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BULLETIN
INSTITUT EKOSAINS BORNEO
(Institute of Ecosystem Science Borneo)
Universiti Putra Malaysia Bintulu Sarawak Campus

~To Be A Reference for Ecosystem Quality~

BULLETIN

Read More

Editors:
Mugunthan Perumal, Latifah Omar, Nozieana Khairuddin, Omar Faruqi Marzuki,
Ellie Teo Yi Lih, Tunung Robin, Adrian Daud, and Anita Rosli

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TABLE OF CONTENTS

Foreword by The Chief Editor

Dr. Latifah Binti Omar
Head of Biodiversity Borneo Laboratory

The publication of the Institute of Ecosystem Science Borneo (also known as Institut EkoSains Borneo/IEB) Bulletin was initially triggered by Prof. Dr. Osumanu Haruna Ahmed, a former Director of the Institute of Ecosystem Science Borneo.

The articles elaborate on fascinating research topics that need to be known and explored by readers. Research articles in the bulletin provide a diverse variety of topics related to agriculture, forestry, waste management, and socioeconomics. I am grateful to Dr. Mugunthan Perumal (Editorial Board), Ts. Dr. Nozieana Khairuddin (Editorial Board), and Dr. Tunung Robin (Head of Ethnic Borneo Laboratory) for their review and editorial work. Much appreciation to all the Editors who have contributed their work because this bulletin would not be published without them.

Specially Prof. Dr. Patricia King Jie Hung, the Deputy Director of the Institute of Ecosystem Science Borneo who has been monitoring and guiding us throughout the process of bulletin preparation. Like other publications, writing this bulletin is a private activity that serves the public. It is above all for communicating ideas and mind to another mind. There is a diverse overload of finding in the scientific world today. With increasing new findings and modernisation, scientists are called upon to write and document the current problems' diversity and search for solutions. This bulletin focuses on a valuable addition to the existing diverse body of knowledge in agriculture, forestry, waste management, and socioeconomics.

INSTITUT EKOSAINS BORNEO

The Editors

Chief Editor

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

DR. LATIFAH OMAR

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

DR. TUNUNG ROBIN

The Editors

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

DR. MUGUNTHAN PERUMAL

Her areas of expertise include food and biomaterial processing; active-smart packaging, food safety and sustainability; nanotechnology and renewable energy.

TS. DR. NOZIEANA KHAIRUDDIN

The Editors

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. ELLIE TEO

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. ADRIAN DAUD

The Editors

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.

DR. OMAR FARUQI

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

DR. ANITA ROSLI

INSTITUT EKOSAINS BORNEO (IEB)

Established in March 2020

Institute of Ecosystem Science Borneo

VISION

We intend to be Borneo referral centre for research and development in ecosystem quality

MISSION

To be a reference for ecosystem quality

PAST EVENTS

Expert talk by Prof. Dr. Ahmed Osumanu Haruna, former Head of Biodiversity Borneo Laboratory, Institute of Ecosystem Science Borneo, UPMKB on 21st January 2022.

AARDO-MARDI joint online training programme presented by Prof. Dr. Ahmed Osumanu Haruna, former Head of Biodiversity Borneo Laboratory, Institute of Ecosystem Science Borneo, UPMKB on 21 February 2022 – 3rd March 2022.

PAST EVENTS

Knowledge-sharing webinar by an invited speaker, Dr. Mohd Norfaizal Ghazali, Deputy Director of Agrobiodiversity and Environment Research Centre, MARDI on 23rd February 2022.

Knowledge-sharing webinar by Dr. Waseem Razzaq Khan, Postdoctoral Researcher, Institute of Ecosystem Science Borneo, UPMKB on 25th March 2022.

PAST EVENTS

Knowledge-sharing webinar by an invited speaker, Dr. Qammil Muzzammil Abdullah, Senior Lecturer from Faculty of Resource Science and Technology, Universiti Malaysia Sarawak (UNIMAS) on 29th March 2022.

Knowledge-sharing webinar by the invited speakers, Mr. Jasdeep Singh, Managing Director, and Ms. Edna Aloysius, Director of IP SENSE Sdn. Bhd. on 28th June 2022.

PAST EVENTS

Knowledge-sharing webinar by an invited speaker, Assoc. Prof. Dr. Mohd Effendi Bin Wasli, Associate Professor from Faculty of Resource Science and Technology, Universiti Malaysia Sarawak (UNIMAS) on 26th July 2022.

International tea talk series on IOT application in agriculture and forestry by CEO@IEB, Dr. Abdul Memon on 28th July 2022.

PAST EVENTS

International knowledge-sharing webinar on zeolite and its potential uses in agriculture by Head of Biodiversity Borneo Laboratory, Dr. Latifah Binti Omar on 16th November 2022.

Knowledge-sharing webinar by an invited speaker, Mr. Zaki Bin Musa, Senior Research Officer from Malaysian Agricultural Research and Development Institute (MARDI), Kuching on 13th December 2022.

PAST EVENTS

INSTITUT EKOSAINS BORNEO, UNIVERSITI PUTRA MALAYSIA BINTULU SARAWAK CAMPUS VISIT TO MARDI BINTULU RESEARCH STATION ON 8TH NOVEMBER 2022

PAST EVENTS

PAST EVENTS

RESEARCH COLLABORATION DISCUSSION BETWEEN CURTIN UNIVERSITY MIRI SARAWAK AND INSTITUT EKOSAINS BORNEO, UNIVERSITI PUTRA MALAYSIA BINTULU SARAWAK CAMPUS ON 7TH DECEMBER 2022

PAST EVENTS

Curtin University Miri Sarawak delegations:

- Prof. Dr. Tuong Thuy Vu - Dean, Faculty of Engineering and Science (FOES)
- Prof. Dr. Nagarajan Ramasamy - Dean, Research and Development
- Dr. Fidella Tiew - Director, School of Pre-U and Continuing Education
- Assoc. Prof. Dr. John Lau Sie Yon - Associate Dean of R&D, FOES
- Ir. Dr. Lim Chye Ing - Associate Dean of External Engagement, FOES
- Assoc. Prof. Dr. Ling Huo Chong - HoD, Department of Electrical and Computer Engineering
- Prof. Dr. Garenth Lim King Hann - Department of Electrical and Computer Engineering
- Assoc. Prof. Dr. M. Prasana - HoD, Department of Applied Science (Geology)
- Assoc. Prof. Dr. Wong Kwong Soon - HoD, Department of Civil and Construction Engineering
- Assoc. Prof. Dr. Moola Mohan Reddy - Mechanical Engineering Department
- Assoc. Prof. Dr. Law Ming Chiat - Mechanical Engineering Department
- Assoc. Prof. Dr. Bridgid Chin Lai Fui - Chemical and Energy Engineering Department
- Dr. Tan Yie Hua - Senior Lecturer, Chemical and Energy Engineering Department
- Dr. Mahmood Bathaee- Chemical and Energy Engineering Department
- Dr. Lee Yih Nin - Lecturer, Department of Applied Science (Aquaculture)

PAST EVENTS

ACADEMIC VISIT FOR INTERNATIONAL AND REGIONAL FORESTRY COURSE (FS30303), FACULTY OF TROPICAL FORESTRY (FPT), UNIVERSITI MALAYSIA SABAH (UMS) TO INSTITUT EKOSAINS BORNEO, UNIVERSITI PUTRA MALAYSIA BINTULU SARAWAK CAMPUS ON 8TH DECEMBER 2022

PAST EVENTS

Universiti Malaysia Sabah (UMS) delegations:

- Mr. Musri Ismenyah - Course Coordinator/ Lecturer - Faculty of Tropical Forestry
- Mrs. Hardawati Yahya - Lecturer - Faculty of Tropical Forestry
- Mr. Erwan Bin Sulin @ Silin - Assistant Science Officer, Faculty of Tropical Forestry
- 26 undergraduate students of Faculty of Tropical Forestry

INSTITUT EKOSAINS BORNEO

WINNING AWARDS

INNOVATION AND TECHNOLOGY EXPOSITION (INTEX22) ON 15TH-16TH JUNE 2022

GOLD AWARD

Ts. Dr. Nozieana Khairuddin, Nurul Husna Che Hamzah, Mohammad Sobri Merais, Dayangku Nurshahirah Awang Wahab, Ida Idayu Muhamad, Nur Afiqah Ali, Nor Shafinaz Azman, Md Bazlul Mobin Siddique

Innovation: Smart Anti-Pest Fruit Packaging

SILVER AWARD

Prof. Madya Dr. Leong Sui Sien, Prof. Dr. Patricia King Jie Hung, Prof. Dr. Shahrul Razid Sarbini

Innovation: Probiotic Feed

BRONZE AWARD

Dr. Latifah Omar, Kavitha Rajan, Visvini Lohanathan

Innovation: Self-built Rotary Machine for Urea Coating

INSTITUT EKOSAINS BORNEO

WINNING AWARDS

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Visvini A/P Lohanathan Mohd. Hasyrin Hassan Cassandra Sarah David
Universiti Putra Malaysia Bintulu Sarawak Campus

FOR THE ACHIEVEMENT OF

GOLD MEDAL

BY THE INVENTION · INNOVATION ENTITLED :

Refuses Become Resources for Urea Retention Improvement

AT THE 7TH ANNUAL EDITION OF THE INTERNATIONAL INVENTION INNOVATION COMPETITION IN CANADA, iCAN 2022

ORGANIZED BY TORONTO INTERNATIONAL SOCIETY OF INNOVATION & ADVANCED SKILLS (TISIAS)

HELD ON AUGUST 27TH, 2022 IN TORONTO, CANADA

MOONSUK CHANG
ORGANIZING CHAIRMAN

BOB HUYBRECHTS
CO-CHAIRMAN OF THE JURY

CERTIFICATE OF AWARD

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Visvini A/P Lohanathan Mohd. Hasyrin Hassan Cassandra Sarah David
Universiti Putra Malaysia Bintulu Sarawak Campus

FOR THE ACHIEVEMENT OF

ORGANIZER'S CHOICE AWARD

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Refuses Become Resources for Urea Retention Improvement

AT THE 7TH ANNUAL EDITION OF THE INTERNATIONAL INVENTION INNOVATION COMPETITION IN CANADA, iCAN 2022

ORGANIZED BY TORONTO INTERNATIONAL SOCIETY OF INNOVATION & ADVANCED SKILLS (TISIAS)

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MOONSUK CHANG
ORGANIZING CHAIRMAN

BOB HUYBRECHTS
CO-CHAIRMAN OF THE JURY

KLIAFP

This certificate is presented to

LATIFAH OMAR
RAJAN KAVITHA
OSUMANU HARUNA AHMED

KASIM SUSILAWATI

in recognition of

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for the paper entitled

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Refuses Become Resources for Urea Retention Improvement

at the 7th International Invention Innovation Competition in Canada, iCAN 2022
held on August 27th, 2022 in Toronto, Canada

Bob Huybrechts
President

Mike McFarthing
Director of Education

PUBLICATION

The Giant Passion Fruit (*Passiflora quadrangularis* L.): Their Uniqueness and Potential Uses

Shiamala Devi Ramaiya[1, 2]

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Passiflora quadrangularis **L., also known as Giant granadilla, belongs to the family of Passifloracea, and has gained attention in recent years to the growers and farmers due to the size of its large fruit with aromatic flavour and its health benefits. This non-native *P. quandrangularis* is a fast-growing vine and has the ability to adapt to the local condition with plants continuously growing and producing flowers and fruits all year around. The annual fruit production in East Malaysia was ~18 800 kg ha^{-1} with weight ranging 774.20-3034.40 g. It is the most striking species in its genus due to bears larger and more aromatic flowers and possesses flavonoid Vitexin compound that could help to treat anxiety and insomnia. *Passiflora quandrangularis* is the only species that produce pulp with edible mesocarp that has a crunchy texture and melon-like taste.**

Fig. 1: Passion fruit farm at Universiti Putra Malaysia Bintulu Sarawak Campus.

Concerning the nutritional properties, the juice is a natural, nutritious drink with ample essential nutrients and minerals that are required by the body in the right proportion. Beyond nutrients, the fruit also possessed higher vitamins A and C and antioxidant activities which provide specific health benefits such as preventing diseases, enhancing body immunity, and protecting against heart diseases and aging.

Fig. 2: Creeping vine of Passiflora quadrangularis.

Fig. 3: The beautiful flower of Passiflora quadrangularis

Additionally, the UPLC-Q-TOF analysis using the methanolic extract of the leaves showed to have higher secondary metabolites compounds suggested used to make an infusion, a tea that is used to treat insomnia and epilepsy. The extracted seed oil contains essential fatty acids, mainly unsaturated fatty acids, indicating that the oil has considered premium edible oil. *Passiflora quandrangularis* hold a great potential to be commercialized in Malaysia, and various food products can be developed to support the fruit industry in Malaysia.

To read more please visit:

- https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0255059
- http://119.40.116.186/resources/files/Pertanika%20PAPERS/JTAS%20Vol.%2043%20(4)%20Nov.%202020/16%20JTAS(S)-0040-2020.pdf
- https://www.myfoodresearch.com/uploads/8/4/8/5/84855864/_6__fr-2018-233_ramaiya_1.pdf

PUBLICATION

Food Waste: Where it Should Go

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Malaysians produce a massive amount of waste every year especially during festive seasons such as Hari Raya. To overcome this situation, the food waste can be reduced by minimizing edible food loss, draining moisture, and home composting. In other parts of the world, there are some countries which are facing food shortage and food security crisis. These people, at all times, have physical, social and economic access to sufficient, safe and nutritious food, to meet their dietary needs and food preferences for an active and healthy life.

The people who are blessed with lots of good food should try their best to minimize the food loss by buying foods that are sufficient for themselves and not just buying all what they want even though they know that they cannot finish it by themselves. They should think about the less fortunate person in poor countries who have nutrient deficiencies due to the lack of food and spend their money for donation to those people.

Fig. 1: Solid Waste Management and Public Cleansing Corporation director Siti Yusnita Mohamad Yusof says food waste contributed the highest volume at 2,184 tonnes. – The Vibes pic, May 11, 2022.

Fig. 2: A social entrepreneur platform company Yuiko has achieved a reduction of approximately 225 tons of kitchen waste and a reduction of approximately 79 tons of CO2 in 2020 through the sale of "urban compost".

Kitchen waste also one of the organic wastes that can be composted. The waste can become organic fertilizer to the home backyard plants. People should do some gardening so that they can have their own organic vegetables without buying at the market. The pandemic COVID-19 has caused limitations for people to go to the stores for groceries shopping and they have to spend most of their time at home. People are also working from home, and they have many leisure time to do activities such as gardening. Thus, they will need to put fertilizer and compost for the plants.

Hence, food waste is not something that can just been thrown in the landfills because the leachate will cause groundwater pollution. Besides, a decreasing place for landfill sites and high cost of landfill sites management will cause many problems in the future.

Food waste can become a resource for renewable energy because it can generate electricity with a high technology treatment such as biogas facilities. A study by Abdul Aziz et al. (2019) reported that food waste has a good potential as biogas feed source because it contains proteins, fats, carbohydrates and various trace element which promote a balanced process.

In Japan, 220 out of 1800 Japanese local governments implement separate collection of household food waste, although incineration is still a common practice for food waste disposal. Malaysia has put a lot of effort to develop a sustainable landfill site. However, we can help our country to become a country which supports the sustainable development goals (SDGs) by practicing the activities that can utilize the food waste such as by composting and minimizing the waste as much as we can.

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PUBLICATION

Understanding Economic Valuation Towards Biodiversity Conservation in Sarawak's National Parks

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- **ECONOMIC VALUATION**

Monetary valuation of non-marketed environmental services been accepted in many developed country studies, but it is considering new in the Malaysian context. The presence monetary terms in natural and environment valuation enable meticulous measure of environmental costs and benefits for policies but from the perspective of laymen, it has been found wrong to assess such value. Accounting for the values of non-marketed environmental goods and services requires an apprpriate use of environmental valuation methodologies.

- **BIODIVERSITY CONSERVATION**

Biodiversity is a critical indicator for the sustainable development of human society

since it has a significant impact on well-being which can provides community just not only material welfare and livelihoods but contributes to resiliency, security, social relations, health, and freedom of choices and actions. The failure of economic systems and present policies to value the environment and its benefits is the root causes of biodiversity loss. Failure to evaluate the natural resources would result in underestimation of their true value. One way to give the value to a biodiversity, is by conduction an economic assessment thru for the biodiversity conservation.

Fig. 1: Pitcher plant (Nepenthes spp.) in Gunung Mulu National Park.

Fig. 2: Proboscis monkey (Nasalis larvatus) in Bako National Park.

- **SARAWAK'S NATIONAL PARK**

National parks supply tourism experience through its recreational, cultural, and ecological setting. It plays an important role of global biological conservation in the world. Sarawak territory has been recognized internationally as one of the 25 biological hot spots, having rich biodiversity, distinctive ecosystems, and extraordinary biological elements. It is a blessed territory with 14 National Parks and one of them (Gunung Mulu National Park) has been recognized as UNESCO World Heritage Site.

Fig. 3: Bako National Park, Kuching, Sarawak.

- **POLICIES AND POTENTIAL**

National parks supply tourism experience through its recreational, cultural, and ecological setting. It plays an important role of global biological conservation in the world. Sarawak territory has been recognized internationally as one of the 25 biological hot spots, having rich biodiversity, distinctive ecosystems, and extraordinary biological elements. It is a blessed territory with 14 National Parks and one of them (Gunung Mulu National Park) has been recognized as UNESCO World Heritage Site.

Malaysia National Policy on Biological Diversity (NPBD) stated that government and non-government taking this biodiversity conservation issue seriously and many efforts that have been taken but the awareness of biodiversity conservation still in poor level. There are various causes that give a threat to biodiversity loss. Low public awareness on biodiversity conservation is the main cause of biodiversity loss. It is linked on how societies use the resources, the failure of economic systems,and policies management style.

In a policy and management perspective, the acquisition of public funding on environmental conservation in Malaysia is not easy because of a low focus on the environmental issues and agendas by the government as compared to e.g., the education and health agenda. Taking into account the value of nature resources before planning and management are often a crucial point for a successful conservation implementation. A strategic plan for intensifying efforts would potentially elevate public support for conservation, especially in the rural area.

Fig. 4: Local people activities for livelihood.

To read more please visit:

- **http://malaysianforester.my/forestry/current_journal.php**

- **https://www.researchgate.net/publication/342509416_Perception_on_Environmental_Conservation_in_Similajau_National_Park_Sarawak_Malaysia**

PUBLICATION

Indigenous Leafy Vegetables of Sarawak

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Sarawak, located at the Borneo Island and the largest state in Malaysia have vast tropical rainforest about 8.7 million ha which provide diverse plant species utilized by local people for daily needs. Local people especially those living in the rural areas depend heavily on the forests and endowed with deep knowledge on natural food resources. Commonly, the locals collected the wild indigenous plants from their surrounding forest for daily consumption. The ethnobotanical studies in Sarawak revealed variety of plant species derived from the forests used as leafy vegetables. Vegetables are edible portion of plant parts, either roots, stems, leaves, flowers, or fruits consumed as a source of nutrients and commonly include in daily diets. It forms from a diverse plant species and based on its different edible portion, vegetables are classified into algae, mushrooms, root, tubers, bulb and stalk, leafy, inflorescence and seed. Leafy vegetable is one of the vegetable group which had tender part including leaves, petioles, succulent stems, shoots and flowers are consumed while the hard stem are inedible and discarded. Meanwhile, indigenous leafy vegetables (ILV) represent a group of leafy vegetable which was originally grown in a particular region or were adopted into the region for a long time. The study done in Bintulu, Sarawak reported 20 ILV species consumed by local communities. They are *Acalypha caturus* Blume (daunsepang), *Brassica juncea* (L.) Czern var. Ensabi (ensabi Iban), *Claoxylon longifolium* (Blume) Endl. (daunmandei), *Diplazium esculentum* (Retz.) Sw. (paku), *Dracaena elliptica* Thumb (daun sabong kura), *Erechtites valerianifolia* (Link ex Spreng) DC (daun anak mambong), *Gnetum gnemon* L. (daun sabong), *Helminthostachys zeylanica* (L.) Hook (tongkat langit), *Limnocharis flava* (L.) Buchenau (jinjir/emparuk), *Mangifera pajang* Konsterman (daun mawang/embang), *Neptunia oleraceae* Lour. (dauntangki), *Pangium edule* Reinw, *Piper umbellatum* (L.) Miq. (daun burung), *Premna cordifolia* Roxb. (daun singkil/buas), *Pterococcus corniculatus* (Sm.) Pax & H. Hoffm (daun nga), *Pycnarrhena tumefacta* Miers (daun tubu), *Scorodocarpus borneenssis* Becc. (daun kesinduk), *Smilax odoratissima* Blume (daunkemudang), *Stenochlaena palustris* (Burm.f.) Bedd. (midin) and *Syzgium polyanthum* (Wight) Walp. (daun bungkang).

The young leaves collected from trees, shrubs, herbs, and climbers used as leafy vegetables prepared or cooked for many delicacies. The consumption methods of the ILV vary depending on the preference, taste, culture and locality. Commonly, leafy vegetables are preferred to consume fresh or half - cooked to maintain the nutrient and taste, hence they are eaten raw, boiled, cooked or blanched. Some leafy vegetables the boiling process are necessary to reduce the bitterness and detoxification. Leafy vegetables are eaten together with the starchy food or staple foods as relish. Malaysian commonly practiced a simple traditional relish, known as 'ulam' in Malay and accompanied together with traditional sauce known as 'sambal belacan'. The cooking recipe are varied according to the dishes, but other ingredients such as dried prawns, anchovies, chilies, shrimp paste, coconut milk, spices, and other vegetables often added to improve the taste. Some of the ILV were not only consumed as vegetables but also used as food flavouring such as daun tubu (*Pycnarrhena tumefacta*), daun kesinduk (*Scorodocarpus borneensis*), and daun bungkang (*Syzgium polyanthum*). Daun tubu possesses a savoury umami taste which is commonly used to enhance food by the Iban, Kenyah, Kayan, Bidayuh, and Kelabit ethnic groups in Sarawak. Daun kesinduk possesses a strong and pungent odour similar to garlic are added in 'pansuh' (meat cooked in bamboo). The leaves of singkil are cooked as the main ingredient for a special dish in Sarawak which is bubur pedas.

In rural areas, the locals harvested ILV from the wild such as jungle and their fringes, in wastelands, along streams, in paddy fields and backyard garden as their food sources. In contrast, people in urban area are less exposed to the ILV because of their lack access to the sites where the vegetables grow naturally. ILV are one of the sources to generate income for the households. The vegetables also been sold at native markets or locally known as 'Pasar Tamu' which is one of the local's attractions and the spot to seek wild and jungle products. This enabled people in the town to obtain and consume the ILV. These vegetables are inexpensive and nutritious with high nutrient values comparable to other commercialized vegetables. Particularly, leafy vegetables provide a wide range of nutrients such as vitamins, essential minerals, amino acids as well as natural antioxidants for human health and nourishment. The intake of vitamins and minerals can contribute to health as they involved in numerous biochemical processes. For example, it is one of the main sources of dietary fiber required for bowel health and other chronic diseases. Besides, they also contain low dietary fat, hence the intake is good in lowering the obesity rate and incidence of cardiovascular disease. Inadequate intake of these nutrients and other micronutrients can lead to various nutritional deficiency diseases. The studied ILV were considered good for health promotion because these vegetables contain a significant amount of essential nutrients such as minerals, fibers, protein, vitamins and antioxidants while being low in fat and sodium compared to other foods. However, the antinutrients also present in high concentrations thus might affect the bioavailability of minerals and affect health if consumed in large proportions. Therefore, the need for processing such as cooking and fermentation to reduce the antinutrient level such the leaves need to be crushed by hand and drain at running water as are highly recommended.

Currently, the ILV remain underutilized for general population especially at the urban areas. It was commonly overlooked by developed population and noticed as low prestige and nutritionally inferior. The traditional knowledge on the useful plants also decreasing especially among younger generations due to urbanization and migration to the urban areas for better employment and education. Besides, the knowledge on nutrition was also low especially among elder people causing a challenge in promoting healthy diet habits. Malaysian also facing threat of various chronic diseases due to the unhealthy eating habits which include low vegetables intake in their daily diets.

PUBLICATION

Refuse to Resource: Refused Sago Starch Flour for Urea Encapsulation

Latifah Omar[1, 2,*]

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- **Refused Sago Starch Flour for Urea Encapsulation**

Encapsulated urea has many advantages over uncoated urea, such as decreased rapid release of nitrogen (N) from urea hydrolysis, enhanced N retention from leaching by rain or irrigation water, improved availability of inorganic N for a prolonged time, increased N use efficiency, minimized urea application frequency, and reduced adverse environmental effects from N leaching and volatilization (Han et al., 2009). Urea encapsulation is a process of coating urea with a thin layer or film on the surface of the urea granular to ascertain slow or controlled release of N to the soil by diffusion through the pores or the coatings' erosion and degradation (Niu and Li, 2012). Coating materials for urea encapsulation categorized into two types which are organic polymeric substances or inorganic mineral compounds. The polymeric resins, thermoplastic polymers, and natural polymers such as starch, chitosan, and cellulose are classified as organic substances, whereas gypsum, sulfur, bentonite, and other inorganic mineral-based substances are classified as inorganic coatings. Despite of well-established use of sulfur and phosphoric acid as coating materials, there are some drawbacks in using these materials for urea encapsulation such as high cost, inconsistent release pattern, not environmentally friendly, non-biodegradable, and friable when subjected to elevated soil temperatures. Urea coating materials mostly in a liquid form (typical of aqueous polymer dispersion) and the solvent is evaporated. The coating film thickness varies between 5 μm and 100 μm depends on the urea granular dimension and coating functionality (Suzzi et al., 2012). Coating thickness and solubility are very important for gradual release of N from urea and synchronization of the N release rate with the crops requirement.

In our research, an attempt was made on urea encapsulation with refused sago starch (RSS), which is one of the solid wastes discarded during sago starch flour production. Refused sago starch could be considered as an alternative coating material for urea encapsulation due to the abundantly available, low cost, biodegradable, environmentally friendly, weak coating barrier, and hydrophilic (Suherman and Anggoro, 2017). Sago starch flour production generates significant amounts of residual solid wastes such as sago bark from debarking of sago log, pith residues during crushing the fibres, and rejected starch from sieving the high quality of sago starch for export purpose. During starch extraction, after pith pulverizing, the high-quality starch separated from rejected starch by sedimentation which involved rotary sieves, extractors, and sieve bends. High quality sago starch is heavier and sink faster leaving behind vast amount of the rejected starch. The RSS is acidic in nature which is appropriate to be used as coating material for urea encapsulation. During urea hydrolysis, higher concentration of ammonia (NH_3) in soil solution is formed due to high pH. If urea coated with acidic material such as RSS, the pH would be temporarily reduced, results in the lower concentration of NH_3 in soil solution, thus N loss via NH_3 would be minimized.

- **Procedures of Urea Encapsulation**

Some of the methods adopted for urea encapsulation are pan coater, rotary drum, and fluidized bed coater technology (Beig et al., 2020). We encapsulated urea using a self-built mini rotary machine which was assembled from two stainless-steel basins with 30 cm in diameter and 10 cm depth attached to the driller to rotate the basins. Fan regulator was used to control the speed of the rotary machine (Figure 1).

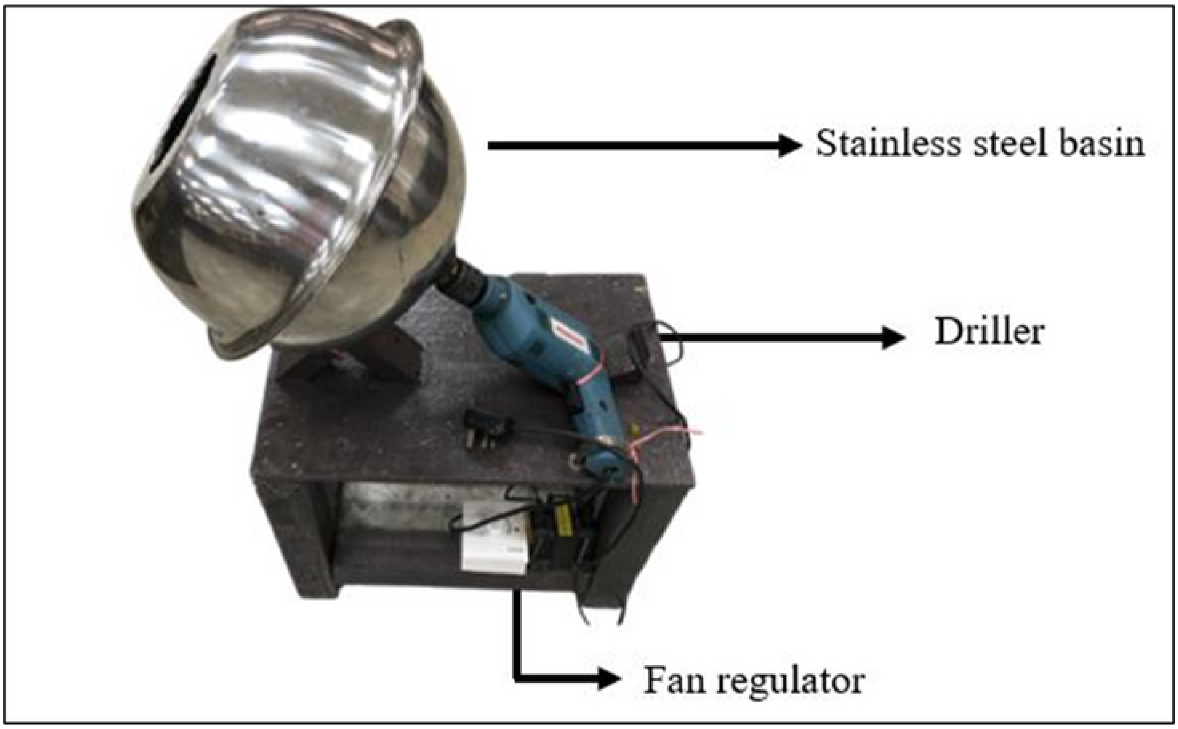

Fig. 1: A self-built mini rotary machine for urea encapsulation with refused sago starch.

Refused sago starch as urea coating material was formulated and dyed with green colour to distinguish the RSS-coated from the uncoated urea (Figure 2).

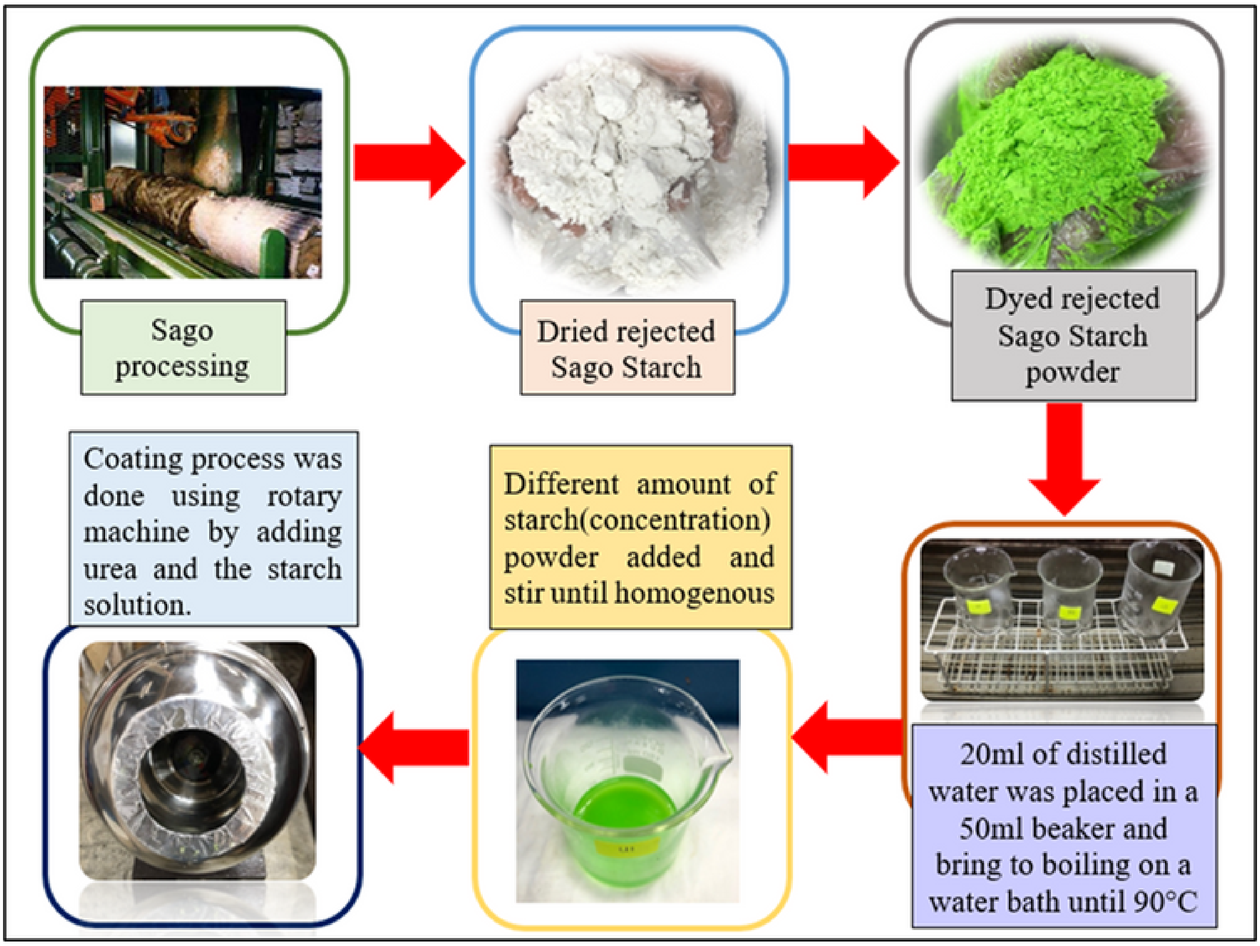

Fig. 2: Method of urea encapsulation with refused sago starch.

Refused sago starch-coated urea were tested for ammonia emitted from urea in comparison with uncoated urea. Ammonia volatilization study was conducted for 30 days using a closed-dynamic airflow system.

- **Released of Nitrogen from Uncoated Urea and RSS-Coated Urea**

The emission of NH_3 from uncoated and RSS-coated urea occurred in three phases as indicated in Figure 3. The estimation of NH_3 emissions from uncoated urea and RSS-coated urea was observed in 30 days whereby the NH_3 loss in the uncoated urea and RSS-coated urea declined to 1%.

In phase 1, uncoated urea dissolved rapidly due to high solubility and rapid urease-catalyzed hydrolysis of urea, whereas RSS-coated urea delayed in solubility due to the presence physical barrier of the coating layer and remained 0% of NH_3 loss as compared with uncoated urea. When uncoated urea and RSS-coated urea applied to the soil, soil water in the form of vapour react with uncoated urea and RSS-coated urea. For the case of uncoated urea, due to water soluble in nature, urea degraded or hydrolyzed with the presence of urease enzyme (urea amino hydrolase) that catalyzes a reaction in which one molecule of urea is hydrolyzed to form two molecules of NH_3. In aqueous solution, urea decomposition produces ammonium ions (NH_4^+) and cyanate after which cyanate ion undergoes conversion to carbon dioxide (CO_2) and NH_3 (Jorgensen and Alexandrova, 2007).

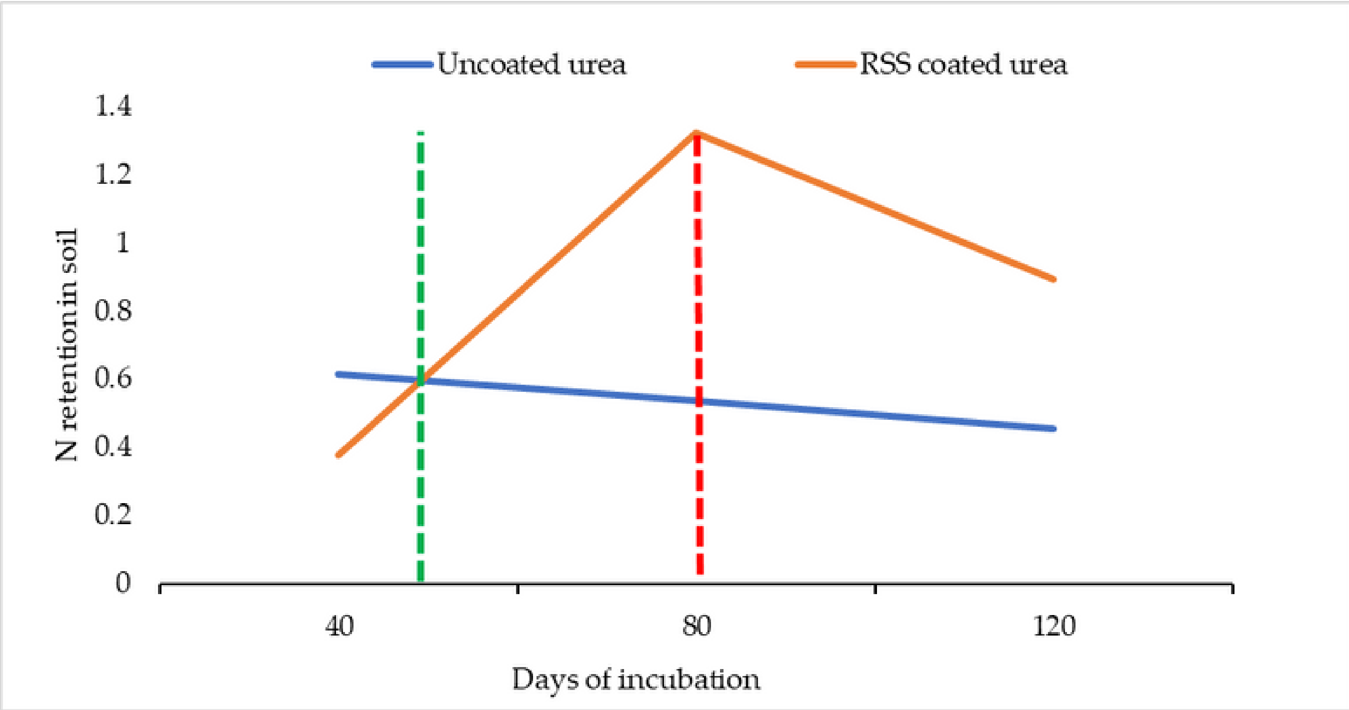

Fig. 3: Phases of nitrogen loss from uncoated and coated urea in soil incubated for three batches.

In phase 2, most of the N from uncoated urea consistently released N results in lower total N in soil compared with RSS-coated urea. When urea coated with RSS, soil water vapour penetrates the coating layer, cracks the coating layer, and penetrates to the core, whereby a small fraction of the urea dissolved gradually after which delayed the progress of urea hydrolysis (Figure 3). In the third phase, most of the N from uncoated urea dissolved completely, thus, the soil total N concentration is declined. Similar trend also occurred in RSS-coated urea but with lower total N than that of uncoated urea (Figure 3).

The pattern shown in Figure 3 reflects that the RSS-coated urea released N slowly over time at the start (phase 1), rapidly in the middle periods (phase 2) and later times (phase 3) suggests that controlled release of N from coated urea in soil. Despite the fact of RSS is hydrophilic in nature, the large molecules in starch clumped together as hydrophobic which means the RSS tend to avoid water. Hence, when RSS contact with water, the starch transformed into hydrogel which contribute to increasing the orifice size of the 3D network of the starch after which it benefits the diffusion of the N in the core of the gel network (Guo et al., 2006). The acidic nature of the RSS (pH 3) significantly affects the interactions of chemical species in the urea granule and the diffusion coefficient of the ions. In an acidic environment (pH 2–5), high concentration of H+ ions lead to the carboxylate anions (COO−) to be protonated and prevents anion-anion electrostatic repulsion in the network decreasing the swelling capacity (Rashidzadeh and Olad, 2014).

- **Take Home Messages**

Refused sago starch could be included as one of the coating materials for urea encapsulation. The RSS-coated urea lessens N loss through NH_3 emission compared with uncoated urea due to the thin layer or film from RSS coat to shield and retain N in urea from being rapidly hydrolyzed. Gradual N released from RSS-coated urea is important to ensure N availability in the soil and to ensure N are synchronized with crops requirement.

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PUBLICATION

Target Plant Concept (TPC): A Holistic Framework for Seedling Quality within a Forest Restoration Programme

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The quality of seedlings is essential to any successful forest restoration programme. The physical and genetic characteristics of seedlings are referred to as seedling quality. Physical quality refers to the physical condition of seedlings as they grow in the nursery, whereas genetic quality refers to the genetic characteristics of the germplasm source [1]. Although good nursery practices can improve seedling's physical quality, there is no quick fix to enhance seedling genetic quality. The concept of seedling quality has evolved over the past century to the point where plant attributes are used to improve seedling nursery culture and forecast seedling survival and growth after outplanting [2].

The morphological and physical characteristics of plants have been examined. However, in reality, only a few attributes are utilised in operational programmes [3], because an "ideal operational measure" must be quick, easy, inexpensive, dependable, non-destructive, quantitative, and diagnostic [4]. Shoot height, root collar diameter, root systems, and shoot-to-root ratios are often measured based on morphological features [5]. According to Takoutsing et al. [6], these characteristics are easy to quantify in operational contexts, ensuring their usage in small-scale nurseries in developing countries and large commercial nurseries in first-world countries [7-9]. Morphological features influence seedling survival and growth after planting at forest restoration sites because they leave their mark on seedling attributes for long periods of time [2, 10]. Since they decrease vulnerability to planting stress by enhancing water intake and delivery to leaves, larger root collar diameter, and root system size increase the likelihood of survival and growth [2].

After South [11] examined Wakeley's [12] morphological criteria, it was discovered that root collar diameter remained the best trait for predicting field growth potential. In locations with competing plants, greater height provides a competitive advantage (i.e., access to light), according to several researchers. When possible site environmental circumstances are restrictive, seedlings with smaller shoot systems or lower shoot-to-root ratios are better acclimated (e.g., dry soils, high evaporative demand).

The Target Plant Concept (TPC) is a framework for combining plant production and field establishment into a single holistic process. Since numerous plant characteristics are linked to outplanting success, seedlings should be cultivated in a nursery with the planned outplanting site circumstances in mind. Plant qualities that are likely to lead to project success should be identified in collaboration between nursery growers and field managers.

Dumroese et al. [13] offered a full overview of the framework's main concepts as well as examples of how it might be used. The TPC framework proposes quantifiable plant characteristics as seedling production "targets". Based on constant monitoring of field performance, the targets can be fine-tuned each season. Other features, such as root systems [14, 15] and internal or physiological attributes [16, 17], are quantitative and thus worthy considerations. Application of seedling growth models [18] may enable more robust forecasts of post-planting performance as data management becomes more viable in real-time decision-making.

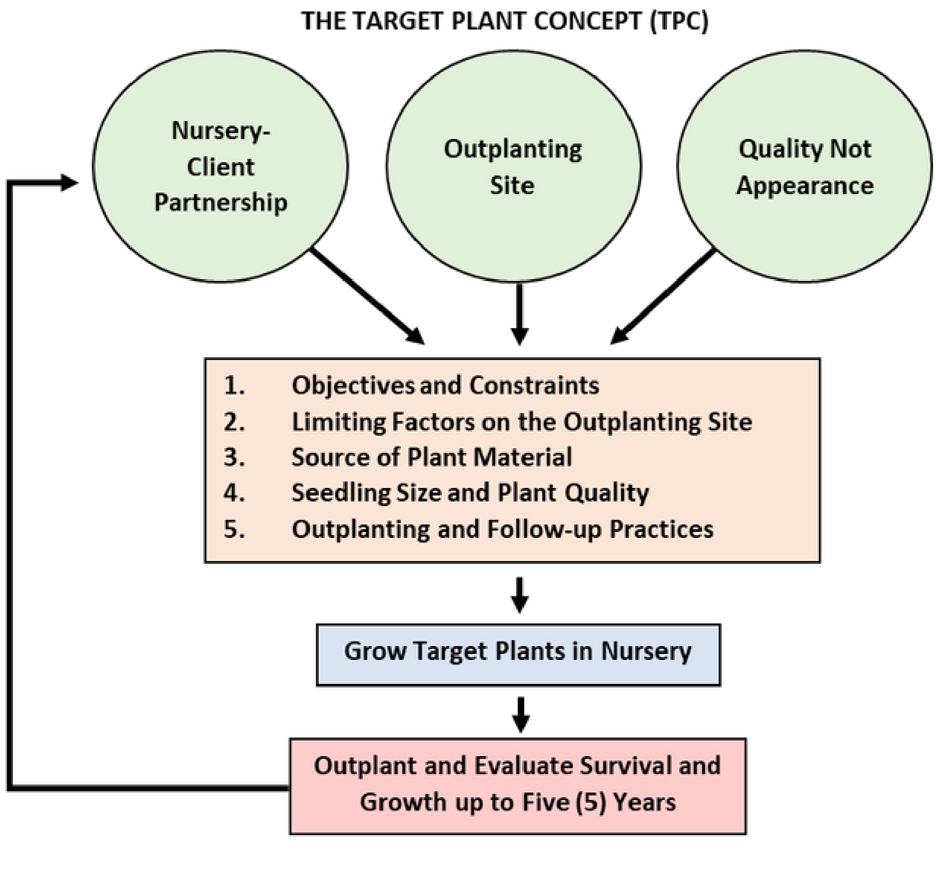

Fig. 1: The Target Plant Concept (TPC) starts with three key elements that guide a cyclic improvement process: nurseries must work together with clients, target plants are defined at the outplanting site, and quality, not appearance, dictates success. Five core components then provide a framework for creating the target plant. The plants are grown, outplanted, and evaluated before starting and improving the cycle again (adapted from Dumroese et al. [13]; Landis [19]).

By applying the TPC approach, nursery production, outplanting, and tending procedures can all be improved over time. The TPC used to have six to eight fundamental components, each of which needed to be handled before seedlings could be produced in a nursery. The core of five all-encompassing components is simplified in Figure 1. In either case, the TPC can be customised for usage with direct sowing, transplanting from other sources, or cuttings. Nursery and field partners can work together to define the target plant for each reforestation or restoration project by discussing each of the five components of the concept.

Previous Research Activities on Seedling Production and Outplanting of Engkabang jantong (*Shorea macrophylla*) in Sampadi Forest Reserve, Lundu, Sarawak following the TPC Approach

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An Idea for Compensating Local Farmers for a Sustainable Method of Pineapple Farming

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Abstract

Agricultural activities have the share in contributing to greenhouse gases in the atmosphere. The method of residue burning (RB), which has been practiced in Samarahan, Sarawak in Malaysia contributed to the emission of carbon into the atmosphere. Steps should be taken to address this issue by promoting sustainable method of farming. Pineapple farmers can be given incentives to change to a more sustainable method such as zero burning (ZB) whereby a mechanism like the clean development mechanism (CDM) can be adopted at the local level to encourage farmers adopting this sustainable farming technique. This incentive is primarily derived from the value of carbon sequestered in the soil through the practice of ZB. Although farmer will suffer financial loss due to additional cost, they can be compensated for this loss under ZB. Thus, farmers still can receive better income with the compensation and at the same continuing to practice ZB.

Keywords: zero burning, carbon sequestration, compensation, sustainable agriculture

Introduction

Agricultural activities are still important to most people in the developing countries especially in the rural areas as it can become their means of earning a living. Samarahan is situated in the coastal area of the state of Sarawak in Malaysia, an area which is known for its agricultural activities. The Integrated Agriculture Development Area (IADA) is the agency responsible to monitor the agricultural activities and to help farmers with their crop planting. Pineapple is the main crop under IADA scheme and it has made Samarahan as one of the producers of fresh pineapple in the state. Sarawak is the second major producer of Pineapple in the

country with more than 38,000 tonnes in 2017 (Borneo Post, 2019). Farmers are planting pineapple for family consumption or to be sold at the local market and this subsistence farming has been practiced for generations. These low-income farmers are dependent on the government subsidies for the expansion of their crop production and the IADA is there to help them to increase their income.

The area planted with pineapple is made of peat soil as this kind of soil has been traditionally used for pineapple planting in Malaysia due to the adaptability of pineapple to peat soil (Py et al., 1987). However, we should be concern on the use of peat soil for agricultural activities in view of the releasing of carbon into the atmosphere. Agricultural land is found to have lower amount of carbon stored in the soil and inappropriate method of farming can lead to greenhouse effects (caused by carbon released in the atmosphere). The mechanics of soil and greenhouse gases in relation to agricultural practices depends on many factors as shown by Lal (2001a). The traditional method of pineapple farming is residue burning (RB) whereby after harvesting and taking the pineapple suckers, the residue (after being chopped) is burned. For these small-scale farmers, they have been burning the pineapple residue in the past and this would also contribute to the haze problem that is now becoming almost an annual problem in the country. Adopting a more sustainable method such as zero burning (ZB) can mitigate the release of carbon into the atmosphere and incentives could be used to encourage farmers to adopt this environmentally friendly method. As more areas are being explored for pineapple cultivation, not only in Samarahan, but other areas in the state, it is the right time to encourage farmers to use the practice of ZB in pineapple cultivation. Sustainable agriculture is becoming more important today than ever as many are warrying of the issue of global warming. Thus, ZB can be a viable option in promoting sustainable agriculture.

Methodology

In this study, we will look at the income generated by farmers under RB and then looking at the viability of adopting ZB. First, we need to establish the kind of revenue that the farmers are receiving and what are the costs that they incurred in order to know the profit they get. There are 206 farmers interviewed and we use the average value in calculating their costs and returns. Most of the farmers in Samarahan are planting the *Josapine* and *Cayenne* breed which is for the fresh fruit market. This is different from the high density planting of the *Gandul* breed which is planted for canned pineapple. They are planting at a relatively lower density, which is averaging around 27,000 fruits per hectare (ha). The average output by the farmers is estimated to be about 70% of total fruits planted. This means that out of the 27000 planted, only about 18,900 are harvested, which gives the yield of 15.309 metric tonne (MT) per hectare for the farmers. The farm gate price for grade A pineapples is Ringgit Malaysia (RM) 1.00 and for grade B is RM0.80 while grade C pineapple is priced at RM0.50. Thus, the average price of the pineapple can be obtained by calculating the revenue from each grade of pineapple. This gives us the value of RM887.7 per MT of pineapple. Therefore, the revenue received by the farmers in Samarahan is about RM13,590 per ha for one cycle of planting. Pineapples in this area are harvested after 13 months from planting and then another 3 to 4 months for preparation of pineapple

Table 1: Cost structure of pineapple planting with different practices.

	Zero Burning		Residue Burning	
	First cycle (RM*)	Subsequent cycles (RM*)	First cycle (RM*)	Subsequent cycles (RM*)
Labor Costs				
Land preparation	1000	1000	1000	1000
Planting	810	810	810	810
Weeding	800	800	800	800
Fertilizer application (spray)	450	450	450	450
Fertilizer application	105	105	105	105
Hormone application	150	150	150	150
Harvesting	945	945	945	945
Residue racking & stacking of leaves	500	500	0	0
Sum	4760	4760	4260	4260
Material Costs				
Suckers	5400	0	5400	0
NPK Fertilizer	1764	1764	1764	1764
Urea	243.6	243.6	243.6	243.6
Hydrated lime	49	49	49	49
Cuprum sulfate	40.6	40.6	40.6	40.6
Zinc sulfate	29	29	29	29
Ferum sulfate	18.85	18.85	18.85	18.85
NAA Hormone	110	110	110	110
Parakuat (clearing)	35	35	35	35
Gesapex (weeding)	348	348	348	348
Sum	8038.05	2638.05	8038.05	2638.05
Total Costs	12,798.05	7398.05	12,298.05	6898.05

***Note: Ringgit Malaysia (RM), RM1 = US$4**

suckers. Thus, another cycle of planting will be done about 18 months after the first cycle of planting.

We have to convert these figures into an annual streams income for the farmers to be able to know what the farmers are earning from pineapple planting. As one cycle of planting is spread over a period of 18 months, we simplify this by taking the values given in Table 1 and divided them into 18 (months) to come up with the annual income received by the farmers. As we are suggesting the use of ZB in pineapple planting to reduce the emission of carbon dioxide, we need to look in the long run to be able to capitalize on the benefits of ZB. Resource management often looks in long run perspective and therefore we take 24 years (or 16 cycles of planting) in this case. This is in the range of the minimum period required to do analysis on the effect on natural resources. In this case it is the soil on which pineapples are planted. Then the net present value (NPV) is used to compare the income of farmers with the present RB and the proposed ZB. We use the discount rate of 4% which is lower than the market rate to emphasize the long-term environmental impact. A lower rate will take into account the future benefits and is recommended for natural resource management to reflect that it is a long-term investment. Taking a higher discount rate (at market rate) tend to focus on the immediate gain at the early period of investment.

The benefit of using ZB is the carbon sequestration value which will be increasing over the years.

The accumulation of carbon in the long run is an added benefit to society as it mitigates the release of carbon dioxide into the atmosphere. The RB practice by the farmers will deplete the carbon content in the soil through the burning of the pineapple residue at the end of the planting period. As pointed out by Jain et al. (2014), the burning of residue contributes to the release of carbon into the atmosphere as well as other greenhouse gases. Sustainable agriculture means that the resource used (i.e., soil) should be managed in a sustainable manner. The negative effects on the environment should be minimized if not avoided. Although there is no specific study on the soil carbon content of the area planted with pineapple in Samarahan, it is well known that soil carbon content for land converted for agriculture well below that of the forest (Sharma et al., 2019). Agricultural soils lost between 25-75% of its original carbon pool according to Lal (2001c). This can be between 60-80% for severely degraded soils. Wei et al. (2014) estimates on average a decrease of 41% in the tropical regions.

There are different methods to estimate carbon sequestration such as by Lal (2001c), Albrecht and Kandji (2003), Jepsen, 2006) and recently Yang et al. (2019). A decade ago, this is still at a development stage as argued by Nair et al. (2009). The rate of accumulation of carbon is normally on the increase only after the 3rd-5th year and begins to slow down after 20 years as shown by Lal (2001c). The accumulation of carbon after the 25th year may slow down but still increasing the carbon stock in the soil. In our case the base carbon is assumed to be at 45 tonne carbon (tC)/ha for agricultural land. Peat soil in its natural state can hold carbon up to 200tC/ha (Pearce et al.; 2002; Hooijer et al., 2006) and for agriculture soil Pearce (2001) estimates the value to be at 63tC/ha. For the unconverted forest we take a moderate value of 150tC/ha following SCBD (2001) and a 70% loss of carbon means we are left with 45tC/ha. This is well between the 40tC/ha and 63tC/ha given by Unger (2001) and Pearce (2001) respectively.

Sequestration of carbon is possible through good agricultural practice (GAP) and ZB practice is one way of doing this. For ZB, accumulation of carbon is gradual for the first 9 years followed by a sharp increase from then on until the 20th year. After that there is a sharp decrease in the accumulation rate. This pattern of soil carbon sequestration rate is similar to what was demonstrated by Lal (2001c). Figure 1 shows the rate of soil carbon sequestration. The accumulation of soil carbon is given by Equation (1) which is the estimated function of the soil carbon sequestration. Figure 2 shows the pattern of soil carbon accumulation up to 50 years as given by Equation (1). Meanwhile RB will cause the release of carbon into the atmosphere and therefore reduce the amount of carbon in the soil. We assume that soil carbon is decreasing at an average rate of 3tC/ha/year and if RB continues the soil is depleted of carbon in a matter of 15 years.

$$C_t = -0.09t^3 + 0.326t^2 - 1.787t + 45 \qquad \textbf{Eq. (1)}$$

where C_t is the estimated carbon sequestration for year t

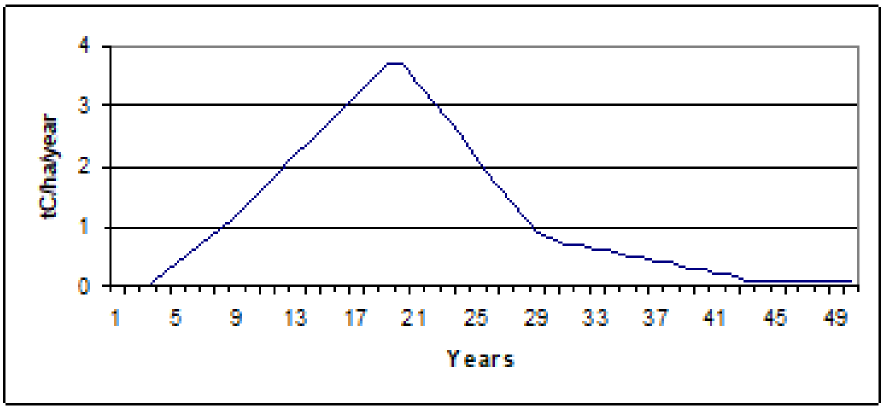

Fig. 1: Rate of soil carbon sequestration.

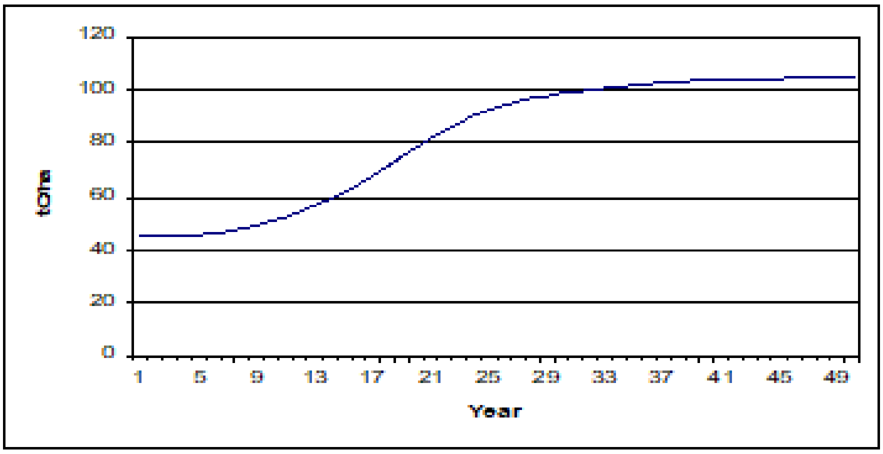

Fig. 2: Accumulation of soil carbon.

Carbon market is just like any other new market out there. Clarkson (2000) suggests a value of $34/tC and Tol et al. (2000) stated that it would be difficult for it to be more than $50/tC. This range of $34-$50/tC can be considered high as pointed out by Pearce (2001). Zhang (2000) suggested a moderate value of $10/tC which is used by Pearce (2001) considering the high value concern. However, if we take the value of carbon traded carbon market, the value is considered as quite high and in the European market for example, it is valued at EU$20/tC (2009 price). Then, in 2015 a minimum price of EU$13/tC has been recommended for a forest management project. For a program that seeks to compensate farmer such as in Samarahan that does not require international level program such as the Clean Cevelopment Mechanism (CDM) under the Kyoto Protocol, perhaps a moderate value of $10/tC (RM40/tC) is already sufficient and reasonable. We will be using the rate of carbon price recommended recently for sustainable development in Malaysia (Joshi, 2019) of RM35/tC in our analysis.

Results and Discussions

The revenues from the two practices are the same as farmers will be planting the same amount of pineapple if they adopt the ZB practice. The NPV of the revenues receive by farmers is RM125,237.71. The cost associated with the ZB and RB will differentiate them in terms of their returns. Then the value from carbon sequestration is different under the two practices which will determine whether ZB is a preferable option over the current RB practice. The total costs under ZB and RB for the 24-year period are given in Table 2. The practice of ZB shows a much higher

Table 2: NPV of total cost and carbon sequestration (per ha).

	Total Cost	Carbon Sequestration
Zero Burning	RM80,323.76	RM30,311.88
Residue Burning	RM75,236.99	RM10,189.23

cost because of the additional costs in residue racking and stacking of leaves as shown in Table 1 earlier.

Table 3 shows the net benefits receive by farmers under the two practices. Although farmers will receive lower returns if they adopt ZB at RM44,913.95 compared to RM50,000.72 for RB, they can be compensated by the higher value of carbon sequestration under ZB. The value of carbon sequestration under ZB is RM30,311.88 which should be higher since there is the accumulation of soil carbon during the 24-year period. RB results in lower value as the soil releases carbon over the years.

CDM at the international level (Liu, 2008). The price of carbon plays an important role in this case as it affects the attractiveness of ZB. The higher the price of carbon, then more can be gained from ZB. Carbon price is set to be higher in the future and this has been proposed by Joshi (2019) in the context Malaysia. There are CDM projects in Malaysia although most of that involve the industrial sector. Agricultural projects seem to be less attractive to potential investor if it is not a reforestation or an afforestation project. Inclusion of smallholders should be targeted in the effort to promote sustainable agriculture as most farmers in a developing country like Malaysia fall under this category.

Table 3: Net benefits of ZB and RB in NPV (4%) terms (RM per ha).

	ZB (RM)	%	RB (RM)	%
Pineapple Revenues	44913.95	59.71%	50000.72	83.07%
Carbon Sequestration	30311.88	40.29%	10189.23	16.93%
Net benefits	75225.83	100.00%	60189.23	100.00%

The percentage of carbon sequestration value from the total benefits is much higher (40.29%) with ZB compared to RB. This means that more benefits can be derived from carbon sequestration when the price is higher. For the price of carbon, it must be priced significantly high and at RM35/tC, ZB is clearly a better option for the farmers as they can be compensated through the value of carbon. This however begs the question of whether this a viable option as there is currently no compensation mechanism for local farmers. The government should look into the possibilities of compensating farmers through a national or state level mechanism similar to what is done under

Monetary compensation to the farmers is an incentive for them to adopt a more sustainable approach in pineapple planting. This is an incentive to promote sustainable agriculture at a smaller scale. Both the government and the private sectors should participate actively for this kind of program to materialize. A monitoring agency is required for certification and should work closely with IADA for compensation to the farmers and this will be similar to the payment for certified emission reduced (CER) under CDM. The private sectors should be encouraged to participate and the government can give a tax incentive for them. There has to be a way to encourage farmers to move toward sustainable agriculture through GAP.

Conclusions

Sustainable agriculture can be implemented through GAP by farmers. This is looking at the long-term implication of agriculture to the environment. Agriculture has its share in contributing to the greenhouse gas emission worldwide. The developing countries are still dependent on agriculture and farmers in the rural areas are mainly smallholders. Their primary concern regarding farming is to meet their daily needs and this subsistence farming is common to most farmers in developing countries especially in the rural area. Their traditional method of planting involves burning of pineapple residue, which has negative impacts to the environment. This is also an easy way to get rid of the pineapple residue and it is a convenient method for them.

The idea of proposing ZB practice to the farmers is challenging as it would mean their costs has increased and thus will affect their income. More importantly there must be a mechanism that enables the farmers to be compensated for any reduction in their revenues if they adopt sustainable approach in farming. Enforcement is necessary for a mechanism that seeks to reward farmers to work properly. There must be a value for cleaner environment and this can be used to compensate the farmers for their losses when embracing GAP in the form of ZB. This is a win-win situation in our quest to promote sustainable agriculture among farmers and at the same time increasing their income. This is a more realistic approach then asking someone to leave the land as it is to mitigate carbon emission.

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PUBLICATION

Iban Women and Side-Income Activities in Sarawak

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Introduction

Women are key to sustainable development and quality of life in the family. Over time, women had transitioned from their roles in traditional society to modern economy. The traditional roles refer to women's roles as wife, mother, and household' managers while the transitional roles refer to the participation in economic activities. The change in modern economic requires most families to have dual bread earners. Women also play crucial roles as bread earners to support their family life whether they are married, singles, or even as single mothers as well. Sometimes, housewives become female-heads of their households as their husband moves away from the family in search of employment and social prestige (Kelly, 2013). Thus, it is undeniable the important roles of women in the family nowadays as they play multiple roles, instead of their traditional status as a wife.

As bread earners, many women are now involved in informal sector, either full-time or part-time depending on which fit well with the demand of "multiple roles" they have transitioned into. Furthermore, the informal sector does not require high education and skills (Ida & Nurliani, 2016). In 2019, 9.4 percent of all females employed in Malaysia worked in the informal sector (Statista, 2021). According to Department Statistics Report, Malaysia (2020), more than 40 per cent of the activity in the informal sector operated at home, one third with no fixed location (mobile) and 18.1 per cent at market or street stalls.

Side-Income Activities Among Iban Women

This has been the case of some Iban women today that has ventured into small businesses to generate side income while at the same time keeping their job at their workplace. Iban women in rural areas or longhouses are involve in farming, fishing, handicraft, and processing food for personal use, sale, and exchange purposes. Longhouses communities tend to sell and swap their products with each other. Besides, they are also selling the products to a wholesaler or selling them in town areas (Sunday market or *tamu*). A general look at the *tamu* or any local markets show that there is a significant number of women involved in selling local agricultural produce. They can be helping their families in that particular business or merely earning some extra income as their husbands are working somewhere else.

Nowadays, many Iban women migrate to urban areas following their husbands, for employment and even for a better life. Either they are full-time housewives or jobholders, some of them will earn side-income by doing home business activities such as handicraft making, baking, tailoring, cooking, and online business to support family life, as the living cost is expensive compared to living cost in rural areas. When they move to urban or town areas, some of their traditional activities are discontinued such as farming activities as they do not have land space for farming. They are most likely involved in farming in their village as they have ample of land but not in town, unless they have knowledge and skills in modern farming such as hydroponic farming system. However, they could continue other traditional activities such as handicraft making but it may differ in terms of raw materials used and design. For example, they may not produce rattan mat and bamboo basket as the rattan and bamboo supply is not always available in urban areas, but they will use plastic packaging strip (PPS) as the main raw materials.

Research Objectives

The purpose of this study is to investigate the participation of Iban women in side-income activities in Sarawak. From this study, we could identify types of side-income activities among Iban women in Sarawak. If there are obstacles in side-income earning, we could propose suitable solutions according to problems and situations. Different problems and situations need to be overcome by different approaches and methods. This study could be a reference to government and relevant agencies to plan strategies to help and improve Iban women development and empowerment.

Methodology

The study employs a descriptive study design to describe the participation of Iban women in side-income earning such as respondents' profile, side-income activities, and obstacles in side-income earning. Thus, the information will be collected through the questionnaire. This research proposed two methods in data collection i.e., face-to-face interview and self-administered questionnaire. The face-to-face interview is principally for older respondents and for those who do not understand the questions while the self-administered questionnaire is for respondents who able to answer the questions. However, due to the pandemic Covid 19 and Movement Control Order (MCO) in Sarawak, the web-based survey by using Google Form is the best method to reach potential respondents in Sarawak.

Findings of Study

Profile of Respondents

There were 138 respondents interviewed for this study and their locations are given in Table 1 below. The respondents come from all over Sarawak, except for the northern part of Sarawak in Limbang. Half of the respondents are from Bintulu and Sibu in the central region followed by Miri. This covers areas that have high population of Iban especially in Bintulu and Sibu divisions. Miri and Kuching are the other divisions with high population of Iban (Sarawak Government).

The majority of the Iban women involved in the study do have secondary school education. About 40% (n=55) of them completed form 5 (Sijil Pelajaran Malaysia) and 8% (n=12) completed form 6 (Sijil Tinggi Pelajaran Malaysia) (see Figure 3). There are 24% (n=33) who completed diploma level education and 21% (n=29) who has a degree or higher education.

Corresponding to this education level we can see that half of the respondents are working in the public (government) sector (22.5%, n=31), the private sector (22.5%, n=31) and self-employed (6%, n=8). There are 33% (n=46) of them who are

Table 1: Locations of the respondents.

Location (Division)	Number of respondents	Percentage
Betong	4	2.90%
Bintulu	31	22.46%
Kapit	10	7.25%
Kuching	12	8.70%
Miri	16	11.59%
Mukah	3	2.17%
Samarahan	6	4.35%
Sarikei	10	7.25%
Sibu	40	28.99%
Sri Aman	6	4.35%

The mean age for the respondents is 33.7 years and the distribution of age is shown in Figure 1. The group that makes up the below 20 years are mainly students who are involved in side-income activities. Iban women of the age group between 20 and 39 years constitute about 70% (n=97) of the survey and this shows that this 20s and 30s (young and working adults) are the most actively involved in side-income activities among Iban women. There are 14.5% (n=20) in the 40s age group. Less than 10% (n=13) of them are above 50 years old. Two-third of the respondents are married whereby 27% are not married and 6% are single mothers (see Figure 2).

housewives (see Figure 4). Although half of the respondents are employed, the majority of them still involved in side-income activities. As entrepreneurial skills are being encouraged among women, we can see that a majority of the Iban women in this study are involved in side-income activities and perhaps this is to increase their household income as the majority of them belong to the B40 group (see Figure 6). There are 72% (n=99) of them that belong to the B40 category and a further analysis reveals that 52.9% (n=73) of them are in B1 category which in this survey are those earning less than RM2540 per month. As cost of living continues to increase, it is

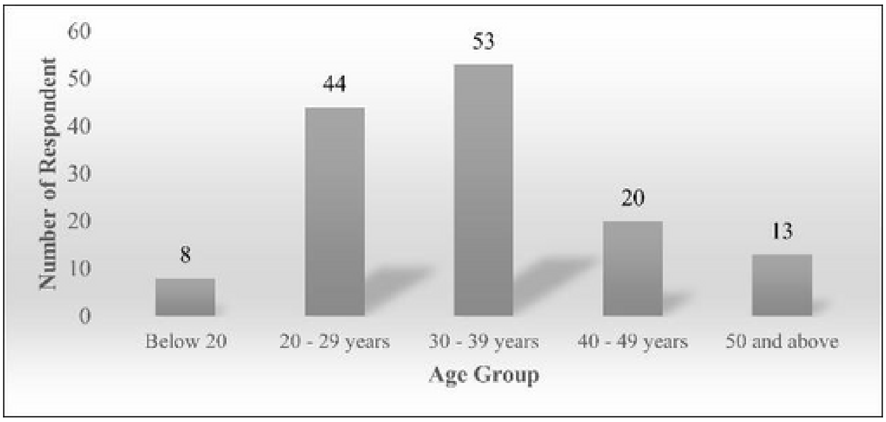

Fig. 1: Age group.

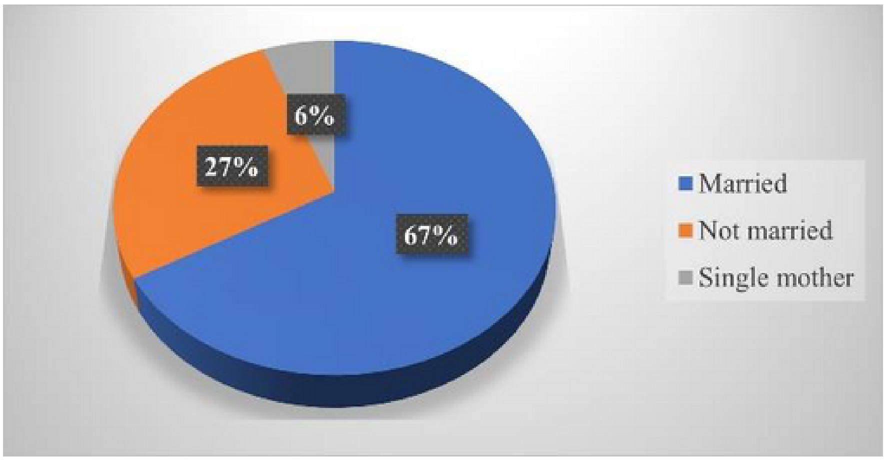

Fig. 2: Marital status.

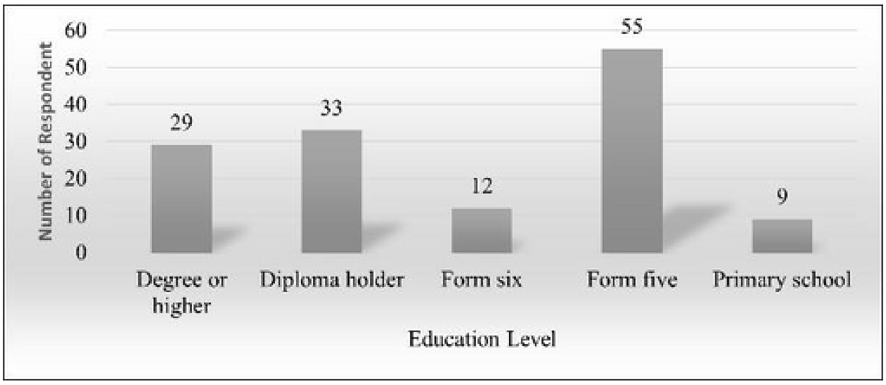

Fig. 3: Education level.

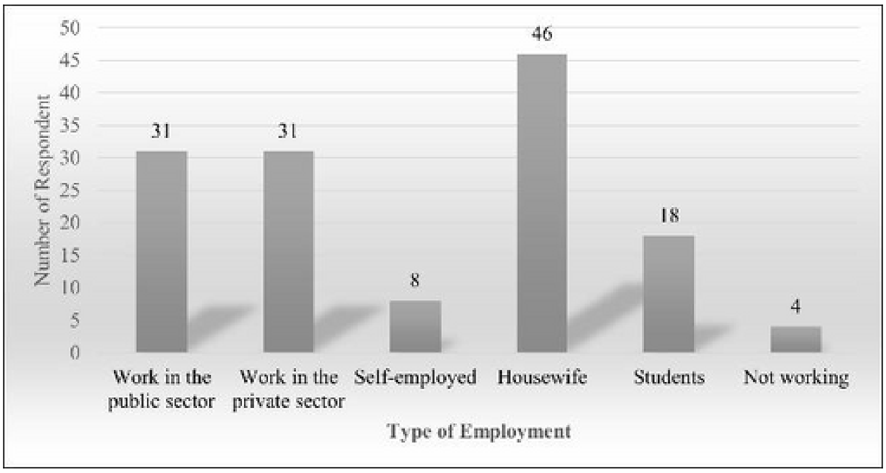

Fig. 4: Employment.

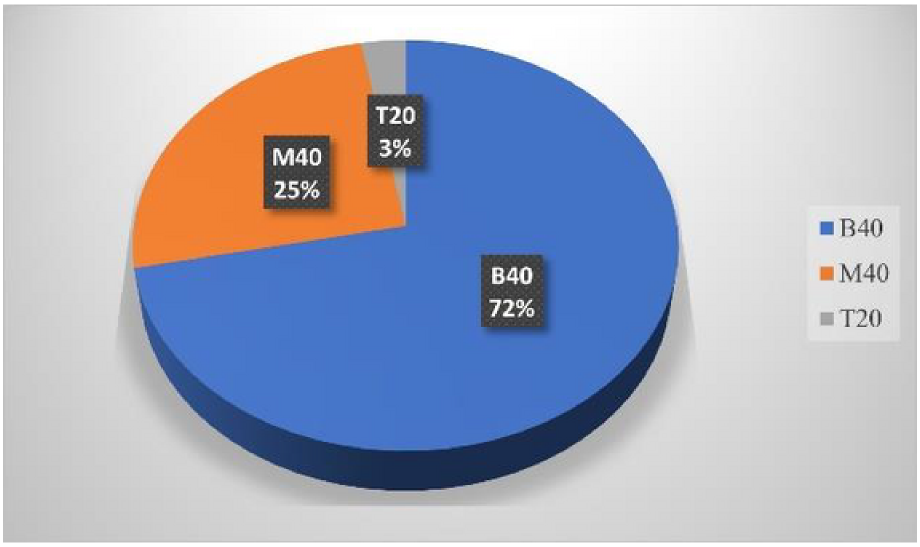

Fig. 5: Household income level.

not surprising that many households need to make ends meet and the role of women in helping to increase household income can be seen in this study. The M40 category make up 25% (n=35) of the respondents and the remaining 3% stated that they are in the T20 category.

Participation of Iban Women in Side Income Activities

Iban women do side income activities for several reasons. Based on the survey, 114 respondents do side income activities to have additional income for family and some of them also do the side income activities as hobby (n=35) and leisure activity (n=43) (see Figure 6).

Iban women do several side income activities such as business (n=115), farming (n=96), food processing (n=85), handicraft making (n=75), tailoring (n=4), crocheting (n=6), and other (n=29) (see Figure 8). There are several types of business activities done by Iban women such as becoming a drop shipping agent, operating a restaurant, mini grocery store, clothing store, and others. For farming, they plant paddy, vegetables, fruits, and perennial crops (pepper, rubber, and palm oil) as subsistence as well as additional source of income. For those who are involved in food processing, their products are Iban traditional food, cake, biscuits, and catering. For those who produced handicrafts, they make Iban traditional textile (*pua kumbu*, traditional custom), woven basket and mat, and beads-based products (neckless, bracelet, key chain, souvenir). The other types of side income activities are as part-time employee, YouTuber, investor, e-hailing driver, tuition teacher, overtime work, traditional dance instructor, and runner services. Iban women do few side income activities that are based on their interest and skills. For example, Iban women do farming and handicraft as their source of income.

Respondents sell their products in several ways such as online selling (n=106), selling to neighbourhoods (n=75), at their home (n=48), market (n=22), selling at the retail shop (n=21), selling in bulk (n=20), and selling during the festival exhibition (n=15) (see Figure 8). However, the selling methods depend on the type of products. For instance, vegetables are considered as non-durable products that can be sold at home, selling to neighbourhoods, market (*pasar tamu*), and online (with cash on delivery).

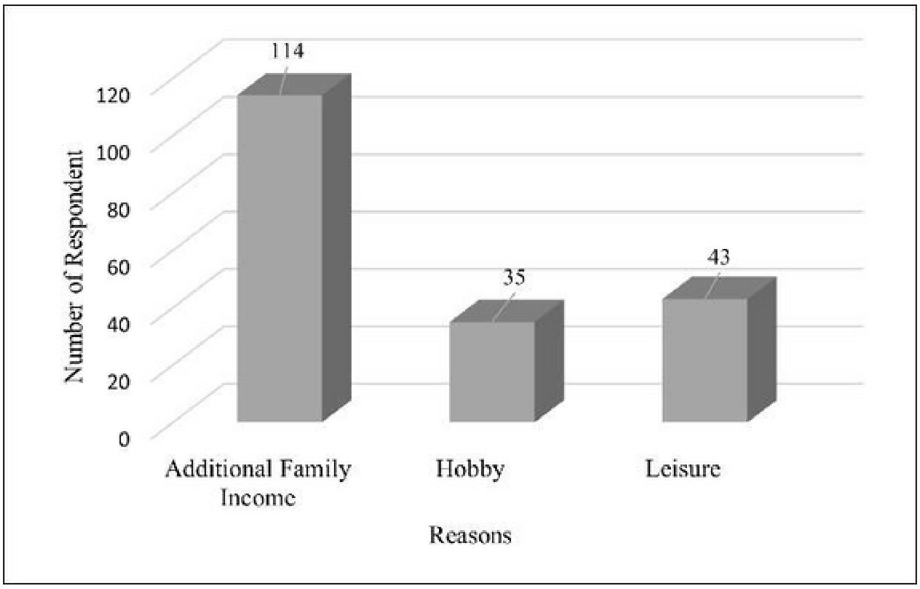

Fig. 6: Reasons to participate in side income activities.

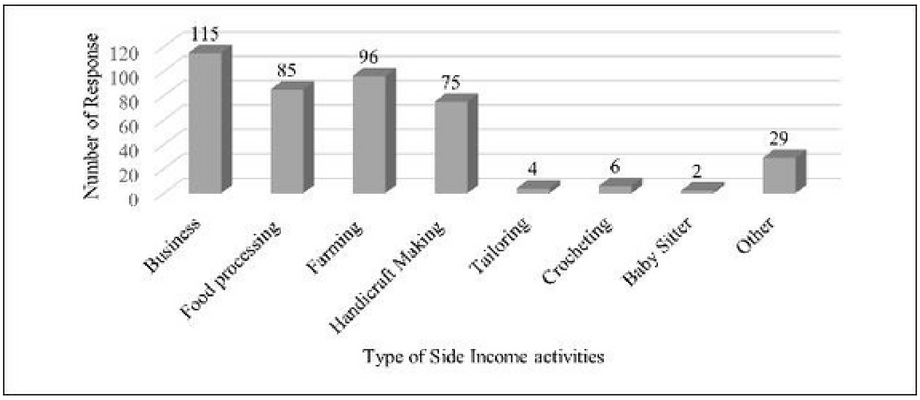

Fig. 7: Type of side income activities.

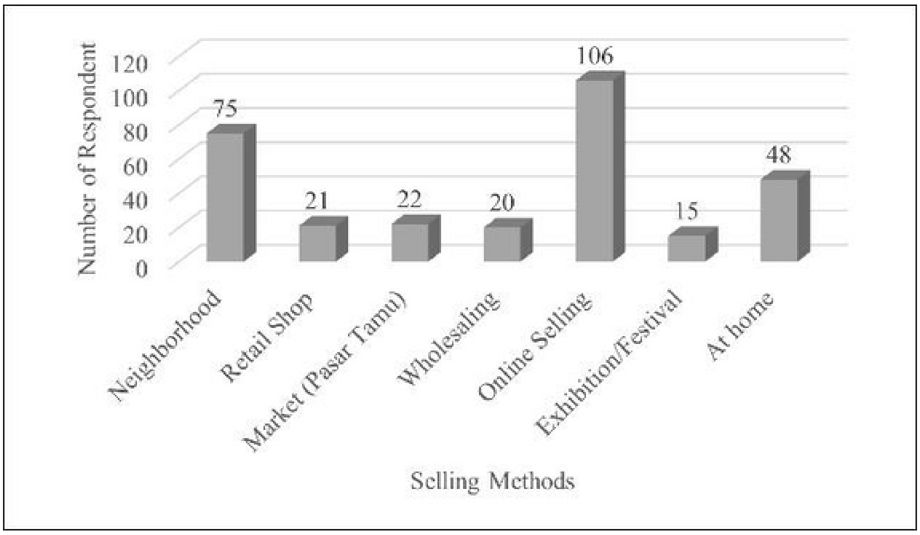

Fig. 8: Selling methods.

A total of 37 respondents reported that they sell their products every day and followed by 17 respondents and 3 respondents who sell their products 1 to 3 times per month and 4 to 6 times per month, respectively (see Figure 9). However, as side income activities are flexible activities, more than half of the total (n=76) respondents reported that their selling activities are erratic. This is depending on the availability of products and customer's order. If there is no product produced and customer request there will be no selling activities. For instance, food products will be produced depending on the demand from customers.

The income from side-income activities is not very favourable. A total of 83 respondents have reported that they are gaining RM500 or below per month from side income activities while 46 respondents gaining more than RM500 per month. Meanwhile, 9 respondents reported that their earnings per month are not stable (Figure 10).

Obstacles in Side Income Activities

The respondents have reported that they are facing several obstacles in side income activities (refer Figure 11). A total of 80 respondents reported that they have problems in obtaining capital to start up their side income activities due to the difficulty in getting the loan and that they do not know the relevant agencies who provide financial assistance. Almost 50% of the respondents earned household income RM2539 and less per month and it is considered a low-income family based on gross income household in Sarawak (Poket Stats Negeri Sarawak, 2021). It may be one of the reasons they could not come up with the start-up capital for their side income activities. A total of 74 respondents stated that they have marketing problems such as they do not have own transport to market their products, high transportation rental cost, do not know how to conduct online marketing, competition with other producers, and living far from town (or sales center). Some of respondents have less knowledge and skills (n=53) in certain fields such as basic knowledge (reading, writing, and calculation), do not know how to use internet and business applications, less knowledge in business and entrepreneurship, farming, handicraft making, and food processing.

Suggestion to Overcome the Obstacles

Based on the problems, respondents were asked what their suggestions are to overcome the obstacles. As start-up capital is the main constraint for them to get involved in side income activities, 82 respondents suggested relevant agencies provide financial assistance. A total of 77 respondents needs business and entrepreneurship courses, 77 respondents ask for marketing and promotional assistance, and 70 need skill courses for certain fields such as handicraft making, tailoring, food processing, farming, and so on. Besides, 55 respondents requested to have subsidy assistance for shop or kiosk rental. Meanwhile, the other suggestions are motivation courses to encourage them to participate actively in side income activities (see Figure 12).

Main Outcome

Based on the findings of the study, the following are several activities that could be conducted to support the side-income activities among Iban women in Sarawak

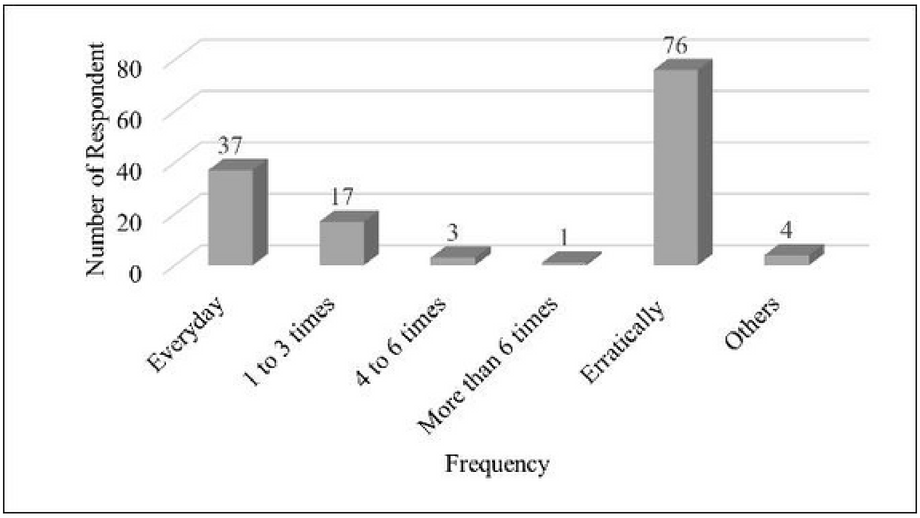

Fig. 9: Frequency of selling per month.

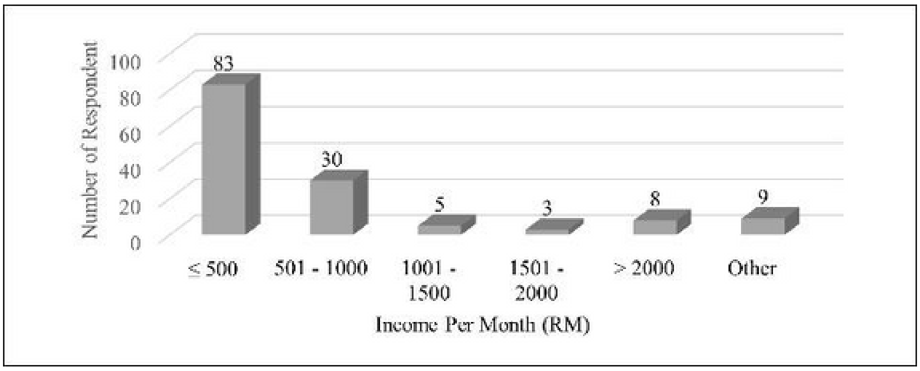

Fig. 10: Income obtained from side income activities.

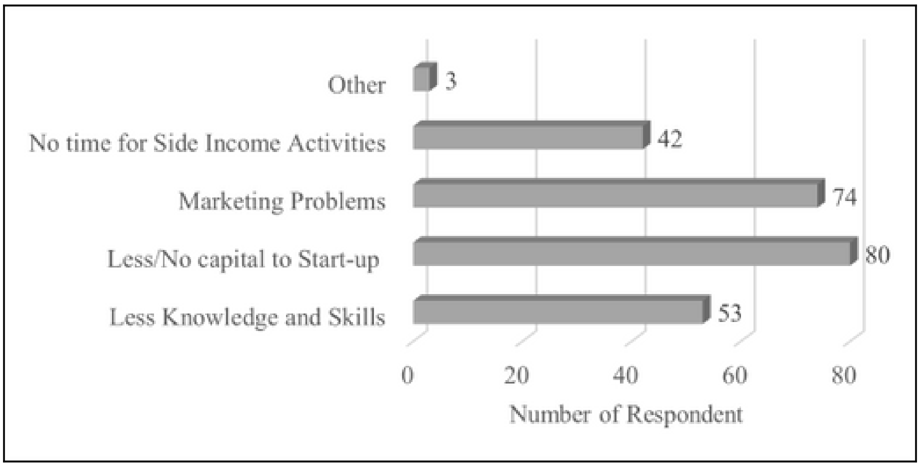

Fig. 11: Obstacles in side income activities.

a) Providing knowledge and Skills

i. Business Education and Entrepreneurship Skills Training
ii. Information and communication technology (ICT) Trainings
iii. Handicraft Making Courses
iv. Food Processing Courses
v. Modern Farming Management Courses

b) Providing Financial support

Thus, to support Iban's empowerment and development the government, NGOs and relevant agencies could provide microfinance programs especially for Iban women in Sarawak. There are few microfinance programs in Sarawak such as Amanah Ikhtiar Malaysia (AIM), Tabung

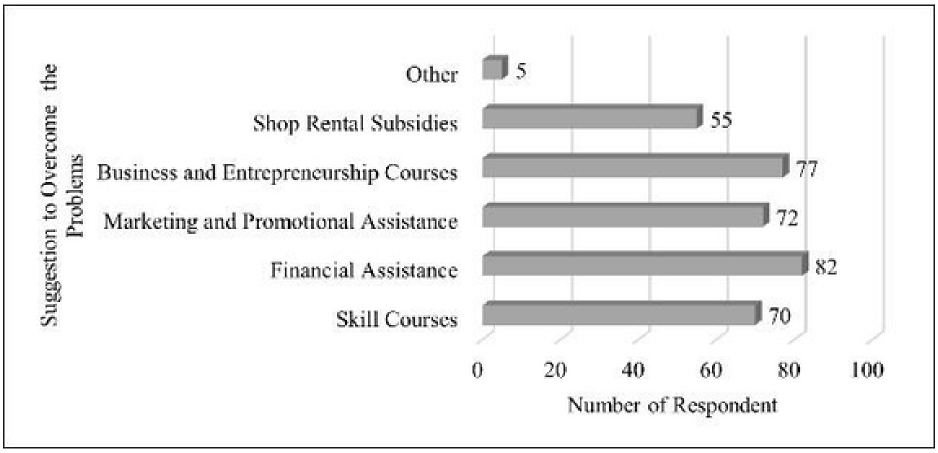

Fig. 12: Suggestion to Overcome the Challenges.

Conclusion

Iban women empowerment and development could be enhanced by providing relevant training and financial programs to support their side-income activities. However, not all the training could fit their needs. For instance, they may have good skills in certain activities such as farming, handicraft making, and food processing but they do not know how to market their products. Therefore, they may need marketing management training and financial support. Iban women in town areas may not be interested in handicraft making due to no or limited skills and at the same time they have difficulty to get the raw materials as traditional handicraft making heavily depend on the availability of natural resources such as bamboo, rattan, etc. For this case, they may need food processing courses as food and beverages do have high demand in town areas. Thus, this study is important to identify what do they need to support their side-income activities.

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PUBLICATION

3D Printing Prototype Redox Flow Battery

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Introduction

Redox flow batteries (RFBs) are considered one of the most promising solution to large-scale energy storage as the energy stored can be scaled up according to the needs. RFBs have a very flexible design as the electrolytes are stored in external tanks, separately from the electrodes [1]. There are various parameters that needs to be tested and optimized in a study of the redox flow battery. To aid the lab study that must be conducted, it is necessary to fabricate small-scale prototypes which can be easily modified. 3D printing prototype is a faster option to prototyping by Computer-Aided Design (CAD) software and 3D printing technology. Several 3D printing methodologies are available commercially depending on the material deposition mechanism [2, 3]. In this study, we explore the 3D printing of different compartments in a redox flow battery using the material extrusion 3D printing method. The aims of this study are to design redox flow battery, to print prototype redox flow battery using 3D printer and finally, to assemble a 3D printed redox flow battery prototype.

Methodology

The design process used for 3D printing prototype Redox Flow Battery are first is identified the need and constraint. Then made a conceptualization way to solve the problem follow by plan of the prototype by using FreeCAD 0.18 software. Next the prototype is created through Original Prusa I3 MKS 3D printing using PLA filament (Figure 1). The complete printed prototype is tested and evaluated. Finally, the prototype design is optimized based on the findings.

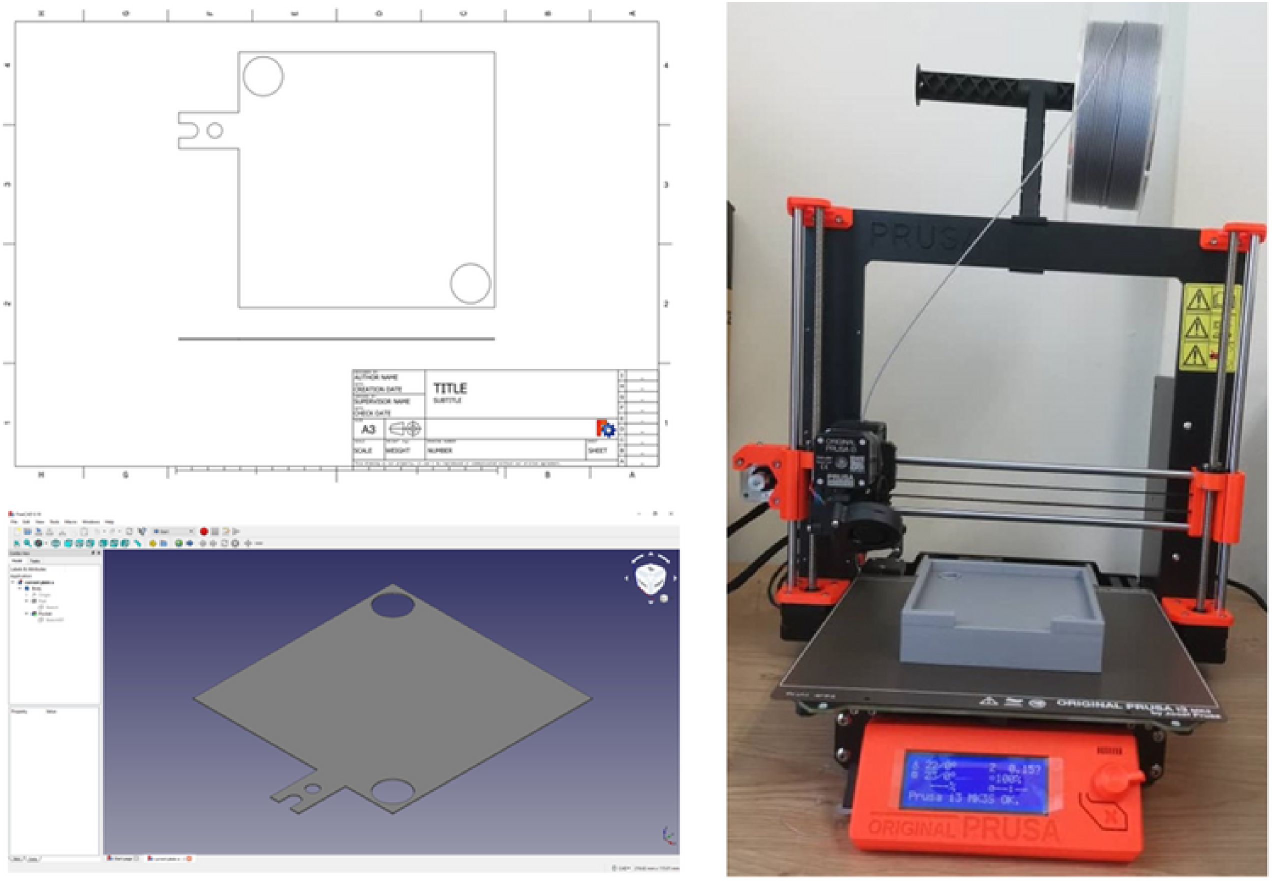

Fig. 1: Design process for 3D printing.

Results

Total time taken to 3D printing prototype is around 48 hours including 3D printer calibration. Figure 2 shown the parts printed and the complete assembled prototype Redox Flow Battery.

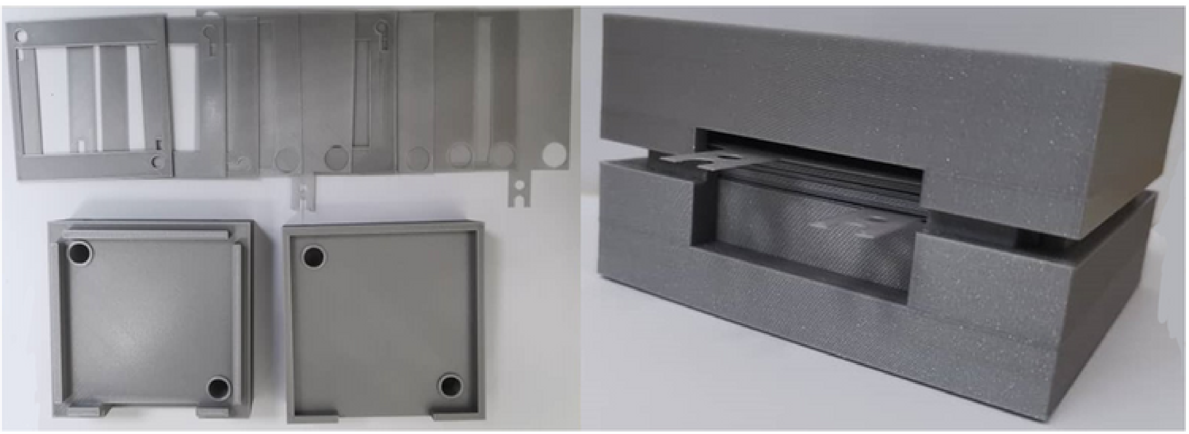

Fig. 2: 3D printed Redox Flow Battery.

Conclusion

3D printing technology will greatly help researcher to upgrade and improve in designing redox flow battery due to speed, flexibility, and cost benefits.

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