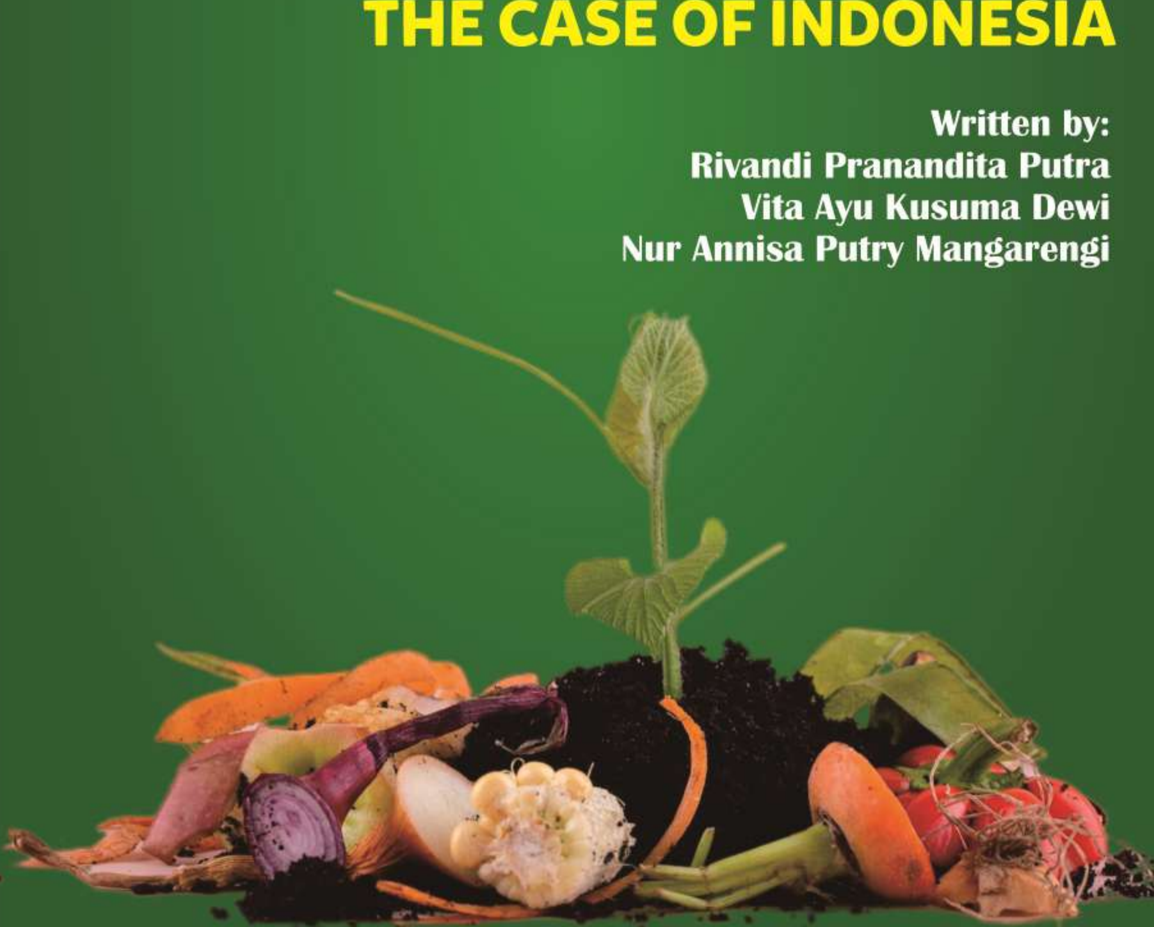
THE UTILISATION OF ORGANIC WASTE

THE CASE OF INDONESIA

Written by:
Rivandi Pranandita Putra
Vita Ayu Kusuma Dewi
Nur Annisa Putry Mangarengi



THE UTILISATION OF ORGANIC WASTE THE CASE OF INDONESIA

Written by:
Rivandi Pranandita Putra
Vita Ayu Kusuma Dewi
Nur Annisa Putry Mangarengi

Penerbit widina

THE UTILISATION OF ORGANIC WASTE: THE CASE OF INDONESIA

Writer:
Rivandi Pranandita Putra
Vita Ayu Kusuma Dewi
Nur Annisa Putry Mangarengi

Cover Design:
Septian Maulana

Source of Illustration:
www.freepik.com

Layout:
Handarini Rohana

Editor:
N. Rismawati

ISBN:
978-623-500-570-6

First Printing:
December, 2024

PUBLISHER:
WIDINA MEDIA UTAMA
Komplek Puri Melia Asri Blok C3 No. 17 Desa Bojong Emas
Kec. Solokan Jeruk Kabupaten Bandung, Provinsi Jawa Barat

Member of IKAPI No. 360/JBA/2020
Website: www.penerbitwidina.com
Instagram: @penerbitwidina
Telpon (022) 87355370

FOREWORD

We express our deepest gratitude, with no words other than thankfulness, for the blessings and grace of God Almighty. Thanks to His mercy, the book titled "The Utilisation of Organic Waste: The Case of Indonesia" has been successfully completed and published. We hope that this book can contribute to scientific knowledge and broaden the understanding of anyone interested in the topic of The Utilisation of Organic Waste: The Case of Indonesia.

However, we acknowledge that this work has its shortcomings and is far from perfect, as the saying goes, "No ivory is without cracks," and in truth, perfection belongs only to God. Therefore, we are open to receiving constructive criticism and suggestions from our readers, as they are essential for our continuous effort to improve and perfect our future works.

Finally, we would like to extend our sincere thanks to all parties who have supported and contributed to the entire process of writing and publishing this book, making it possible for it to be presented before the readers. We hope this book will be beneficial to all and contribute to the advancement of knowledge in Indonesia.

December, 2024

Writer

TABLE OF CONTENTS

CHAPTER 1
THE DEFINITION AND TYPES OF ORGANIC WASTE

Human life cannot be detached from what is called waste. It is ubiquitous in all facets of mankind's life. Waste itself is leftovers in the form of products or goods that are no longer used. Azwar (1990) elucidates waste as something that is not used, is not liked, or must be thrown away. As stated in Indonesian Law Number 18 of 2008 concerning waste management, waste is the residuals of daily human activities and/or natural processes in solid form. Meanwhile, Hartono (2008) defines waste as material that is discarded from human or natural activities with no economic value.

In general, waste can be categorised into two types, i.e., inorganic and organic. In conformity with the Big Indonesian Dictionary (*Kamus Besar Bahasa Indonesia*), organic waste is defined as waste that comes from plants and is easily recycled. Yet, organic waste can also be interpreted as a type of waste that comes from the remains of living creatures or organisms (plants, animals, or humans) that can decompose naturally (biodegradable) without any human intervention. This implies that organic waste also comprises the residuals of living creatures other than plants (all biological agents), for instance, animal carcasses and faeces from living organisms. Thus, the utterance that organic waste merely consists of vegetable, fruit, and leaf wastes is actually misleading.

Although there are plenty of types of organic waste, organic waste is often associated with food waste, considering that the largest proportion of organic waste in the world is food waste. According to data from the Food and Agriculture Organisation of the United Nations (FAO), as much as 1.3 billion metric tonnes of waste are generated per year from one-third of the amount of food produced for human consumption. The data released by the National Waste Management Information System of the Republic of Indonesia in 2023 exhibits that roughly 44.1% of waste disposed of in landfills is food waste. Food waste encompasses all types of waste generated from food processing processes and leftover food ingredients, such as chicken and fish bones, egg shells, vegetable heads, fruit peels, and varying other organic materials that are not consumed. Food waste can also originate from losses in the supply chain process and the reluctance of consumers to have 'ugly'

CHAPTER 2
PROBLEMS REGARDING ORGANIC WASTE

Waste-related matters are at all times evoking. Problems pertaining to waste management are actually not a new issue, especially in emergent nations such as Indonesia. In these countries, until now, it appears that no effective solution has been found to solve them. According to Ngoc & Schnitzer (2009), most developing countries produce a surmountable amount of solid waste, which is accompanied by inadequate handling and management. In Indonesia, chiefly in major cities, waste management is still homework to tackle and requires handling and attention from diverse parties. Proper waste management is a nexus amid multiple facets, making it not an easy issue to resolve, and many developing nations, such as Indonesia, are, as yet, still wrestling to figure it out.

It is alleged that many Indonesians view the presence of organic waste in nature as not too much of a problem. Organic waste is often overlooked as it is thought to decompose by itself. Organic waste can indeed be broken down naturally by microbes into natural compounds. However, it takes time. If left unchecked, many places will be polluted with organic waste, which will not only disturb the aesthetic view but can also be detrimental to the surrounding environment. To a large extent, organic waste can cause consequential impacts on the environment. For instance, when such waste enters the water flow, it can reduce the amount of oxygen in the water and stimulate the growth of dangerous organisms. Accordingly, even though organic waste can decompose naturally without any human interference, this type of waste still needs to be managed properly.

We cannot place reliance anymore on the natural decomposition process of organic waste because the volume of organic waste will always rise over time. The amount of waste produced every day is apparently greater than what can be decomposed per day, considering that decomposition takes time, particularly for dry organic waste. The increasingly massive production of organic waste due to population growth and improved people's welfare and purchasing power implies that waste will continue to pile up. For sure, this requires proper handling so that the volume of waste does not continue to pile up and get out of control. When organic waste is not well managed, it can lead to several problems, including environmental, health, as well as socio-economic problems.

CHAPTER 3
POTENCIES AND BENEFITS OF ORGANIC WASTE MANAGEMENT

Arising issues related to organic waste, as have been discussed beforehand, indicate a red alarm that waste problems must be addressed appropriately. This is also stated in the target of Sustainable Development Goals (SDGs) number 12 concerning responsible consumption and production, where in paragraph 3 it is stated that by 2030, the goal to be achieved is to halve the amount of global food waste per capita at the level of retail and consumers and reduce food losses throughout the production and supply chain, including post-harvest losses. The Indonesian government also partakes in realising this target through Presidential Decree 97 of 2017 concerning National Policy and Strategy for Management of Household Waste and Similar Types of Household Waste.

Variegated problems related to the presence of organic waste can actually be overcome through proper management. Based on Act of the Republic of Indonesia Number 18 of 2008 concerning Waste Management, waste management can be defined as the process of changing the form of waste, which is carried out by changing the characteristics, composition, and quantity of waste. In fact, these problems can have great potential to be utilised in various products that have high selling value. Irwan (2005) postulated that if waste is not used or simply thrown away, then this can be illustrated as "money evaporating". Therefore, to avoid any redundance, it is necessary to manage waste into new items of economic value. In the following chapters of this book, we will discuss some innovations and inspirations for utilising organic waste into various different products.

It is generally agreed that the quantity of waste produced in the world is growing day by day as a result of the increase in human population over time. Up until recently, in Indonesia, most waste, both inorganic and organic, has merely been thrown away in landfills and piled up. Up to the present, waste processing in Indonesia has only been focused on landfills and temporary processing sites, where this has not been effective in dealing with the progressively accumulating volume of waste. A study carried out by Sustainable Waste Indonesia in 2019 disclosed that only approximately 3% of Indonesia's total waste is recycled, while the rest ends up in landfills.

CHAPTER 4
UTILISATION OF ORGANIC WASTE AS FERTILISER

The conversion of organic waste into fertiliser is not an atypical thing. Even the first thing most people think about the utilisation of organic waste is to make it compost, as it is the easiest and most practical thing to do. Myriad types of organic waste can be processed into organic fertiliser, ranging from green manure and compost to biofertilizer. Composting is easy to do since organic material basically undergoes a natural composting process, which is a process in which organic materials are decomposed by bacteria and fungi that use the organic material as a food or energy source. Decomposition is a process of physically and/or chemically breaking down organic material (Putra *et al*., 2021). Organic material is abundant in nutrients, so it has a great potential to be used as material for making organic fertiliser (Dewi *et al*., 2022a; Dewi *et al.,* 2022b).

It is inevitable that all organic materials will undergo a natural decomposition process over time with the help of microorganisms. However, the process of making good organic fertiliser must still go through a composting process, which is a controlled process to speed up the process of breaking down organic material into material that is rich in nutrients. Organic waste contains various types of nutrients and minerals, which are useful for improving soil fertility. The process of making organic fertiliser is not difficult (it could even be said to be quite easy) and can be done by anyone.

In order to grow and develop optimally, almost every type of crop requires additional input in the form of fertiliser. All types of crops require an adequate supply of nutrients so they can grow and develop optimally (Puspitasari *et al*., 2023). Almost all types of crops need essential macronutrients (N, P, K, S, Mg, and Ca), micronutrients (Cl, Fe, Mn, Zn, Cu, B, and Mo), and approximately five non-essential nutrients (Na, Co, V, Si, and Ni). All the nutrients, particularly essential nutrients, are required by crops for perfect metabolism, while the five non-essential nutrients, in some cases, are able to function or temporarily replace the role of several essential nutrients. A deficiency in only one of the essential nutrients could lead to limited crop productivity.

CHAPTER 5
UTILISATION OF ORGANIC WASTE AS BIOCHAR

Apart from organic fertiliser, organic waste can also be processed into biochar. Biochar is a carbon-rich solid material that is the result of the conversion of organic material through incomplete combustion or with a limited oxygen supply (pyrolysis). Biochar shape is similar to charcoal, has relatively stable properties, and is arduous to decompose by soil microbes. The difference between biochar and charcoal is that biochar is produced through incomplete combustion, in contrast to ordinary, which is produced through a complete combustion process.

In the agricultural and plantation sectors, biochar is often employed as a soil conditioner or ameliorant because it could improve the physical, chemical, and biological properties of soils. Extensive studies across the globe have also revealed that the incorporation of biochar to soil can reduce leaching, increase water retention, improve soil cation exchange capacity (CEC), increase biomass and the abundance of beneficial soil microorganisms, and aid neutralise soil pH. The improvement of these soil properties could ultimately enhance nutrient uptake by crops.

As of yet, the types of soil amendment materials that are extensively used by many farmers in Indonesia are compost, manure, and plant biomass. These materials generally decay quickly, so their effects are often only temporary. Meanwhile, biochar can last longer in the soil because the decomposition process is slower and it is resistant to microorganisms. However, in-field practice, biochar application can also be done along with compost, manure, biofertiliser, plant biomass, and other materials such as dolomite to create more synergistic positive impacts on soil quality.

Utilising organic materials in biochar can also be a strategy to mitigate climate change. As is known, biochar is a carbon-rich material, so the use of organic waste in biochar can help reduce the carbon dioxide gas (CO_2) in the atmosphere markedly. The carbon that has been in the form of biochar is then returned to the soil (applied to the land), so that it can reduce the amount of CO_2. Biochar that has been applied to the land will not experience decomposition, so it can survive in the soil for a long time. This process is called carbon sequestration, which is the process of capturing and storing CO_2 from the atmosphere in the soil for a long period of time. Carbon

CHAPTER 6
UTILISATION OF ORGANIC WASTE AS ORGANIC PESTICIDES

Organic waste can also be used as raw material to produce organic pesticides (biopesticides), i.e., any substances used for controlling pests. According to Wuryantini *et al*. (2021), organic waste containing certain secondary metabolite compounds can be used as organic pesticides. Just like organic fertiliser, this pesticide is beneficial for farmers or anyone interested in farming. At some levels, the presence of pests in agriculture is actually tolerable, but at a certain level, pests that damage plants can be devastating, which stipulates the need to use pesticides.

Previous studies have revealed that organic pesticides can effectively repel and kill pests, as long as the right materials and the correct application method are used. The phytochemicals derived from organic materials can act as larvicidal, insect growth regulators, repellents, and ovipositional attractants, as observed by many researchers worldwide. Table 6.1 below depicts some examples of organic pesticides and their effectiveness in tackling the onset and eradicating pests, according to the literature.

Table 6.1 Some examples of organic pesticides made from various organic wastes and their effectiveness in eradicating agricultural pests

Organic wastes	References	Results
Powder from chicken egg shells	Olagunju *et al.* (2021)	At several extract concentrations given (0, 0.25, 0.5, 1, and 2 g), the 2 g treatment gave the most effective results in killing *Sitophilus zeamais*, with a mortality rate of 96.67%.
Extract of tobacco (*Nicotiana tabacum*)	Siswoyo *et al*. (2018)	The intensity of pest attacks on tomatoes treated with tobacco extract biopesticide was 21%, which was lower than the control of 69%.
Peels of jengkol fruit (*Archidendron pauciflorum*)	Astuti (2013)	The treatment with the extract of jengkol fruit peel killed 100% of mulberry snails (*Pomaceae canaliculate*) on the 15th day, while at the same time, the snails were still alive and even reproduced in the control treatment.

CHAPTER 7
UTILISATION OF ORGANIC WASTE AS BIOENERGY

Apart from being processed into the products previously explained, organic waste can also be made into several bioenergy products, for example, biogas and biobriquettes. Utilising organic waste into bioenergy can not only help reduce the volume of organic waste but can also be an alternative energy source that is economical and environmentally friendly.

As is known, up until now, human dependence on fossil energy source is still high, although several innovations in the use of renewable energy have recently been increasingly studied, developed, and supported by various parties. Energy demand, which continues to rise due to population growth and the depletion of world oil reserves, requires urgent development of renewable energy, one of which is bioenergy. If fossil energy sources such as petroleum continue to be consumed and there is no effort to switch to renewable energy sources, it is estimated that oil reserves will run out in the next few decades.

The Intergovernmental Panel on Climate Change (IPCC) also considers bioenergy an essential part of the puzzle for climate change mitigation. The combustion of fossil fuels leads to significant greenhouse gas emissions. To lessen the use of fossil fuel, the Indonesian government is paying serious attention to the development and use of biofuel as an alternative fuel from renewable sources, as stated in the Government Regulation Number 22 of the Republic of Indonesia in 2017 regarding the National Government's General Plan. The urgent call to move away from fossil fuels is raising demand for growing biomass, while simultaneously, we will also need to grow more crops for foods, animal feeds, and other products like wood and fibres. In this case, utilising organic waste as the raw materials for bioenergy production could be a promising alternative.

1. Utilisation of Organic Waste into Biogas

Biogas is a renewable energy product that can be developed from organic waste such as biomass, human waste, and animal waste. Biogas can be produced through the anaerobic fermentation process of organic waste (anaerobic digestion). In the process of making biogas, dregs or sludge will usually be produced, which can be used as organic fertiliser.

CHAPTER 8
UTILISATION OF ORGANIC WASTE AS ANIMAL FEEDS

As an agrarian country, Indonesia has enormous livestock and fisheries potential. Many Indonesians depend on this sector for their livelihood. In many rural areas of Indonesia, people generally keep livestock such as cows, goats, and sheep as long-term investments, considering that their selling prices are quite high. The livestock and fisheries sectors also make a substantial contribution to supporting food security and meeting the nutritional needs of all Indonesians.

The productivity of farmed livestock and fish is, to a large extent, affected by the availability of feed. Feed quality is also paramount, as it can influence the quality of the meat produced. Livestock feed, especially for ruminants, generally comes from greeneries, which contain lots of fibre. However, due to the depletion of pasture land along with increasing human activities, especially in urban and peri-urban areas, many livestock breeders are now relying on artificial feed.

Unfortunately, in the reality, we often hear livestock breeders complaining about the expensive cost of artificial feeds. This rise in feed costs often causes production costs to increase. In livestock production, the largest costs are for purchasing feed, which accounts for up to 70% of the total costs. Even in Indonesia, it is not uncommon for fish farmers or livestock breeders to experience losses due to feed costs that are not commensurate with the cost of their harvest. Therefore, there is an upsurge in the need to seek alternatives to feeds that can be made from materials that are inexpensive and easy to obtain, and such alternative feeds are expected to be more affordable.

To conquer the problem of feed costs, myriad types of organic waste, especially food waste, can be an alternative solution for making feed for fish and various livestock, both poultry (chickens, turkeys, ducks, geese, birds, etc.) and ruminants (cows, sheep, goats, rabbits, etc.). Organic waste is relatively rich in fibre. Numerous studies have found that diverse kinds of organic waste can be a potential feedstock for ruminants, given their ability to use fibre as an energy source.

CHAPTER 9
UTILISATION OF
ORGANIC WASTE AS HANDICRAFTS

Besides being made from inorganic wastes such as bottles, plastic cups, cans, ceramics, and so on, handicrafts could also be made from various organic wastes. Organic waste also has great potential to be transformed into various creative handicraft products. The types of handicrafts that can be made, of course, depend on the materials or organic waste materials and, of course, also depend on our own creativity. These days, there are many Do It Yourself (DIY) inspirations for making handicrafts made from various sources, including organic waste. The business of making handicrafts from organic waste can bring in quite a lot of economic profit. Some examples of other handicrafts that are often made from various organic materials are bags, tablecloths, and so on.

As seen from their function, craft products are classified into two categories, i.e., as a) disposable and b) decorative objects. Crafts as disposable objects are all forms of crafts that are used as tools, containers, or accessories for clothing, for example, bags, wallets, cutlery, pencil cases, and so on. Meanwhile, crafts as decorative objects include all forms of crafts whose function is as accessories, displays, or decoration, such as necklaces, bracelets, key chains, lampshades, woven mats, flower decorations, paintings, tablecloths, and so on (Fatoni *et al.*, 2017). Interestingly, organic waste can be processed into both types of craft products, both as disposable crafts and decorative objects.

The following are some examples of utilising organic materials to make handicrafts:

- Maize cobs can be processed into tissue holders.
- Maize peels can be made into floral decorations.
- Dried water hyacinth can be transformed into a bag.
- Coconut shells can be made into tableware, such as cups, bowls, and drink jugs.
- Clam shells can be made into various cute knick-knacks or accessories.
- Eggshells can be made into decorative pots.
- Fish bones can be made into various unique accessories.
- Dry banana petiole can be made into paintings, bags, sandals, pencil cases, and tissue boxes.

CHAPTER 10
UTILISATION OF ORGANIC WASTE AS ECO-ENZYME

Eco-enzyme is a product resulting from the fermentation process of organic waste with the incorporation of brown sugar or molasses as a liquid substrate. Eco-enzyme is a multi-purpose liquid, as it offers several benefits. Some of the common uses of eco-enzyme are as a detergent mixture, dish cleaner, toilet cleaner, vegetable and fruit cleaner, disinfectant, hand sanitizer, and many more. Eco-enzyme can help us save money on purchasing cleaning fluids. Eco-enzyme can also be used for other purposes, for instance, as a crop fertiliser, pest repellent, or air purifier.

Apart from the abovementioned benefits, eco-enzyme can also be a promising material for improving the quality of polluted water. Eco-enzyme is actually a catalyst that can speed up biochemical reactions in water. There are various types of enzymes contained in eco-enzymes, such as the lipase enzyme, which functions to break down fat into fatty acids and glycerol, and the amylase enzyme, which functions to break down carbohydrates into simpler sugars. With these enzymes, if an eco-enzyme is poured into polluted water, it can aid water microbes in degrading pollutants naturally. Apart from restoring polluted water ecosystems, several studies have also demonstrated that eco-enzymes can eliminate unpleasant odours in contaminated water.

Making eco-enzymes is simple and easy to do. It only requires water, sugar (either brown or white sugar) as a carbon source, and organic waste to be fermented. Plastic-based materials are recommended to be used as containers for the eco-enzyme fermentation process. Containers made of glass should be avoided, as they could break due to fermentation and microbial activity. The fermentation process for making eco-enzyme takes approximately three months. After that, a dark brown liquid will form with a strong, sweet, and sour fermented aroma that we can use.

The following figures exemplify eco-enzyme products that have been successfully made in Indonesia. Some of these products have even been successfully commercialised.

CHAPTER 11
RECYCLING ORGANIC
WASTE INTO NEW CROPS OR FOODS

1. Recycling Organic Waste into New Crops (*Regrow*)

There are a number of vegetables and herbs that can be grown or re-cultivated (regrow) instead of throwing them in the trash. Some of the examples are celery, spring onions, chives, kale, mustard greens, white mustard greens, spinach, Brazilian spinach, lettuce, watercress, carrots, and so on. The parts of the vegetable that are typically to be replanted are the stem or root tip. Regrows can be performed with soil or simply by submerging the stem or root tip of the crop in water.

Regrow using water as a medium can be executed using bottles, cans, or glasses. If the type of crop being cultivated is large, a larger container, such as a basin or bucket, could be used. Meanwhile, growing with soil media can be done in pots or polybags. Other containers, such as bottles, cans, and buckets, can also be used, but it should be ensured that the bottom is perforated first to regulate water circulation so that the crops being cultivated do not become waterlogged.

Regrow offers many benefits. Apart from being able to be consumed again, we can also get fresh organic vegetables that we have cultivated ourselves. These re-cultivated vegetables can be guaranteed to be healthy as they do not use chemical fertilisers and pesticides during the cultivation process. Grown crops can also save costs because we no longer need to buy cultivated vegetables.

 Regrowing spring onions Source: https://zerowaste.id/zero-waste-lifestyle/regrow-sayuranmu/	 Regrowing water spinach Source: https://kambingjoynim.com/cara-menanam-kangkung-di-botol-aqua/

CHAPTER 12
CHALLENGES OF UTILISING ORGANIC WASTE

In a nutshell, organic waste, although it has enormous potential to be utilised into new products with high economic value, has a number of defiances that need to be considered. According to Hendra (2016), the Indonesian government still encounters numerous obstacles in organising the waste management system (Hendra, 2016). The greatest defiance in using organic waste lies in raising public awareness. Even though organic waste is abundant and various innovations can be spread around as inspiration, if people are not interested in managing it, then the waste will remain waste. On the contrary, if public awareness concerning waste management is high, such as in those developed countries, then problems related to waste will not exist, or at least, can be handled easily.

Unfortunately, up to now, in several developing countries, such as Indonesia, public awareness of organic waste management is still low and not as high as in many developed countries. According to data released by Statistics Indonesia in 2018, up to 72% of Indonesians still do not care about the waste problem. Even in something as simple and easy as sorting waste (separating waste based on type), not all groups of people in Indonesia have the awareness or the intention to do that.

Not infrequently, we in Indonesia come across people who mix various types of waste into one waste dump. Even if the waste has been separated into organic and inorganic waste, there are still many who end up mixing the two types of waste when they arrive at the final disposal site. The Indonesian Ministry of Forestry and Environment recommended sorting the waste into five types: organic, reusable, hazardous, recyclable, and residue. However, the recommended waste sorting has not been integrated into the real-life practice in most Indonesian landfills. The residents’ participation is lacking, as all waste types collected from the residents' households were mixed, even hazardous waste such as medical waste. As a result, waste collected in landfills is difficult to recycle and treat since recyclable waste and other waste are mixed and ultimately disposed of in landfills. This makes the bottleneck of waste problems arduous to tackle, and it seems like it never ends. As of yet, it seems that there are still many Indonesians who lack the initiative to sort

CHAPTER 13
CLOSING

In many locations in Indonesia, organic waste is not yet managed properly. This is certainly homework, not merely for the government but also for all of us. The issue of waste management is critical as it affects many facets, not only the environmental aspect but also the social, economic, and health aspects. This waste management issue is also linked to the Sustainable Development Goals, especially SDG 1 and SDG 12. SDG 1 aims to exterminate poverty and abolish inequality, while SDG 12 concentrates on promoting responsible consumption and production patterns.

In the previous chapters, various adverse impacts of the presence of waste, especially organic waste, have been discussed. Therefore, the public is expected to be aware of and contribute to the solution to the waste problem. So that the volume of waste does not increase in landfills, the next step that can be taken is to try to reduce waste production, starting with ourselves. However, if this still feels difficult to reduce waste, then a practical solution that can be done is to reuse or recycle them (the concept of reduce, reuse, and recycling, which is also known as the 3R principle). To date, the 3R principle is replaceable with the so-called 9R concept, which encompasses Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover.

Management and use of organic waste are not merely superb for environmental sustainability and preventing health problems; they can also improve the value and benefits of organic waste. In fact, the products produced can be used as a business that brings promising profits. In this book, we have discussed a lot of utilisation of organic waste into new beneficial products, such as fertiliser, biochar, organic pesticides, bioenergy, fish and livestock feeds, handicrafts, eco-enzymes, as well as new plants or foods. These are just a tiny snippet of examples, and we are sure that there may be more potential to be delved into in utilising organic waste to create new valuable products.

To date, there are still many problems regarding poor waste management in numerous countries. Nevertheless, there is an emerging, growing concern about the importance of preserving the environment, and one example is to reuse our waste. The current global food system is even beginning to put attention on the environment, economy, and resources in a balanced way. In every attempt we make to reduce organic waste, either by composting or

REFERENCES

Abdullah K, Irwanto AK, Siregar N, Agustina E, Tambunan AH, Yamin M, Hartulistiyoso E, & Purwanto Y. 1991. Energi dan Listrik Pertanian. Bogor: IPB.

Afrianto WF, Hidayatullah T, Hasanah LN, Putra RP, Diannita R, & Anggraini R. 2021. Urban community engagement to reduce and prevent food waste at household level. International Journal of Community Service, 1(3): 261-271.

Aiman S. 2014. Perkembangan teknologi dan tantangan dalam riset bioetanol di Indonesia. Jurnal Kimia Terapan Indonesia, 16(2): 108-117.

Akhmad NA, Rahman AM, Haryuti FRN, Apriliyani F, Ramadhan AYP, & Widiayani N. 2021. Efektivitas limbah puntung rokok sebagai biopestisida pembasmi kutu putih (*Paracoccus marginatus*) dengan teknik nozzle pada tanaman cabai rawit (*Capsicum frutescens* L.). Agrivigor, 12(2): 48-54.

Albiach R, Canet R, Pomares F, & Ingelmo F. 2000. Microbial biomass content and enzymatic activities after the application of organic amendments to a horticultural soil. Bioresource Technology, 75(1): 43-48.

Amaliana NR, Subagiya, Sulistyo A. 2018. Respon populasi kutu daun persik terhadap pemberian beberapa jenis ekstrak kulit jeruk pada cabai. Agrosains, 20(1): 13-18.

Ana D, Pampang H, & Yunita L. 2015. Potensi limbah kulit durian sebagai bahan baku pembuatan energi alternatif. Seminar Nasional Teknologi 2015, Malang.

Anggorowati DA & Dewi BK. 2013. Pembuatan bioetanol dari limbah sabut kelapa dengan metode hidrolisis asam dan fermentasi dengan menggunakan ragi tape. Industri Inovatif: Jurnal Teknik Industri, 3(2): 9-13.

Anggorowati DA, Pampang H, & Yunita L. 2015. Potensi Limbah Kulit Durian Sebagai Bahan Baku Pembuatan Energi Alternatif. In Seminar Nasional Teknologi 2015 (pp. 843–850). Malang: Institut Teknologi Nasional Malang.

Anggraeni Y, Supriadi, Mustapa K. 2017. Pembuatan bioetanol dari biji salak (*Salacca edulis*) melalui fermentasi. Jurnal Akademika Kimia, 6(3): 191-195.

Anisah D, Herliati, & Widyaningrum A. 2014. Pemanfaatan sampah sayuran sebagai bahan baku pembuatan bioetanol. Konversi, 3(1): 13-17.

Aprianto E, Rosa HO, & Salamiah. 2023. Uji efektivitas ekstrak kulit bawang merah dalam mengendalikan kutu kebul (*Bemisia tabaci* Gennadius) pada tanaman cabai. Proteksi Tanaman Tropika, 6(2): 676-682.

Arif E, Oskar I, & Pallangan Y. 2008. Pengolahan limbah kulit jambu mente sebagai sumber bahan bakar alternatif. Seminar Nasional Tahunan Teknik Mesin VII November 2008, 120:1-7.

Arif E, Salam L, Ariyanto, & Fredy B. 2012. Briket daun kering sebagai sumber energi alternatif. Proceeding Seminar Nasional Tahunan Teknik Mesin XI (SNTTM XI) & Thermofluid IV Universitas Gadjah Mada, Yogyakarta, 16-17 Oktober 2012, 507-513.

Arifiyanti NA, Kartini DNA, & Billah M. 2020. Bioetanol dari biji nangka dengan proses likuifikasi dan fermentasi menggunakan *Saccharomyces cerevisiae*. Journal of Chemical and Process Engineering, 1(1): 51-55.

Astuti P. 2013. Uji efektivitas kulit buah jengkol (*Pithecolobium lobatum*) terhadap kematian siput murbei (*Pomacea canaliculata*). Ziraa'ah, 37(2): 40-45.

Azmi Y, Yulistiyono A, Karyasa TB, Putra RP, Salama SH, Thamrin NT, Septiadi D, Dinata GF, Jumiyati S, & Rizki FH. 2022. Pertanian Terpadu. Get Press Indonesia, Padang.

Azrin M, Bahri S, Nurlaila R, Meriatna, Muarif A, & Fibarzi WU. 2023. Pembuatan bioetanol dari limbah kulit kopi secara fermentasi menggunakan ragi roti. Chemical Engineering Journal Storage, 3(2): 151-162.

Azwar A. 1990. Pengantar Ilmu Kesehatan Lingkungan. Mutiara Sumber Widya, Jakarta.

Ba'diyah U & Yustinah. 2012. Pembuatan etanol dari biji nangka dengan variabel massa pati. KONVERSI, 1(2): 11-16.

Baharuddin M, Sappewali S, Karisma K, & Fitriyani J. 2016. Produksi bioetanol dari jerami padi (*Oryza sativa* L) dan kulit pohon dao (Dracontamelon) melalui proses sakarifikasi dan fermentasi serentak (SFS). Chimica et Natura Acta, 4(1): 1.

Barthod J, Rumpel C, Calabi-Floody M, Mora ML, Bolan NS, & Dignac MF. 2018. Adding worms during composting of organic waste with red mud and fly ash reduces CO2 emissions and increases plant available nutrient contents. Journal of Environmental Management, 222:207–215.

Bestari SA & Asparini D. 2011. Fungsionalisasi Sampah Organik Pasar Tradisional Sebagai Bahan Bakar, Pupuk, Dan Pakan Ternak Bernilai Ekonomis. *Program Kreatifitas Mahasiswa.* Institut Pertanian Bogor.

Bisht N & Chauhan PS. 2020. Excessive and disproportionate use of chemicals cause soil contamination and nutritional stress. Soil Contamination-Threats and Sustainable Solutions, 1-10.

Case SDC, Oelofse M, Hou Y, Oenema O, & Jensen LS. 2017. Farmer perceptions and use of organic waste products as fertilisers— a survey study of potential benefits and barriers. Agriculture System, 151:84–95.

Chandini RK, Kumar R, & Om P. 2019. The impact of chemical fertilizers on our environment and ecosystem. In: Sharma, P. (Eds.) Research Trends in Environmental Sciences. Delhi, AkiNik Publications, 71-86.

Daniar R. 2018. Pemanfaatan bagas sebagai bahan baku pembuatan bioetanol dengan metode *pretreatment* alkali. ALKIMIA: Jurnal Ilmu Kimia dan Terapan, 2(1): 1-10.

Darmayani S, Tribakti I, Musa B, Satriawan D, Rustiah W, Helilusiatiningsih N, Sahabuddin ES, Putra RP, Rahmawati, Dewadi FM, & Cundaningsih N. 2023. Kimia Lingkungan. Get Press Indonesia, Padang.

Dewi VAK, Putra RP, & Afrianto WF. 2022(a). Kajian potensi vinase sebagai bahan fertigasi di perkebunan tebu (*Saccharum officinarum* L.). Sang Pencerah: Jurnal Ilmiah Universitas Muhammadiyah Buton, 8(1): 187-201.

Dewi VAK, Putra RP, Haris A, & Alam T. 2022(b). Limbah Dapur dan Pemanfaatannya. Bintang Semesta Media, Yogyakarta.

Erna, Said I, & Abram PH. 2017. Bioetanol dari limbah kulit singkong (*Manihot esculenta* Crantz) melalui proses fermentasi. Jurnal Akademika Kimia, 5(3): 121-126.

Fadillah E. 2022. Pembuatan bioetanol dari air limbah cucian beras menggunakan metode hidrolisis enzimatik dan fermentasi. Jurnal Riset Rumpun Ilmu Teknik, 1(2): 150-154.

Fajar MN, Mulyadi D, & Muharam S. 2023. Pembuatan bioetanol dari limbah biji nangka (*Artocarpus heterophyllus*) dengan variasi konsentrasi HCl. Journal of Scientech Research and Development, 5(2): 703-713.

Farhan H & Susila IW. 2019. Pemanfaatan ampas tebu (*bagasse*) sebagai bahan bakar alternatif bioetanol dengan metode distilasi menggunakan batu kapur mesh 80 dengan variasi berat dan suhu pemanasan batu kapur. Jurnal Teknik Mesin, 7(2): 83-88.

Fathimah S, Idiawati N, Adhityawarman, & Arianie L. 2014. Penentuan kinetika hidrolisis enzimatis dalam pembuatan etanol dari tandan kosong kelapa sawit. Kimia Khatulistiwa, 3(4): 46–51.

Fatoni N, Imanuddin R, & Darmawan AR. 2017. Pendayagunaan sampah menjadi produk kerajinan. DIMAS, 17(1): 83-96.

Febriadi I. 2018. Pemanfaatan sampah organik dan anorganik untuk mendukung *Go Green* concept di sekolah. Abdimas: Papua Journal of Community Service, 1(1): 32-39.

Filanita A. 2018. Uji kemampuan rendaman kulit buah jeruk nipis (*Citrus aurantifolia*) terhadap pengendalian kecoa. Jurnal Kesehatan Lingkungan, 12(2): 71.

Firyanto R, Nisa L, & Mulyaningsih MS. 2021. Efektivitas pestisida organik ekstrak kulit jeruk nipis terhadap kematian jangkrik. Jurnal Inovasi Teknik Kimia, 6(2): 85-88.

Fitriani, Bahri S, & Nurhaeni. 2013. Produksi bioetanol jagung (*Zea mays*) dari hasil proses delignifikasi. Natural Science: Journal of Science and Technology, 2(3): 66–74.

Fuadi AM & Pranoto H. 2016. Pemanfaatan limbah tandan kosong kelapa sawit sebagai bahan baku pembuatan glukosa. CHEMICA: Jurnal Teknik Kimia, 3(1): 1–5.

Gardetti MA. 2019. Introduction and the concept of circular economy. In *Circular economy in textiles and apparel* (pp. 1-11). Woodhead Publishing.

Guerrero AB, Ballesteros I, & Ballesteros M. 2018. The potential of agricultural banana waste for bioethanol production. Fuel, 213: 176-185.

Guntama D, Herdiana Y, Sujiana UA, Endes RL, & Sunandar E. 2019. Bioethanol dari limbah kulit singkong (*Manihot esculenta* Crantz) melalui metode hidolisa dan fermentasi dengan bantuan *Saccharomyces cerevisiae*. Jurnal Teknologi, 7(1): 86-96.

Gupta A & Singh A. 2017. Efficacy of orange peel as a mosquito repellent. International Journal of Home Science, 3(2): 143-146.

Hanemaaijer A. Kishna M, Kooke M, Brink H, Koch J, Prins AG, & Rood T. 2021. Integral Circular Economy Report 2021. *January*, 1, 221.

Harjono I. 2000. Sistem Pertanian Organik. CV Aneka, Solo.

Hartono R. 2008. Penanganan dan Pengelolaan Sampah. Penebar Swadaya, Jakarta.

Hasanah N, Zaenab S, & Rofieq A. 2015. Perbedaan Kadar Bioetanol Hasil Fermentasi Berbagai Dosis Ragi Tape dari Limbah Sayuran dan Buah. In Prosiding Seminar Nasional Pendidikan Biologi “Peran Biologi dan Pendidikan Biologi dalam Menyiapkan Generasi Unggul dan Berdaya Saing Global” (pp. 149– 156). Malang: Program Studi Pendidikan Biologi FKIP Universitas Muhammadiyah Malang.

Hayuningtyas SK, Sunarto, & Sari ALA. 2014. Produk bioetanol dari jerami padi (*Oryza sativa*) melalui hidrolisis asam dan fermentasi dengan *Saccharomyces cerevisiae*. Bioteknologi, 11(1): 1-4.

Hendra Y. 2016. Perbandingan sistem pengelolaan sampah di Indonesia dan Korea Selatan: Kajian 5 aspek pengelolaan sampah. Aspirasi, 7(1): 77–91.

Hendrasarie N & Mahendra DE. 2020. Pemanfaatan sampah sayur dari pasar tradisional untuk produksi bioetanol. Serambi Engineering, V(3): 1115-1122.

Herliati, Sefaniyah, & Indri A. 2018. Pemanfaatan limbah kulit pisang sebagai bahan baku pembuatan bioetanol. Jurnal Teknologi, 6(1): 1-10.

Huang J, Xu C, Bradley G, Wang X, & Ren P. 2017. Nitrogen and phosphorus losses and eutrophication potential associated with fertilizer application to cropland in China. Journal of Cleaner Production, 159: 171-179.

Ileke KD, Olabimi IO, & Ebenezer BD. 2022. Termicidal activity of two agro wastes against two termite castes subterranean termites, *Macrotermes subhyalinus* [Isoptera: Termitidae]. Biocatalysis and Agricultural Biotechnology, 39: 102266.

Irhamni, Diana, Saudah, Mulyati D, Suzanni MA, & Ernilasari. 2017. Produksi bioetanol dari limbah kulit durian. SEMDI UNAYA, 1(1): 281-288.

Irvan, Prawati P, & Trisakti B. 2015. Pembuatan bioetanol dari tepung ampas tebu melalui proses hidrolisis termal dan fermentasi: Pengaruh pH, jenis ragi, dan waktu fermentasi. Jurnal Teknik Kimia USU, 4(2): 27–31.

Irwan ZD. 2005. Tantangan Lingkungan dan Lansekap Hutan Kota. Jakarta: Bumi Aksara.

Jannah AM. 2010. Proses fermentasi hidrolisat jerami padi untuk menghasilkan bioetanol. Jurnal Teknik Kimia Universitas Sriwijaya, 17(1): 44-52.

Jayanti T & Solfarina. 2015. Pembuatan bioetanol dari biji durian (*Durio zibethinus*). Jurnal Akademika Kimia, 4(3): 110-115.

Kerina DY, Hardoyo, & Atmono. 2022. Fermentasi bioetanol dari bahan baku biji buah-buahan menggunakan ragi roti dan ragi tape. Jurnal Lingkungan dan Sumberdaya Alam, 5(1): 24-34.

Khaira ZF, Yenie E, & Muria SR. 2015. Pembuatan bioetanol dari limbah tongkol jagung menggunakan proses simultaneous saccharification and fermentation (SSF) dengan variasi konsentrasi enzim dan waktu fermentasi. JOM FTEKNIK, 2(2): 1-8.

Kharisma DB. 2020. Urgency of financial technology (Fintech) laws in Indonesia. International Journal of Law and Management, 63(3): 320–331.

Kidane, D. 2011. The potential of orange (*Citrus sinensis* L.) peel oil as a fumigant and repellent to control maize weevil (*Sitophillus zeamais* Motsch). Journal of Biologically Active Products from Nature, 1(3): 193-199.

Kristina, Sari ER, & Novia. 2012. Alkaline pretreatment dan proses simultan sakarifikasi - fermentasi untuk produksi etanol dari tandan kosong kelapa sawit. Jurnal Teknik Kimia Universitas Sriwijaya, 18(3): 34–43.

Lim SL, Lee LH, & Wu TY. 2016. Sustainability of using composting and vermicomposting technologies for organic solid waste bio-transformation: recent overview, greenhouse gases emissions and economic analysis. Journal of Cleaner Production, 111:262–278.

Mahmudati R. 2021. Pembuatan briket sebagai upaya pemanfaatan limbah kulit durian di Desa Sinduagung Kecamatan Selomerto Kabupaten Wonosobo. *Device*, 11(1): 40-44.

McCray JM, Ji S, & Baucum LE. 2015. Sugarcane yield response to furrow-applied organic amendments on sand soils. International Journal of Agronomy, 2015: 1-9.

Miskah S, Saing W, & Siburian C. 2017. Pembuatan bioetanol dari biji cempedak menggunakan metode hidrolisis asam dan fermentasi. Jurnal Teknik Kimia, 4(23): 216-225.

Misselbrook TH, Menzi H, & Cordovil C. 2012. Preface-recycling of organic residues to agriculture: agronomic and environmental impacts. Agriculture, Ecosystem, and Environment, 160:1–2.

Miyanti AS. 2022. Serba Guna Eco-Enzym. Diakses dari https://yankes.kemkes.go.id/view_artikel/109/serba-guna-eco-enzym#:~:text=Menurut%20Imron%20(2020)%20eco%20enzyme,fermentasi%20asam%20manis%20yang%20kuat. pada tanggal 22 Maret 2024.

Muin R, Lestari D, & Sari TW. 2014. Pengaruh konsentrasi asam sulfat dan waktu fermentasi terhadap kadar bioetanol yang dihasilkan dari biji alpukat. Jurnal Teknik Kimia Universitas Sriwijaya, 20(4): 1-7.

Mukhlis, Yacob F, & Rafdi M. 2023. Pemanfaatan limbah ampas tebu melalui fermentasi menjadi bioetanol sebagai energi alternatif rumah tangga. Jurnal Ilmiah Mahasiswa Fakultas Tarbiyah dan Keguruan UIN Ar-Raniry, 1(1): 26-38.

Murni, Arifan F, & Abidin Z. 2015. Optimasi proses bioetanol dari kulit kopi dengan menggunakan proses hidrolisis vibrous bed bioreaktor. Traksi: Majalah Ilmiah Teknik Mesin, 15(1): 1–9.

Murniati, Handayani SS, & Risfianty DK. 2018. Bioetanol dari limbah biji durian (Durio zibethinus). Jurnal Pijar MIPA, 13(2): 155-160.

Mursiah. 2013. Studi Pestisida Botani Kulit Jeruk Nipis (*Citrus aurantifolia swingle*) Terhadap 2 Jenis Belalang. Program Studi Manajemen Hutan. Politeknik Pertanian Negeri Samarinda.

Mushlihah S & Trihadiningrum Y. 2013. Produksi Bioetanol dari Limbah Tongkol Jagung sebagai Energi Alternatif Terbarukan. In Prosiding Seminar Nasional Manajemen Teknologi VXIII (pp. D–15–1 – D–15–8). Surabaya: Program Studi Magister Manajemen Teknologi Institut Teknologi Sepuluh Nopember.

Musita N. 2019. Pembuatan bioetanol dari ampas tahu dengan metode hidrolisis asam dan fermentasi dengan menggunakan ragi instan. Majalah Teknologi Agro Industri, 11(1): 8-13.

Nadia A, Fauziah A, Mayori E, & Sunardi. 2017. Potensi limbah lignoselulosa kelapa sawit di Kalimantan Selatan untuk produksi bioetanol dan xylitol. Quantum: Jurnal Inovasi Pendidikan Sains, 8(2): 41–51.

Naid T, Baits M, & Triana Y. 2012. Produksi bioetanol dari biji buah nangka (*Artocarpus heterophyllus*) melalui proses hidrolisis asam sulfat dan fermentasi. As-Syifaa, 4(2): 121-128.

Ngoc UN & Schnitzer H. 2009. Sustainable solutions for solid waste management in Southeast Asian countries. Waste Management, 29(6):1982–1995.

Ni'mah L, Ardiyanto A, & Zainuddin M. 2015. Pembuatan bioetanol dari limbah serat kelapa sawit melalui proses pretreatment, hidrolisis asam dan fermentasi menggunakan ragi tape. INFO-TEKNIK, 16(2): 227–242.

Nikmah K & Astuti A. 2010. Kajian Fermentasi Bioetanol dari Sisa Makanan Rumah Makan dengan Berbagai Konsentrasi dan Bentuk Inokulum Jamur *Aspergilus oryzae*. Yogyakarta.

Nisa WW. 2014. Produksi Bioetanol dari Onggok (Limbah Padat Tapioka) dengan Proses Sakarifikasi dan Fermentasi Serentak Menggunakan Khamir Hasil Isolasi dari Tetes Tebu. Skripsi. Jurusan Kimia Fakultas Sains dan Teknologi. Universitas Islam Negeri Maulana Malik Ibrahim. Malang.

Nordahl SL, Devkota JP, Amirebrahimi J, Smith SJ, Breunig HM, Preble CV, Satchwell AJ, Jin L, Brown NJ, Kirchstetter TW, & Scown CD. 2020. Life-cycle greenhouse gas emissions and human health trade-offs of organic waste management strategies. Environmental Science & Technology, 54(15): 9200-9209.

Nuryanti L, Muria SR, & Chairul. 2014. Pembuatan bioetanol limbah padat sagu menggunakan enzim selulase dan yeast *Saccharomyces cereviseae* dengan proses simultaneous sacharification and fermentation (SSF). JOM FT Universitas Riau, 1(1): 1-6.

OECD. 2020. Indonesia | Agricultural Policy Monitoring and Evaluation 2020 | OECD iLibrary. Retrieved from https://www.oecd-ilibrary.org/sites/9e2cf2f4-en/index.html?itemId=/content/component/9e2cf2f4-en on July 18, 2024.

Olagunju OD, Rahman MO, Okparavero NF, Abah IA, Odutola BS, Adarabierin IG, Abel GI, Aina OB, Babatunde O, & Haruna PB. 2021. Assessment of insecticidal potency of eggshell powder against maize weevil. African Journal of Agriculture and Food Science, 4(3): 41-50.

Pathak S, Jain N, Bhatia A, Kumar A, & Chatterjee D. 2016. Improved nitrogen management: A key to climate change adaptation and mitigation. Indian Journal of Fertilisers, 12(11): 151-162.

Permana I, Anggoro O, Carsidi D, Alam S, Sihaloho NK, Killa YM, Wida WOA, Putra RP, Mutiara C, Masnang A, Wirda Z, & Elizabeth R. 2023. Kesuburan Tanah dan Pemupukan. Get Press Indonesia, Padang.

Pradigdo SF, Arifan F, Broto W, & Noviana SN. 2021. Pemanfaatan kulit kentang dalam pembuatan bioetanol dengan metode hidrolisa asam di Desa Sikunang. Pentana: Jurnal Penelitian Terapan Kimia, 2(1): 12-20.

Pratiwi, Eka P, Yatim M, & Edahwati L. 2010. Pemanfaatan limbah kulit buah cokelat sebagai bioethanol. In Prosiding Seminar Nasional Teknik Kimia Soebardjo Brotohardjono "Ketahanan Pangan dan Energi" (pp. 1–10). Surabaya: Universitas Pembangunan Veteran Jawa Timur.

Purba DEH, Suprihatin IE, & Laksmiwati AAIAM. 2016. Pembuatan bioetanol dari kupasan kentang (*Solanum tuberosum* L.) dengan proses fermentasi. Jurnal Kimia, 10(1): 155–160.

Puspitasari AR, Ariyani D, & Putra RP. 2022. Agronomic performance and productivity of sugarcane under various dosage application of biofertilizer and inorganic fertilizer. Indonesian Sugar Research Journal, 2(2): 56-66.

Puspitasari AR, Ariyani D, & Putra RP. 2023. Aplikasi pupuk nano cair dan pengaruhnya pada fase pertumbuhan vegetatif tebu. Indonesian Sugar Research Journal, 3(2): 64-71.

Putra RP, Dewi VAK, & Afrianto WF. 2022. Serba Serbi Pertanian Perkotaan. Insan Cendekia Mandiri, Solok.

Putra RP, Ranomahera MRR, Arini N, & Afrianto WF. 2021. Tindakan pengembalian residu panen tebu untuk meningkatkan kualitas tanah dan produktivitas tebu (*Saccharum officinarum* L.). Buletin Tanaman Tembakau, Serat & Minyak Industri, 13(1): 48-66.

Putra RP, Ranomahera MRR, Rizaludin MS, Supriyanto R, & Dewi VAK. 2020. Investigating environmental impacts of long-term monoculture of sugarcane farming in Indonesia through DPSIR framework. Biodiversitas, 21(10): 4945-4958.

Rathore S & Pandey AK. 2020. Waste utilization and minimization in food industry. *Waste to Energy: Prospects and Applications*, 287-307.

Retno DT & Nuri W. 2011. Pembuatan Etanol dari Kulit Pisang. In Prosiding Seminar Nasional Teknik Kimia "Kejuangan" Pengembangan Teknologi Kimia untuk Pengolahan Sumber Daya Alam Indonesia (pp. 11–1 – 11–7). Yogyakarta: Universitas Pembangunan Nasional Veteran Yogyakarta.

Rifaldin H & Kusuma M.N. 2019. Pemanfaatan Buah Salak (Salacca Zalacca) Sebagai Bahan Baku Pembuatan Bioetanol. In *Prosiding Seminar Teknologi Perencanaan, Perancangan, Lingkungan dan Infrastruktur* (Vol. 1, No. 1, pp. 437-442).

Rini TC & Widyaningrum T. 2021. Production of bioethanol from jackfruit rind-waste using *Saccharomyces cerevisiae* with *crude* enzyme treatment of *Trichoderma reesei* and *Aspergillus niger*. Journal on Biology and Instruction, 1(2): 61-70.

Ritchie H. 2020. Food Waste is Responsible for 6% of Global Greenhouse Gas Emissions. Diakses dari https://ourworldindata.org/food-waste-emissions pada tanggal 30 Mei 2024.

Rosita B. 2017. Pemanfaatan limbah kulit kentang (*Solanum tuberosum* L.) untuk pembuatan bioetanol dengan metode hidrolisa asam (HCl). Jurnal Kesehatan Perintis, 4(1): 26-32.

Said M, Diah AWM, & Sabang SM. 2014. Sintesis bioetanol dari jerami padi (*Oryza sativa* L.) melalui fermentasi. Jurnal Akademika Kimia, 3(4): 178-182.

Said NNA, & Purnama H. 2020, Mei. Pembuatan Bioetanol dari Limbah Kulit Kopi Arabika dan Robusta dengan Variasi Waktu Fermentasi. In *Prosiding University Research Colloquium* (pp. 220-228).

Saisa & Syabriana M. 2018. Produksi bioetanol dari limbah kulit kopi menggunakan enzim *Zymomonas mobilis* dan *Saccharomyces cerevisiae*. Serambi Engineering, III(1): 271-278.

Saleh M, Susilawaty A, Syarfaini S, & Musdalifah. 2017. Uji efektivitas ekstrak kulit buah jeruk nipis (Citrus aurantifolia) sebagai insektisida hayati terhadap nyamuk Aedes aegypti. Higiene: Jurnal Kesehatan Lingkungan, 3(1): 30-36.

Santi SN & Widyaningrum T. 2022. Produksi bioetanol dari limbah batang kelapa sawit (*Elaeis guineensis*) menggunakan *Zymomonas mobilis* dengan perlakuan *crude* enzim *Trichoderma reesei* dan *Aspergillus niger*. Jurnal Biolokus: Jurnal Penelitian Pendidikan Biologi dan Biologi, 5(1): 18-23.

Saragih AS, Daulay AH, & Masthura. 2024. Pemanfaatan limbah kulit singkong menjadi bioetanol dengan variasi waktu fermentasi. Jurnal Redoks, 9(1): 31-36.

Sari MU, Hartono R, & Hakim L. 2013. Sifat antirayap ekstrak kulit bawang merah (*Allium cepa* L.). Peronema Forestry Science Journal, 2(1): 139-145.

Siskayanti R, Muliati L, Abdan MF, Jamilah RN, & Wathoni GMF. 2023. Pembuatan bioetanol dari kulit nanas menggunakan *Saccaromytes cerevisiae* terimbobilisasi butiran alginate. Jurnal Redoks, 8(1): 70-80.

Siswati ND, Yatim M, & Hidayanto R. 2010. Bioetanol dari limbah kulit kopi dengan proses fermentasi. Jurnal Hasil Riset, 1-4.

Siswoyo E, Masturah R, & Fahmi N. 2018. Bio-pestisida berbasis ekstrak tembakau dari limbah puntung rokok untuk tanaman tomat (*Lycopersicum esculentum*). Jurnal Presipitasi: Media Komunikasi dan Pengembangan Teknik Lingkungan, 15(2): 94-99.

Situmorang J. 2018. Pengaruh pemberian variasi kadar air kulit jeruk nipis (*Citrus aurantifolia*) sebagai pestisida nabati pengendalian hama *Plutella xylostella* pada tanaman sawi (*Brassica juncea*). *Kingdom (The Journal of Biological Studies)*, 7(1): 28-43.

Soeprijanto S, Prima A, Fransisca I, Ibrahim M, & Wulandari I. 2020, July. The Use of Durian Peel Wastes for Bioethanol Production. In *Seminar Nasional Teknik Kimia" Kejuangan"* (p. 5).

Subekti S. 2010. Pengelolaan sampah rumah tangga 3R berbasis masyarakat. Prosiding Seminar Nasional Sains dan Teknologi, 1(1): I.24-I30.

Sugiarta IKA, Kusuma IGBW, & Santhiarsa IGNN. 2017. Pengujian alat konversi sampah menjadi etanol. Jurnal Mettek: Jurnal Ilmiah Nasional Dalam Bidang Ilmu Teknik Mesin, 3(1): 53–59.

Sukowati A, Sutikno, & Rizal S. 2014. Produksi bioetanol dari kulit pisang melalui hidrolisis asam sulfat. Jurnal Teknologi & Industri Hasil Pertanian, 19(3): 274-288.

Suleman F, Ahadu S, Samalu A, Doe NF, Pooe G, Dawit T, & Laima D. 2021. Uji efektivitas larutan kulit jeruk manis sebagai pestisida alami pengendali hama kutu putih (*Pseudococcus* sp.) pada tanaman kacang panjang. Seminar Nasional Teknologi, Sains, dan Humaniora 2021, Gorontalo.

Susanti AD, Prakoso PT, & Prabawa H. 2013. Pembuatan bioetanol dari kulit nanas melalui hidrolisis dengan asam. Ekuilibrium, 12(1): 11-16.

Sutrisno E, Ramadan BS, Huboyo HS, Ikhlas N, & Karmilia A. 2021, November. Estimating backyard waste burning emission: A case study of Tembalang Campus, Diponegoro University. In *IOP Conference Series: Earth and Environmental Science* (Vol. 894, No. 1, p. 012038). IOP Publishing.

Sutrisno T, Falito MR, Anggono W, & Simanjuntak ME. 2021. Bioethanol limbah kulit jeruk manis (*Citrus sinensis* L. Osbeck) sebagai peningkatan nilai oktan. Jurnal Teknik Mesin, 18(2): 60-64.

Syifa A, Sulhadi, & Darsono T. 2019. The effectiveness of cigarette butts as liquid anti-termite. ISET 2019, Semarang.

Toana MH. 2007. Pengaruh konsentrasi ekstrak kulit jeruk nipis (*Citrus aurantifolia* S.) terhadap kepadatan populasi dan intensitas serangan *Plutella xylostella* L. (Lepidoptera: Plutellidae) pada tanaman kubis. *Agroland: Jurnal Ilmu-ilmu Pertanian*, 14(3): 195-200.

Trisakti B, Silitonga YBR, & Irvan. 2015. Pembuatan bioetanol dari tepung ampas tebu melalui proses hidrolisis termal dan fermentasi serta recycle vinasse (pengaruh konsentrasi tepung ampas tebu, suhu dan waktu hidrolisis). Jurnal Teknik Kimia USU, 4(3): 17-22.

Visakh NU, Pathrose B, Narayanankutty A, Alfarhan A, & Ramesh V. 2022. Utilization of pomelo (*Citrus maxima*) peel waste into bioactive essential oils: Chemical composition and insecticidal properties. Insects, 13(5): 480.

Wachid M. 2011. Potensi bioethanol dari limbah kulit ari kedelai limbah produksi tempe. Gamma, 6(2): 113–122.

Waluyo & Kharisma DB. 2023. Circular economy and food waste problems in Indonesia: Lessons from the policies of leading countries. Congent Social Sciences, 9(1): 9(1), 2202938.

Wardani AK & Pertiwi FNE. 2013. Produksi etanol dari tetes tebu oleh Saccharomyces cereviseae pembentuk flok (NRRL-Y265). Agritech, 33(2): 131–139.

Weinbaum SA, Johnson RS, & Dejong TM. 1992. Causes and consequences of overfertilization in orchards. HortTechnology, 2(1): 112b-121.

Widyaningrum T. 2017. Pengaruh Dosis Ragi dan Waktu Fermentasi Kulit Mangga (*Mangifera indica*) terhadap Kadar Bioetanol Hasil Fermentasi. In The 5th University Research Colloquium Proceeding (pp. 1239–1247). Yogyakarta: Universitas Ahmad Dahlan.

Widyastanti S & Widyaningrum T. 2022. Produksi bioetanol limbah nasi aking fermentasi menggunakan *Zymomonas mobilis* dengan perlakuan konsentrasi *crude* enzim *Bacillus amyloliquefaciens*. Bioscientist: Jurnal Ilmiah Biologi, 10(2): 901-908.

Widyatmoko H & Duhita SA. 2012. Pembuatan etanol dari limbah ampas kelapa dengan menggunakan *Rhizopus olisgoporus* dan *Saccharomyces cereviseae* dengan penambahan phospat. Indonesian Journal of Urban and Environmental Technology, 6(1): 15–22.

Wijayanti K & Sunardi. 2011. Pengolahan Ampas Tahu Menjadi Etanol sebagai Alternatif Sumber Bahan Bakar Nabati Non-Pangan. In Prosiding Seminar Nasional Kimia dan Pendidikan Kimia III "Teori Aplikasi Sains dalam Isu Globalisasi Lingkungan, Profesionalisasi Pembelajaran dan Kewirausahaan" (pp. 362–368). Surakarta: Program Studi Pendidikan Kimia Jurusan PMIPA FKIP Universitas Sebelas Maret Surakarta.

Wu TY, Mohammad AW, Lim SL, Lim PN, & Hay JXW. 2013. Recent advances in the reuse of wastewaters for promoting sustainable development. In: Wastewater reuse and management. Springer, Berlin, pp. 47-103.

Wulandari D, Rani ID, Sandi K, Shabrina DN, & Gurnita. 2023. Pengaruh pestisida nabati ekstrak metanol kulit bawang merah (*Allium cepa* L.) terhadap mortalitas hama kutu daun (*Aphis gossypii* Glover). Bioma, 25(2): 92-97.

Wuryantini, S., Endarto, O., Wicaksono, R. C., & Yudistira, R. A. 2021, May. Utilization of plant waste as botanical pesticide for citrus pest control. In *IOP Conference Series: Earth and Environmental Science* (Vol. 749, No. 1, p. 012022). IOP Publishing.

Wusnah, Bahri S, & Hartono D. 2016. Proses pembuatan bioetanol dari kulit pisang kepok (*Musa acuminata* B.C.) secara fermentasi. Jurnal Teknologi Kimia Unimal, 5(1): 57–65.

Yang B, Xiong Z, Wang J, Xu X, Huang Q, & Shen Q. 2015. Mitigating net global warming potential and greenhouse gas intensities by substituting chemical nitrogen fertilizers with organic fertilization strategies in rice–wheat annual rotation systems in China: A 3-year field experiment. Ecological Engineering, 81: 289-297.

Yudiawati E. 2019. Efektifitas insektisida nabati ekstrak kulit buah jeruk nipis (*Citrus aurantifolia*) terhadap larva *Spodopterra exigua* Hubner. (Lepidoptera: Noctuidae) di laboratorium. Jurnal Sains Agro, 4(2).

Zuo Y, Zhang J, Zhao R, Dai H, & Zhang Z. 2018. Application of vermicompost improves strawberry growth and quality through increased photosynthesis rate, free radical scavenging and soil enzymatic activity. Scientia Horticulturae, 233: 132-140.

PROFILE OF THIS BOOK'S WRITERS

Rivandi Pranandita Putra

Rivandi was born in Lampung, Indonesia, on May 26, 1992. He completed his undergraduate education in the Agronomy study program, majoring in Agricultural Cultivation at Universitas Gadjah Mada in Yogyakarta, Indonesia. Next, he continued his master's education in the Department of Environmental Science at Wageningen University in the Netherlands. Several topics of research interest include environmental science, urban agriculture, agroecology, and soil biology. His present profession is as a lecturer at the Department of Geography, Faculty of Social Sciences, the State University of Malang in Indonesia. Rivandi has experience as a reviewer in several journals, including Sugar Tech (Springer) and the Journal of Agricultural Economics and Rural Development (Premier Publishers). Rivandi can be approached via email at rivandiprananditap@gmail.com or rivandi.pranandita.fis@um.ac.id.

Vita Ayu Kusuma Dewi

Vita was born in Ngawi, East Java, on May 15, 1993. After completing high school, she then continued her education at the bachelor's level in water engineering at Universitas Brawijaya in Malang, East Java, Indonesia. Vita Ayu then continued her master's and doctoral education at the Civil Engineering Department (water concentration) of the Bogor Agricultural Institute (IPB) and graduated in 2020. Currently, Vita Ayu works as a lecturer at the State University of Malang at the Department of Civil Engineering, Faculty of Engineering, with water and hydrological concentration. Vita Ayu can be contacted via email at dr.vita15@gmail.com.

Nur Annisa Putry Mangarengi

Anisa was born in Ujung Pandang, Indonesia, on January 14, 1992. Her undergraduate education was at the Department of Civil Engineering, Environmental Engineering Program, Hasanuddin University, Indonesia. Then, she continued her Master's Degree in Environmental Sciences at Wageningen University, Netherlands. Currently, Anisa is a lecturer at Hasanuddin University, Department of Environmental Engineering. The author's research focuses on the fields of water, sanitation, waste, and wastewater treatment. Before her career as an academic, she had two years of work experience in construction and mining as an engineer and HSE officer. Anisa can be contacted via email at nurannisa.mangarengi@email.com

THE UTILISATION OF ORGANIC WASTE

THE CASE OF INDONESIA

Waste is ubiquitous, and organic waste is just one of them. Organic waste has not been managed well in Indonesia and in many countries around the world. The problem is that organic waste production continues to increase in various countries, including Indonesia, in line with the rise in population and people's purchasing power. On the other hand, it turns out that this type of waste can be used to make various new products of high economic value. Managing waste is a triumph, yet if the waste can be converted into newly useful products, it will be super fruitful. Utilising organic waste in various products is extremely beneficial, as it not only helps reduce the volume of waste and avoids numerous risks of environmental and health pollution but can also generate income. Waste is not far from the impression of being dirty, slovenly, and smelly. Due to this natural feature, many people are not fascinated by using it for other things with economic value. Interestingly, organic waste can not only be processed into compost. This book reviews the potential for incorporating organic waste into various products. There are a total of 13 chapters in this book, including

1) definition and types of organic waste;
2) problems related to organic waste;
3) potential and benefits of organic waste management;
4) use of organic waste as fertiliser;
5) use of organic waste into biochar;
6) utilisation of organic waste as organic pesticides;
7) utilisation of organic waste as bioenergy;
8) utilisation of organic waste as animal feeds;
9) utilisation of organic waste as handicrafts;
10) utilisation of organic waste as eco-enzymes;
11) recycling organic waste into new plants or food;
12) challenges of using organic waste; as well as
13) closing.

ISBN 978-623-500-570-6

Penerbit widina
www.penerbitwidina.com