be visible in the community of Universiti Putra Malaysia (UPM) in general and the UPM Bintulu Campus, Sarawak in particular. We are small in term of staff number and our fund is limited but this month we have witnessed our own physical building coming to reality to soon house both the Biodiversity Borneo and Ethnic Borneo laboratories. From time to time we shall highlight our research mission, focus and programmes, as well as the research activities of our staff and graduate students under each laboratory besides making announcements such as achievements, seminars, mobility and visitors. In the coming instalments of our Bulletin we shall report the progress of our research outcomes and outputs especially that relates to public awareness such as our research networkings, outreaches and publications. As a small and young family of the Institute, it is my humble wish that we cooperate and collaborate with each other to bring the good name and image of our Institute and enhance its research role to address the biodiversity and ethnic studies in Sarawak, in particular. I am sure the Bulletin will be well received and will also strengthen the institute's research niche on ecosystem quality in both Sarawak and the region. I would like to commend the editors for their effort and perseverance that led to the publication of this inaugural issue and wish them success with the Bulletin.



## **DR. ELLIE TEO**

Currently, her research work is focused on carbon-based material especially graphene for the use in energy storage devices (redox flow battery, supercapacitors), sensors and corrosion study.



## **DR. OMAR FARUQI**

His research efforts focus on novel sustainable and renewable energy applications. His research activities are centered around wind energy, more precisely, in the application of solar tower.

# *The Editors*



## **DR. MARK LEE**

His core research activity focuses on molecular designs, theoretical and computational chemistry, and single crystal X-ray crystallography.



## **DR. LATIFAH OMAR**

Her recent researches are focused on the balance requirements of organic and chemical based fertilizers in rice production.





## **DR. TUNUNG ROBIN**

Currently, her research work is focused on the consumption habits, food safety knowledge and practices of consumers.



## **DR. ANITA ROSLI**

Her research interest lies in agricultural economics studies, particularly in productivity and efficiency analysis in agricultural production.

# *The Editors*



## **DR. ADRIAN DAUD**

His research focuses on resource and environmental economics issues and this covers any economic-related activities and the strain it put on the environment.



## **DR. MUGUNTHAN PERUMAL**

His current research work focuses on the ecological study of enrichment planting of indigenous species for restoration and rehabilitation of tropical rainforest ecosystem.

# INSTITUT EKOSAINS BORNEO (IEB)

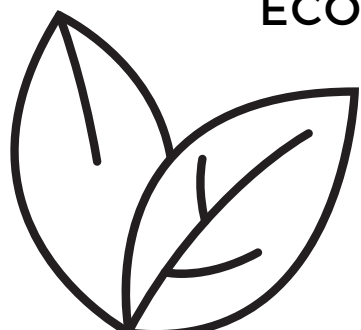
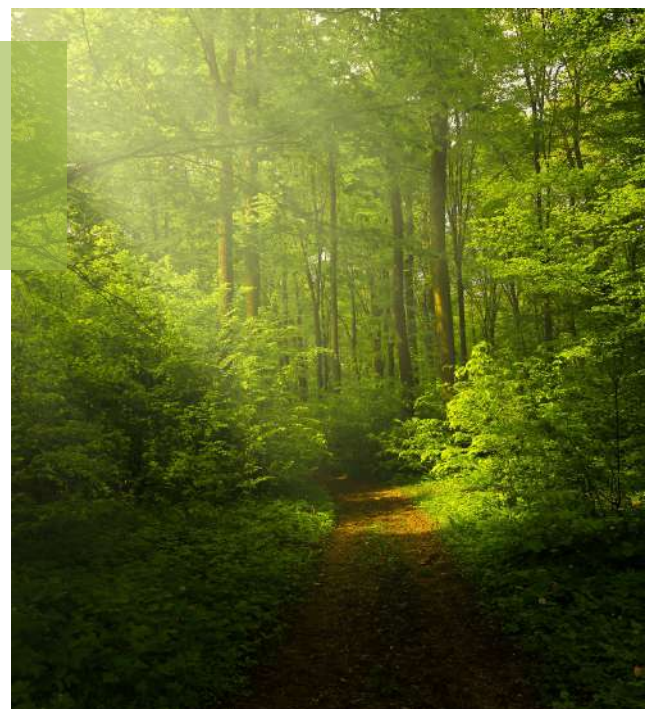


## VISION

WE INTEND TO BE  
BORNEO REFERRAL  
CENTRE FOR  
RESEARCH AND  
DEVELOPMENT IN  
ECOSYSTEM QUALITY

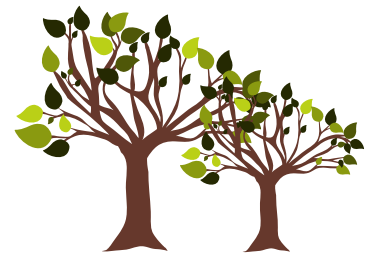
## MISSION

TO BE A REFERENCE OF  
ECOSYSTEM QUALITY





# PAST EVENTS



Webinar on Winning public and private research grants by Prof. Dr. Ahmed Osumanu Haruna (Head of Biodiversity Borneo Laboratory, Institut EkoSains Borneo, UPMKB), 23rd January 2021.

Webinar on  
**Winning public and private research grants**

Speaker  
  
**Prof. Dr. Ahmed Osumanu Haruna**  
Head of Biodiversity Laboratory Borneo  
Institut EkoSains Borneo  
Universiti Putra Malaysia (UPM)

0000 Saturday 23 Jan 2021 06:30pm MYT 10:30am GHT 11:30am NGT zoom

Free Registration:  
Use this link:  
<https://cutt.ly/ojTQNKa>  
or scan this QR Code to register

Jointly organised by:  
Institut EkoSains Borneo  
Universiti Putra Malaysia  
Sarawak Campus  
AGSIM



Webinar on "Beyond publishing papers: Patent, license, and commercialize research inventions and innovations" by Prof. Dr. Ahmed Osumanu Haruna (Head of Biodiversity Borneo Laboratory, Institut EkoSains Borneo, UPMKB), 6th March 2021.

zoom Webinar co-organised by: Association of Ghanaian Students in Malaysia Institut EkoSains Borneo Universiti Putra Malaysia Sarawak Campus Supported by: SALIHIN

**Beyond publishing papers:  
Patent, license, and  
commercialize research  
inventions and innovations**

Part One

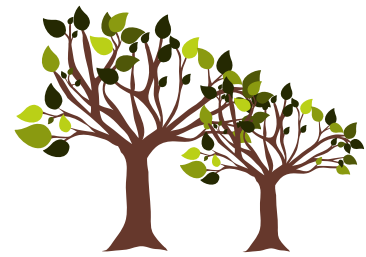
 **Prof. Dr. Ahmed Osumanu Haruna**  
Head of Biodiversity Laboratory Borneo  
Institut EkoSains Borneo  
Universiti Putra Malaysia (UPM)

0000 Saturday 6 Mar 2021 06:30pm MYT 10:30am GHT 11:30am NGT





# PAST EVENTS



"The Thesis and the Viva Voce" by Associate Professor Dr. Patricia King Jie Hung (Department of Crop Science, Faculty of Agricultural Science and Forestry, UPMKB), 30th July 2021.

UPM | Kampus Bintulu Sarawak

**PUTRA SARJANA@UPMKB**  
Seminar Series for Postgraduate Students

## "The Thesis and the Viva Voce"

Friday  
July 30, 2021  
3.00 – 5.00p.m.

Many students are unsure what their examiners actually look for when they submit their thesis and undergo their viva. In addition, many feel the viva to be the part of the postgraduate experience that causes the most stress and anxiety. In this workshop, you will learn exactly what your examiners expect from students, their thesis and their viva, which will enable them to be confident in facing their examination committee.

**Speaker**  
Associate Professor Dr. Patricia King Jie Hung  
Deputy Director, Institut Ekosains Borneo  
Universiti Putra Malaysia Bintulu Sarawak Campus

Online Cisco Webex  
Meeting number: 158 682 6239  
Password: SARJANA21

QR code for registration

☐ Seminar e-Certificate are provided

AGRICULTURE • INNOVATION • LIFE  
BERILMU BERBAKTI



Tea Talk Series 3: Tips to get your articles published in The Malaysian Forester and Pertanika by Prof. Datin Dr. Faridah Hanum Ibrahim (Director of Institut EkoSains Borneo, UPMKB), 6th August 2021.

UPM | Kampus Bintulu Sarawak

## Tea Talk Series 3

### Tips to get your articles published in The Malaysian Forester and Pertanika

6th August 2021  
Friday 9.00 - 10.00 am

Cisco Webex  
Meeting number: 158 422 2881  
TEATALK2021

**Speaker**  
Prof Datin Dr. Faridah Hanum Ibrahim

**Moderator**  
Dr Kwan Yee Min

Organized by  
Faculty of Agricultural Science and Forestry, UPMKB

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# PUBLICATION: ENGINEERING

## DRONE SEEDING HELPS REFORESTATION

by Dr. Omar Faruqi Marzuki  
(omar\_faruqi@upm.edu.my)



Illegal deforestation which is the main cause of world's forests degradation. Due to the rampant issue, researchers have explored various ways to restore the forests affected and one of the novel ideas is by using drone for forest seeding. How does drone seeding mechanism design help reforestation? Dr. Omar Faruqi Marzuki, Dr. Ellie Teo Yi Lih and Assoc. Prof. Dr. Azmin Shakrine Mohd Rafie reviewed current research papers related to

drone seeding around the world, focusing on the mechanism of drone seeding. They found that mainstream of drone seeding mechanism employs gravity drop to spread the seed and the seed container nozzles are designed for specific seeds depending on the seed type, size and shape.

To read more please visit:

[http://malaysianforester.my/forestry/current\\_journal.php](http://malaysianforester.my/forestry/current_journal.php)

# PUBLICATION: SOUTHEAST ASIA HIGHLIGHTS

## FOREST COVER IN SOUTHEAST ASIA OVER THREE DECADES

by Dr. Mark Lee Wun Fui  
(mleewf@upm.edu.my)

Forest coverage has declined substantially in Southeast Asia over the recent decades. Exploring the factors that effect these changes could reverse the adverse effect of deforestation in these regions. A comprehensive estimate of forest gains and losses in Southeast Asian countries is provided in a recent research article by Emmanuel Paradis from the University of Montpellier, France.

The author has suggested that the changes in forest cover is considerably engendered by socioeconomic changes particularly in participating countries with important agroforestry sectors. The forest dynamics of Southeast Asia is seen predominantly influenced by the forest cover changes in Indonesia due to its land area. Besides, synchronicity in forest cover patterns was also found between Indonesia and its neighboring country Malaysia.

To read more please visit:  
<https://www.sciencedirect.com/science/article/pii/S1389934120306584>





# **PUBLICATION: AGRICULTURE ECONOMICS**

## **HOW EFFICIENT ARE PEPPER FARMERS IN SARAWAK?**

by Dr. Anita Rosli  
(anitarosli@upm.edu.my)

Pepper is a traditional crop and source of income for approximately 67,000 people in rural Sarawak. The current estimate of the area under pepper cultivation is approximately 13,000 hectares (Department of Agricultural Sarawak, 2020). High production at the farm level is important to ensure that pepper continues to be one of the income sources for rural farmers, and in a competitive manner. Therefore, development of the pepper industry is of great importance, especially production at the farm level. In crop production, high yield is important as this will benefit farmers by their gaining increased sales revenue. However, high yields should be in line with minimizing the quantity and cost of agricultural inputs, which will enable farmers to achieve high productivity and profits in crop production.

To read more please visit:

[http://www.aessweb.com/journals/5005/October2020ic=download  
&id=5159](http://www.aessweb.com/journals/5005/October2020ic=download&id=5159)





# MANAGEMENT PRACTICES ON PEATLANDS THROUGH SAGO CULTIVATION

by Dr. Latifah Omar  
(latifahomar@upm.edu.my)

## 1. SAGO PALM CULTIVATION AS BUFFER ZONE

- In Dalat peatland, sago farmers planted the sago palm near to river which serves as buffer zones to avoid peatlands degradation when silt loads were trap by the large fibrous root system of sago palm.
- Sago palm is a hardy plant and thriving in swampy acidic peat soils and neutral alluvial soils. Being a buffer zones, sago palm resists to floods, drought, and heavy winds.



Figure 1: Sago palm cultivated at Kampung Bungan Dalat, Sarawak

## 2. ZERO OPEN BURNING IN SAGO PALM CULTIVATION



Figure 2: Sago palm planted in newly opened peatland

- The sago farmers in Dalat aware about the consequences of open burning, thus they practice less open burning in newly opened area for sago palm cultivation.
- Most of the land clearing using conventional way such as slashing in less than one hectare of sago farm.



Figure 3: Aerial view of newly open peatland for sago palm cultivation



### 3.MAINTAIN WATER TABLE DEPTH



Figure 4: Clearing of river using the excavator to maintain water table

- The excavator is used to do the river clearing works to maintain the water table at an optimum depth and this is one of the approaches to conserve peatland from being dry out to the extent of irreversible drying.
- The nearer the water table is held to the optimum depth for sago palm, the better the yield of starch extracting from the sago log. The maintenance of the water level during the sago palm growing period contribute to the conservation of Dalat peatland from being degraded.
- It is important to maintain intermittent flooding by water in sago palm cultivation, whereby nutrients deposited by surface water or running water provide nutrients for sago palm to grow and develop. Moreover, during the growing period, sago palms need waterlogged conditions to produce suckers and form the cluster of palms.

## 4. ENVIRONMENTALLY FRIENDLY NATURE OF SAGO PALM



Figure 5: Sago worm reared in sago stump

- Sago palm is considered as environmentally friendly because during the growth and development, the palm did not require fertilizers and pesticides application.
- No fertilization needed for sago palm at young age because at growth stage, the palm seedlings prefer waterlogged peatland whereby they obtained nutrient for their growth from the deposited of running water.
- During vegetative growth, the sago farmers mounted the palm seedlings with forest litters to maintain peatland humidity.
- In term of pest, the palm weevil *Rhynchophorus ferrugineus* is one of the common pests which bores into the sago palm trunks and lays its eggs inside.
- However, there is no pest management done to remove the palm weevil, rather when the sago palm harvested for log, the stump and log that bear the flower will be left for 45 days for naturally rear the sago beetle after which the sago grubs will be harvested and eaten as local delicacy and sell for RM50 per kg.



# PUBLICATION: FOOD SAFETY

## CONSUMERS' FOOD SAFETY KNOWLEDGE

by Dr. Tunung Robin  
(tunungrobin@upm.edu.my)

The consumption of food prepared outside the home increases exposure to the risks posed by poor hygiene in food service. Foodborne diseases can be prevented if consumers, who are the end users in the food supply chain, have adequate knowledge on food safety and adhere to good practices when handling food. We evaluated consumers' food safety knowledge, which include the correct temperature for food refrigeration, cross-contamination, and common foodborne disease symptoms. These studies highlighted that the consumers generally have good food safety knowledge. Evaluating consumers' food safety knowledge and consumption habits are important in developing effective risk communication.

To read more please visit:

[https://www.myfoodresearch.com/uploads/8/4/8/5/84855864/\\_30\\_\\_fr-2020-357\\_basurra.pdf](https://www.myfoodresearch.com/uploads/8/4/8/5/84855864/_30__fr-2020-357_basurra.pdf)

[https://www.myfoodresearch.com/uploads/8/4/8/5/84855864/\\_19\\_\\_fr-2020-037\\_anusha.pdf](https://www.myfoodresearch.com/uploads/8/4/8/5/84855864/_19__fr-2020-037_anusha.pdf)



# FOREST REHABILITATION PROJECT IN SARAWAK

## *SHOREA MACROPHYLLA* (DE VRIESE) P.S. ASHTON (ENKABANG JANTONG): A POTENTIAL INDIGENOUS CANOPY SPECIES FOR FOREST RESTORATION AND REHABILITATION IN THE TROPICS

by Dr. Mugunthan A/L Perumal  
(mugunthan.perumal@upm.edu.my)

The United Nations (UN) General Assembly (New York) declared 2021-2030 as the “UN Decade on Ecosystem Restoration” on March 1, 2019. This call to action recognises the need to substantially speed worldwide restoration of degraded ecosystems in order to combat the global warming problem, improve food security, and conserve the planet’s biodiversity. Since the inception of the Bonn Challenge in 2011, forest restoration has attracted particular attention and enjoys much international support. However, to date, Malaysia has not made a commitment to the Bonn Challenge. The Bonn Challenge sets a target of restoring 150 million hectares of the world’s deforested and degraded land by 2020, and 350 million hectares by 2030.





These restoration efforts have the potential to meet the national commitments to the Aichi Biodiversity Targets and Land Degradation Neutrality. Shorea macrophylla (de Vriese) P.S. Ashton or locally known as “Engkabang jantung” (Light Red Meranti) (in Malaysia) and “Tengkawang Hantelok” (in Indonesia) is an endemic riparian species of Southeast Asia’s most important tropical rainforest tree in the Dipterocarpaceae family. It was chosen for its socio-economic and ecological relevance as one of the Sarawak’s top indigenous





canopy species for tropical forest restoration and rehabilitation programmes. In the mixed dipterocarp forests of Sarawak and Brunei, this species can reach heights of 50 m, diameters at breast height of 50-60 cm, and buttress heights of 2.0 m under natural conditions in suitable areas. This species is a site-specific species and thrives on clay alluvial soil of riparian forest and lower slopes of clay hills below 600 m above sea level with a growth rate of 2.2 cm mean annual increment in diameter at breast height.

This lowland indigenous tree species is one of the fastest-growing species in the genus Shorea, and is usually found in wet habitats such as rivers and periodically inundated areas. S. macrophylla flowers sporadically in mass flowering years and produces recalcitrant seeds with at most 1-month viability after collection. Due to their fast growth and hardiness, S. macrophylla is considered a prime candidate for restoration efforts in the humid tropics with poor soils.

To read more on the previous related publications, please visit:

<https://www.hindawi.com/journals/ijfr/2021/8859205/>

<https://www.hindawi.com/journals/ijfr/2017/6721354/>

<https://thescipub.com/pdf/ojbsci.2017.7.17.pdf>

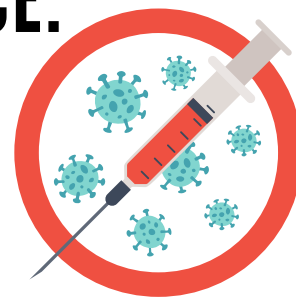






# COVID-19 VACCINATION EXPERIENCE: WE'RE FULLY VACCINATED!

by Dr. Ellie Teo Yi Lih  
(ellie\_teo@upm.edu.my)



Research associates of Institut EkoSains Borneo (IEB) have recently completed their covid-19 vaccination at Pusat Pemberian Vaksin (PPV) Universiti Putra Malaysia Bintulu Sarawak Campus. We spoke to a few of our Research Associates on their experience in getting the Covid-19 vaccination.

## First dose experience

On the day itself, we joined the queue of people waiting in line. Usual SOPs were adhered to – scanned the MySejahtera QR code provided, temperatures taken and we were then given a number and consent form. When our numbers were called, we were allowed into the hall and directed to the counters manned by doctors who took short medical history on any medical conditions and medications. After the doctor has agreed that we are suitable to receive the vaccine, we have to sign the consent form. Right away we were ushered into booths where injections were administered.

“It felt like a sting.” Says Dr Omar Faruqi Marzuki, one of our Research Associate when asked on his experience on the first dose.

Post jab, we sat in the observation bay for 15 mins to ensure that we do not have any severe reactions to the vaccination such as anaphylactic shock. After the observation period, we collected our vaccination card where we can find all the details of the vaccination we received and also the date of our second dose which is three (3) weeks later.

“I felt like I run a marathon.” says Dr Mark Lee on feeling lethargic, when asked about side effects he experience post-jab.

Dr Omar Faruqi Marzuki reported side effect in the form of increase in appetite for several days after the jab. He also felt more lethargic for a few days. While Dr Anita Rosli did not experience any side effects for her first dose.



## Second dose experience

Our second dose was three (3) weeks later and the initial part which involved SOP adherence was the same. There were a sea of people waiting for the vaccination but the numbers were called quickly. Once our numbers were called, we can enter the hall and waited once again for our numbers to be called into the vaccination booth.

“Similar to my first dose injection, it was painless and fast.” Said Dr Ellie Teo, when asked on her second dose experience.

After the injection, off we went to the post jab observation bay for 15 mins.

Dr. Anita Rosli experience slight fever after her second jab and it went away after the next day. Meanwhile Dr. Omar Faruqi reported that he experience the same side effects as his first dose which was increase in appetite and feeling lethargic. These are common side effects reported by majority of those who took the jab.

We have fulfilled 14 days post second jab and therefore we are now fully vaccinated. We would like to express our gratitude to personnels and volunteers at the vaccination centre of Universiti Putra Malaysia Bintulu Campus Sarawak who made the process possible and smooth.





# OUR NEW BUILDING!

By Dr. Ellie Teo  
(ellie\_teo@upm.edu.my)



**Our Institut EkoSains Borneo (Institute of Ecosystem Science Borneo) witnessed a milestone this month; we will soon move to our new building!**

**The new building will house both the Biodiversity Borneo Laboratory and Ethnic Borneo Laboratory. Research associates and students from the Institut EkoSains Borneo (Institute of Ecosystem Science Borneo) will soon be able to do their researches from this new building.**

**Follow us on our Bulletin to see the updates on the new building!**

# PUBLICATIONS

## BIODIVERSITY BORNEO LABORATORY

- 1 Ahmad Mustapha Mohamad Pazi, **Waseem Razzaq Khan**, Ahmad Ainuddin Nuruddin, Mohd. Bakri Adam, and **Seca Gandaseca**. (2021). Development of mangrove sediment quality index in Matang Mangrove Forest Reserve, Malaysia: a synergetic approach. *Forests*, 12(9), 1-21. <https://doi.org/10.3390/f12091279>
- 2 Ali Maru, **Osumanu Haruna Ahmed**, Walter Charles Primus, and Alicia Vanessa Jeffary. (2021). Dielectric response of nitrogen in soil amended with chicken litter biochar and urea under *Oryza sativa* L. cultivation. *Scientific Reports*, 11, 1-10. <https://doi.org/10.1038/s41598-021-91426-6>
- 3 Andrew, B., Khairulmazmi, A., Siti Izera, I., Mohd Farid, A., **Ahmed, O.H.**, and Wong, M.Y. (2021). Elucidation of molecular phylogeny of *Rigidoporus microporus*: a white root rot disease fungus of rubber (*Hevea brasiliensis*) in Malaysia. *Journal of Tropical Forest Science*, 33(3), 274-289. <https://doi.org/10.26525/jtfs2021.33.3.274>
- 4 Benice, A., Khairulmazmi, A., Siti Izera, I., **Ahmed, O.H.**, and Wong, M.Y. (2021). Disease prevalence and molecular characterisation of *Rigidoporus microporus* associated with white root rot disease of rubber tree (*Hevea brasiliensis*) in Malaysia. *Journal of Rubber Research*, 24, 175-186. <https://doi.org/10.1007/s42464-021-00083-x>
- 5 Fahad Rasheed, Adnan Gondal, Kamziah Abdul Kudus, Zikria Zafar, Muhammad Farrakh Nawaz, **Waseem Razzaq Khan**, Muhammad Abdullah, **Faridah Hanum Ibrahim**, Claire Depardieu, Ahmad Mustapha Mohamad Pazi, Khayyam Anjum, Shazia Afzal, Seemab Akram, and M Nazre. (2021). Effects of soil water deficit on three tree species of the arid environment: variations in growth, physiology, and antioxidant enzyme activities. *Sustainability*, 13(6), 1-13. <https://doi.org/10.3390/su13063336>
- 6 Goh Chin Guan, **Omar Faruqi Marzuki**, Yui Pang Hung, **Ellie Yi Lih Teo**, and Nor Mariah Adam. (2021). Management of risk at the Sungai Sarawak barrage. *International Journal of Academic Research in Business and Social Sciences*, 11(17), 217-228. <http://dx.doi.org/10.6007/IJARBS/v11-i17/11401>
- 7 Haidar Fari Aditya, **Seca Gandaseca**, Mochtar Lutfi Rayes, and Daljit Singh Karam. (2021). Toposequent effect on soil morphology and classification of Ultisol soil in the Ayer Hitam Forest Reserve, Peninsular Malaysia. *Jurnal Sylva Lestari*, 9(2), 202-212. <https://doi.org/10.23960/jsl29202-212>



# PUBLICATIONS

## BIODIVERSITY BORNEO LABORATORY

- 8 Hamayoon Jallat, Muhammad Fahim Khokhar, Kamziah Abdul Kudus, Mohd Nazre, Najam u Saqib, Usman Tahir, and **Waseem Razzaq Khan**. (2021). Monitoring carbon stock and land-use change in 5000-year-old Juniper forest stand of Ziarat, Balochistan, through a synergistic approach. *Forests*, 12(1), 1-15. <https://doi.org/10.3390/f12010051>
- 9 Intan Soraya Che Sulaiman, Azham Mohamad, and **Osumanu Haruna Ahmed**. (2021). *Murdannia loriformis*: a review of ethnomedicinal uses, phytochemistry, pharmacology, contemporary application, and toxicology. *Evidence-Based Complementary and Alternative Medicine*, 2021, Article ID 9976202, 1-15. <https://doi.org/10.1155/2021/9976202>
- 10 Ishfaq Ahmad Khan, **Waseem Razzaq Khan**, Anwar Ali, and Mohd Nazre. (2021). Assessment of above-ground biomass in Pakistan forest ecosystem's carbon pool: a review. *Forests*, 12(5), 1-18. <https://doi.org/10.3390/f12050586>
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- 13 Ji Feng Ng, **Osumanu Haruna Ahmed**, **Latifah Omar**, Mohamadu Boyie Jalloh, Yee Min Kwan, Ken Heong Poong, and Adiza Alhassan Musah. (2021). Combined use of calciprill and sodium silicate improves chemical properties of low-pH soil. *Agronomy*, 11(10), 1-18. <https://doi.org/10.3390/agronomy11102070>
- 14 Johan, P.D., **Ahmed, O.H.**, Ali, M., **Latifar, O.**, and Aainaa, H. (2021). Optimisation of charcoal and sago (*Metroxylon sagu*) bark ash to improve phosphorus availability in acidic soils. *Agronomy*, 11(9), 1-28. <https://doi.org/10.3390/agronomy11091803>
- 15 Kavinraj Krishnan, Audrey Awing Ngerong, Karen Ahim, **Osumanu Haruna Ahmed**, Maru Ali, **Latifah Omar**, and Adiza Alhassan Musah. (2021). Mitigating potassium leaching from muriate of potash in a tropical peat soil using clinoptilolite zeolite, forest litter compost, and chicken litter biochar. *Agronomy*, 11(10), 1-16. <https://doi.org/10.3390/agronomy11101900>

# PUBLICATIONS

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