CIRCULAR ECONOMY IN THE INDONESIAN AGRICULTURAL SECTOR

Case Studies from The Field

For A Circular Vision

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Agrodite

Agrodite is an Indonesian based enterprise with expertise in agriculture and circular economy. We support governments, private sector companies and other interested stakeholders with a strategy and a vision for a more circular business and future. Agrodite is committed to sustainable development and implements projects with impact for smallholder farmers, plantations or (state-owned) agri-businesses.

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Introduction

I am very proud to present our first paper on the circular economy concept in the agriculture domain in Indonesia. It first explains what circular economy (CE) is and what the benefits are. Secondly, it makes the connection between sustainable development, circularity and the agriculture sector. Lastly, it will showcase several practical cases from Indonesia. The case studies are presented by pioneers and young talents from Indonesia, putting their time and energy in solving indispensable waste and environmental issues.

This document will be updated every 4 months with the latest cases and initiatives from Indonesia. Therefore, it will be an open document, that is also available online, at the website of Agrodite. In the next versions, also more MNCs and established Indonesian companies will develop case studies to better understand their efforts towards a circular business approach.

With the examples of cases presented, Agrodite would like to open the mind of individuals towards the circularity concept, but also showcase how companies and governments can make the transition from only using raw materials to re-using materials in their value chain. From an innovative perspective, we would like to inspire companies and governments to control their waste streams and to design material use before the production process. In this way, it can be ensured that raw materials will be used in a circular manner.

Introduction

The circular economy concept is gaining steady momentum in Indonesia, with the recently held 3rd annual Indonesia Circular Economy Forum (ICEF). In 2019, this forum had the interesting theme around circular business practices, with state-owned and private sector companies' initiatives at the center of attention. Panel discussions and workshops were gathered around packaging, use of plastics, marine debris, infrastructure and housing construction. Agrodite would like to advocate for more attention to food and organic waste, coming from households, processing facilities (of raw materials) and mills, or directly from the agriculture sector.

With this paper, Agrodite hopes to attract a large and diverse audience. For those who want to learn more in general about circular economy, but also for those who want to deepen their practical knowledge. The case studies could inspire you to think about your own working field and ways to transform it into a circular one. Enjoy reading this paper.

Agrodite is ready to help you and your company become more circular.

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MAKING THE CASE FOR CIRCULAR ECONOMY

MAKING THE CASE FOR CIRCULAR ECONOMY

The circular economy is presented as a system of resource utilization where **reduction** (minimum use of raw materials), **re-use** (maximum reuse of products and components), and **recycle** (high quality reuse of raw materials) are suggested. At the basis, the circular economy model is designing out waste. The Ellen Macarthur Foundation, a valued charity who wants to build a positive future through a circular economy, has the following definition for the circular economy:

"Looking beyond the current take-make-dispose extractive industrial model, a circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles: design out waste and pollution; keep products and materials in use; regenerate natural systems."

Table I exemplifies the three core principles of the model and highlights the ultimate goal of circular economy to preserve natural capital by controlling the finite resources and increasing the renewable ones. In other words, the circular economy is not a model concentrating on producing more and more goods. Instead, it creates the condition for the use of services – sharing, renting and recycling – instead of owning things. Materials are not lost at the end of their useful life but are used to make new products.

Table 1: *Core Principles of A Circular Economy*

Principles	Examples of Positive Effects
Design out waste and pollution (from the negative impacts of economic activity)	1. Reduction in the release of greenhouse gases 2. Reduction of polluted land, air and water 3. Decreasing traffic congestion 4. Reduction of plastics 5. Eco- and smart design at the start of production process
Keep products and materials in use (by designing multiple purposes)	1. Preserve value in form of energy, labour and materials 2. Keep products, materials and components circulating 3. Development of bio-based materials 4. The 6Rs (see next page)
Regenerate natural systems (instead of using non-renewable resources)	1. Reducing the input of fossil materials and energy 2. Soil regeneration by returning nutrients 3. Private sector value chain improvements 4. Renewable energy solutions

The Ellen Macarthur Foundation has greatly explained the system thinking behind the model and the three principles. Following this link, more can be read on this:

https://www.ellenmacarthurfoundation.org/circular-economy/concept/infographic

Their demonstrated model separates between biological and technical material cycles. The biological material cycle represents organic (**consumable**) materials, like food, wood and water, which can be returned to the environment. With processes like anaerobic digestion and composting, it can regenerate living systems with nutrients to soils and oceans. Also, in this cycle, it is important to let the ecosystem do its work, as long as the streams are not contaminated with toxic substances. Technical materials follow a different reuse process than biological materials. Materials, such as metals, plastics, and synthetic chemicals, (in the form of washing machines, cars, plastic toys etc.) are **used and not being consumed.** They cannot go back to the environment. Instead of dumping these materials in nature, products, materials and components should be re-used, by using the 6-R strategy. In the circular economy, the materials are in a continuous cycle, remaining (most of) their value. For both the biological-cycle and the technical-cycle, the lifespan of a product must be made as long as possible.

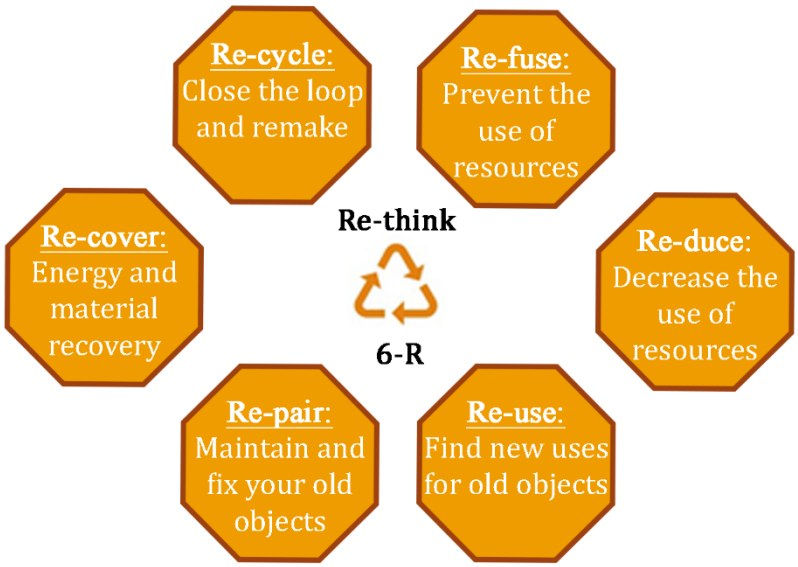
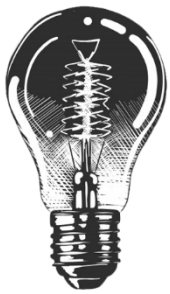


***FIG 1**: 6-R Strategy*

Linear vs Circular Economy

In a linear economy, raw natural materials are taken, then transformed into products and finally being discarded. Value is mostly created by producing and selling as many as products as possible. This kind of production system and management of resources bolster short-term consumption and is leading to an unsustainable world.



Example of a linear economic model in the production of a lightbulb:

Take : A lightbulb manufacturer takes resources like metal and glass for the production.

Make : The manufacturer makes the lightbulb and sells it to consumers.

Dispose : The consumer throws away the lightbulb once it does not work anymore.

In the lightbulb example, neither the manufacturer nor consumer will ever see that lightbulb again, once it is discarded. The bulb is made from the cheapest materials possible and sold for a price consumers are willing to pay. However, the materials to make the bulb are finite, we do not have endless material available to make lightbulbs.

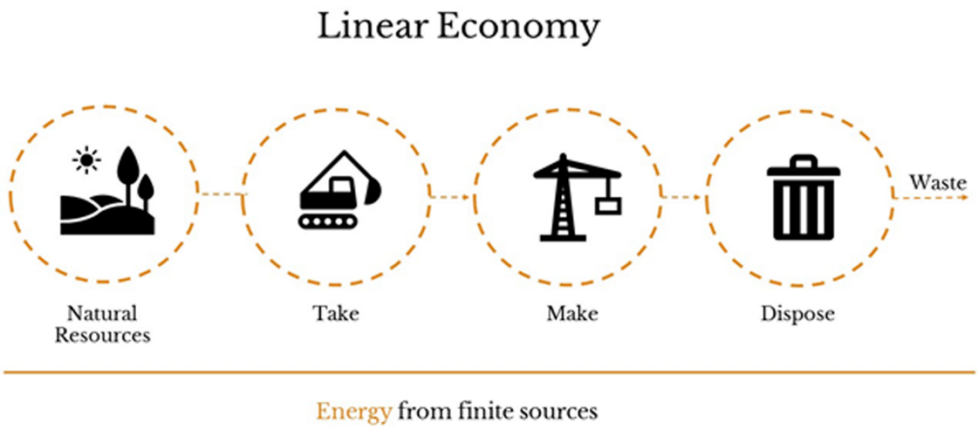


***FIG 2**: Linear Economy*

Linear Economy

In a circular economy model, the cycles of raw materials are being closed. By using the 6-R approach, materials are re-captured and valued again. The circular economy model is also a shift in thinking. Producing and selling a product will still happen, but more thoughts are undertaken into **"product as a service".** Owning a car or a lawn mower could be history, because why owning a lawn mower if you are not using it very often, or why owning a car while transport can be more efficient and cheaper. Staying in the lightbulb example: in the future, a consumer will not buy a lightbulb anymore, the manufacturer will offer light as a service to consumers. Consumers only pay for the light they use, while the manufacturer remains the owner of the bulb. The manufacturer would like to have the bulb back once it does not work anymore. In this way, it is easier to reclaim valuable materials, and they can maintain an ongoing company-customer relationship.

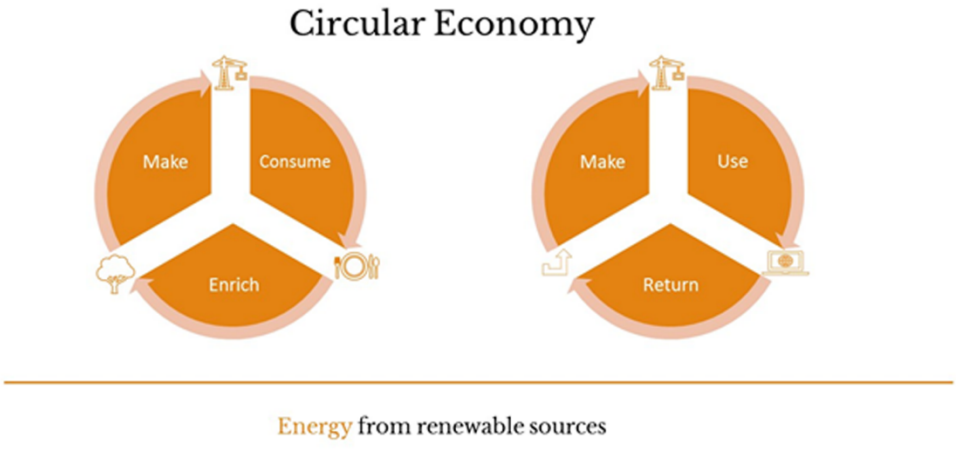


***FIG 3**: Circular Economy*

Circular Economy

The pie chart on the left in the figure above is the biological material cycle and the pie chart on the right is the technical material cycle. In the biological material cycle, the waste can be enriched to become of value again, like by composting organic waste, or feeding cows leftover waste from a soy processing mill. In the technical material cycle, the waste has to be returned. In the best case scenario, it can be sent back to the same manufacturer, but very often in Indonesia, old consumer goods (f.i. a broken fridge) go to small shops where they take the valuable parts. Very often, these shops repair the broken goods and try to sell it again in the lower market segment. Although this sounds circular and it provides work for many people, the responsibility for the waste is shifted to these shops instead of the manufacturer. As part of new policies around extended producer responsibility (EPR), the manufacturer should take it back and use the materials again. **The circular economy is not just a phenomenon for the global economy, it actually should be a strategy to create multiple circular economies at local, regional and global scales, and in different industrial sectors.**

The Benefits of A Circular Economy

Governments and the private sector are coming to the understanding that the linear economy is under pressure. If not yet felt now, the economic and ecological disadvantages of this system will be felt in the future, on which need to be anticipated already. Pressure on the earth's ecosystems jeopardizes the future provision of clean water, air and healthy soil. The fluctuation of raw material prices also causes for greater risks for companies and the market.

According to the calculations from the Circularity Gap Report, 9% of all raw materials were fully recycled by 2019. In 2018, this percentage was actually slightly higher at 9.1%. There is still a long way to go to reach something near 100% and to show what the benefits are for business and governments transforming its economy and their business models into a circular one.

Circular economy has the potential to be a considerable improvement to businesses. Several companies are already proving that reusing resources is more cost-effective than using raw materials from the ground up. Product as a service is one of the interesting new models that could create new profit streams and strengthen customer relationships. Raw materials are often high costs for companies, but through circular economy these costs can be reduced by having a stable supply of materials. However, more cases are needed, at a larger scale, to show that circularity is not a bubble and the new buzzword for sustainability, but a serious business model that brings profitable opportunities.

Table 2: *Benefits of A Circular Economy*

Benefits of a circular economy	
Economic	**Ecological**
Economic growth through value creation	Reduction of GHG emissions
Cost reduction by effective resource management	Reduction of exploitation of natural raw resources
Better employment opportunities	It uses renewable energy instead of fossil fuels
Increase of sustainable innovation	It stimulates improved farming systems with fertile soils, healthy air and clean water
Changing demand from consumers	Less waste in the food value chain

In Europe, the top 5 sectors with the most circular economy initiatives are mentioned above. In this paper, we focus on the agricultural sector, on how circular economy can close the loop from farm to table and how the food processing industry and retail can contribute to circular value chains.

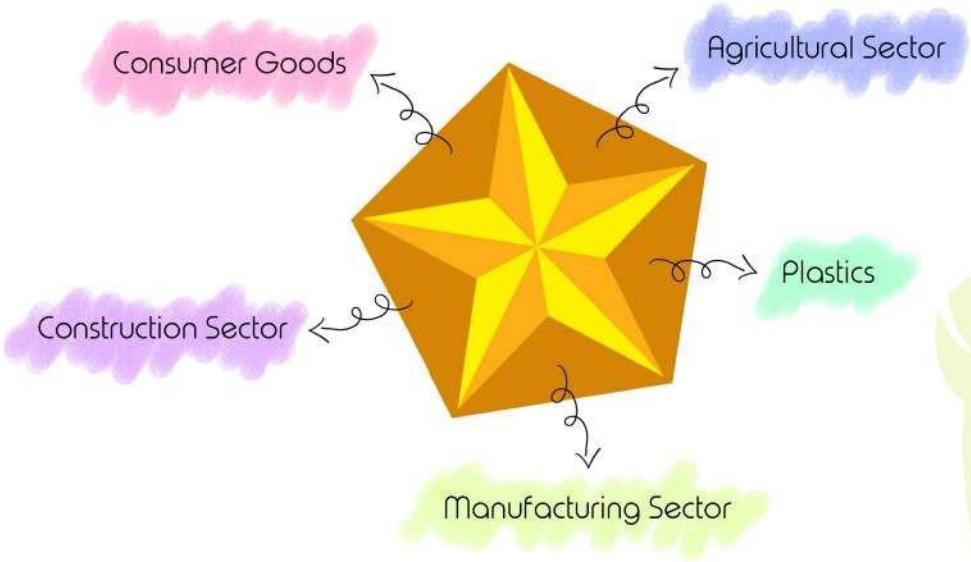


FIG 4: *Top 5 Sectors in Europe in Circular Economy*

Circular economy in the agri-food sector: Closing the loop from within

The world's population is increasing quickly, and it is predicted to grow to almost 10 billion people in 2050. Another 2 billion people will join us on planet earth, and they all need to live and eat. By that time, also Indonesia will have more than 300 million inhabitants, with more people having a middle income. Our farmers, growers and fishermen feed the people. However, the way we produce our food and the demands of consumers are not sustainable. Indonesian consumers have a personal responsibility in their daily life choices in what to eat and what not. It is important to know how food is produced. With raised awareness on food production and the life of farmers, consumers could shift their thinking, by not always choosing for the lowest price and the most convenient choices. Middle-income families also demand a better living environment in Indonesia. Farmers are

not only growers or keeping livestock, their land play a vital role in the enjoyment of nature as well. They are the guards for our soil, water, plants, fertilizers, wildlife, and other biodiversities.

The waste that is generated now and in the future at a household level (organic and solid waste) also needs to be processed in a professional manner, facilitated by the government (and if not, by private sector initiatives). Processing and sorting the organic waste from households is still an enormous challenge in Indonesia. The awareness in cities like Jakarta is rising, as dumping sites like Bantar Gebang cannot endlessly grow and has exceeded its full capacity.

Agriculture is mainly linear in structure and resource intensive, with the use of artificial fertilizers, synthetic nitrogen and other agrochemicals. With innovation and technology and profitable business practices, a contribution has to be made to develop a sustainable food system for all people in Indonesia, and worldwide. Other stresses like climate change, limited arable land and fresh-water availability, aging farmer population, urbanisation and a declining biodiversity are making innovations even more crucial. A circular food system will help to grow on less land, feed all people, without causing an extra burden to the environment.

The United Nations has developed the Sustainable Development Goals (SDGs) to achieve a better and a more sustainable future for all. Especially Goal 12 is important for the concern of circularity. As the figure on the next page shows, Goal 12 concentrates on consumption and production patterns, in which social and economic progress does not lead to environmental degradation. This specific Goal has more essential elements to it, but the focus in this paper is on the ones that represents agricultural waste and material and food loss in production and supply chains.

According to the FAO, it is estimated that **1.3 billion tonnes of food is currently lost** in the global food chain, while one in nine people is malnourished. Food losses and waste are responsible for **8%** of the greenhouse gas emissions that are heating up the planet. **Up to one third of the food produced for human consumption is wasted.** That also means that labour and investments have been wasted for the production of this food. Linking agriculture to the circular economy philosophy, it should be concentrating on a production system that uses minimal amount of external chemical inputs, that closes nutrient/resource loops in the same system and that reduces the negative impacts on the environment.

It is not just one farmer, but the entire agri-food chain needs to examine at every stage, from production till waste management, if other approaches are required. A regional landscape approach between different farmers could be a start. Horticulture growers, livestock farmers and processing facilities could ideally work together, by exchanging feed for the cattle from crop waste, and high quality fertilizer/compost products from livestock manure. Farmers and the facilities can plan together on closing the nutrient loops, with help from the local government. In countries like Indonesia, the logistics of providing manure or crop residues to other farmers is enormous. It needs central organization to lower the cost of doing this.

FIG 5: *Sustainable Development Goals No. 12*

In the development of sustainable value chains in the farming and processing sectors, blind staring on circular economy as a solution for everything is not advisable. As can be read in the different case studies in the next chapter, not all initiatives are fully closing loops or circular. The bioeconomy, defined as those parts of the economy that use renewable biological resources (such as agricultural waste) to produce food, feed, materials and energy, may not necessarily close resource loops in agricultural production systems. However, these resources and manure can produce energy/chemicals for the wider bioeconomy, thereby not being circularised. Same counts for the production of horticulture crops or flowers in one continent and being consumed in another continent. These crops and flowers are grown in soil and nurtured in one place and then moved to another place.

Certain nutrient inputs, energy and water resources are then transported between continents as well, whereas circularity dictates that these resources need to return to the production site and remain in the same agricultural system. Despite not being fully circular, the path of the natural resources is a better one than being burnt off or discarded at a landfill, which is a normal practice in Indonesia.

Circular Economy in The Agricultural Sector

- Reuces inputs for the same production level
- Closes and recycles nutrient loops
- Reduces and recycles waste
- Processes by-products
- Reduces carbon emissions
- Is nature-inclusive
- Shares data on waste

Zooming in on agricultural waste, it mainly comprises of cellulosic fibres possessing high fixed carbon content. Agricultural waste shows considerable applicability due to its high strength, environmentally friendly content, low cost, and ease of availability and reusability. Conventional strategies to process agricultural and food waste is through incineration for energy recovery, feed for livestock or composting. In Indonesia, other waste valorisation strategies are presenting themselves with potentially higher value and better marketable products. The next chapter will show several examples.

Besides the increased need for energy in Indonesia in 2050, also the demand for water will rise. With the growing population and expected growth in industries and agriculture, water will become a scarcity in Indonesia, not even mentioning the effects of climate change on the long term. Given this forecast, in many sectors, but also the agriculture sector, water resources will need to be managed more sustainably and efficiently.

Worldwide, almost 70% of its fresh water is used for agricultural purposes. Innovation and new technologies are coming to the Indonesian market to optimize the use of water on farms. Technologies for precision irrigation, but also technologies for the treatment of wastewater in such a way it is clean enough to re-use for irrigation, or as drinking water in residence areas, are reaching farmers and plantations. However, for smallholder farmers (who rely mostly on rain), these systems are often still too expensive. Nevertheless, farmers have to think about solutions to use less water and still increasing their production. Re-using wastewater also has much potential to create sustainable sources of water for agriculture sector.

Agri-innovation and technology has already supported the sector to increase the production. However, on the inputs like water, we need innovations to reduce the usage. Same counts for the over-application of fertilizers and pesticides. Agri-technology and innovation can boost the circularity in the sector. Smart technologies could help farmers with the right amount and the right place for the usage, which could reduce costs and still increase production. Satellite data and agri-drones could be operated together to detect which places need more water or fertilizers. The drones can be configurated it will fertilize only those areas who really need it. The sensors of these drones are also able to detect pest and diseases at an early stage. This could all lead to healthier crops and a decrease in harvest loss. For smallholder farmers in Indonesia with less than one hectare of land, the use of drones could be utopic. However, they do not have to own a drone, drone as a service could be applied here, and only pay per hour or day of use, together with other farmers.

Although we discuss circular agriculture as a new concept, it actually consists of elements deriving from the field of agro-ecology, bio-based economy and industrial ecology. These systems often focus on local or traditional knowledge, trying to copy how nature solves complex issues. However, with circular agriculture, solutions are offered in the whole food system. Especially in a country as Indonesia, circular agriculture should not only focus on food production and waste management, but it should include environmental management, public health, jobs and income and climate change adaptation and mitigation.

In the next chapter, several challenges and risks related to circular start-ups are mentioned. Setting up a circular model can take some time and the registration of new products can be costly. Consumers and other companies often still need to be convinced that certain type of products are healthy and safe. Another risk is the circulation of toxic materials coming from different sources and finally ending up the food system. As a start-up, having an excellent business case for waste deriving from companies and processing facilities, could have social negative impacts for certain groups. In Indonesia, certain 'mafia groups' are owning the waste of companies in return for protection in the area. The reduction of waste or processing it differently means loss of jobs and income for these groups and that will jeopardize the local harmony between companies and the community.

But besides these risks and challenges, the following case studies in the next chapter are an encouragement to every Indonesian consumer, producer, business owner, MNC manager, government official to start to think in circular concepts.


Case
Studies

Case Study

Background

Mush'ab Nursantio
Co-founder of Biteback Biotechnology Pte. Ltd and Regional Coordinator of Thought For Food Foundation

Biteback is an insect biorefining start-up based in Singapore and Indonesia. The company is aiming to reduce our dependence on palm oil by creating a nutrient-dense, more sustainable alternative. At **Biteback**, we are using **edible insects** to transform biomass from agro-industry waste streams into high-quality nutrients and organic chemicals. We started this company as part of a university research project, initially, we looked at insects as a source of protein but soon realized the potential for oil-based products, especially as an alternative to palm oil. Growing up in Indonesia we have witnessed the destruction of natural resources due to the ever-increasing demand for palm oil and the endless expansion of palm plantations. We also strongly believe that a sustainable solution developed by an Indonesian company will help increase awareness from other young Indonesians and spur other developments in innovation around conservation and sustainability in our country.

What is the problem?

Palm oil is the most used vegetable oil on the planet and can be found in almost half of all packaged items in supermarkets, from bakery goods and snacks to shampoo and detergent. Indonesia, as the largest producer of the commodity, has cleared millions of hectare of rainforest to make room for palm plantations. However, palm oil remains to be the most sustainable vegetable oil in terms of yield and resource utilization. As the world population growth heads toward 9 billion people in 2050, it's very likely the demand also keeps increasing. This will bring negative impacts through primary resource extraction, processing pollution, and consumption waste.

Case Study

What is the innovation?

Biteback offers more options in the market and a novel approach to the way we produce goods and consume. We blur the division between waste and resources. Enable us to meet nutrient needs without necessarily adding new resources such as pesticide or fertilizer and fertile soil, as the cultivation can be done indoor and scaled vertically. Biteback has developed a process to extract oil from edible insects. Insects require little feed, water or land, and produce almost no greenhouse gases – a much more sustainable alternative to palm oil. In just one year, insects (*Zophobas morio* larvae) yield almost 38 times more oil than oil palms do using the same amount of land. The insects can grow on biomass from agro-industry waste streams, as feedstock such as wheat husk, rice husk, sugarcane bagasse, and/or palm press cake waste. The fatty acid properties cover what is also mostly available in the palm oil and possess an advantageous combination of rich in unsaturated fats and healthy fats including omega-3, 6, and 9.

Challenges

Consumer acceptance is a challenge. Although entomophagy (the practice of consuming insects) is practiced by more than 2 billion people, the practice has become less common as the middle class is increasing in the region like Asia and Africa and they tend to follow a western diet. Despite several regulatory hurdles, various insect-based products have been incorporated in industry, like red-dye from cochineal. It has even been labelled halal too.

Case Study

Business Model

As we have focused on higher oil yielding insects such as superworms (*Zophobas morio*) we see an opportunity to create value-added processes and technology that can be licensed and incorporated into other insect protein companies and/or to biomass producers, or run as a standalone business as part of a larger and more developed insect value chain.

We see an industry scale that using our technology can effectively produce sustainable insect-based alternatives to palm oil along with a variety of other B2B and B2C refined insect products

FIG 6: *Zophobas morio is a Species of Darkling Beetle - Larvae*

FIG 7: *Cooking Oil from The Superworms*

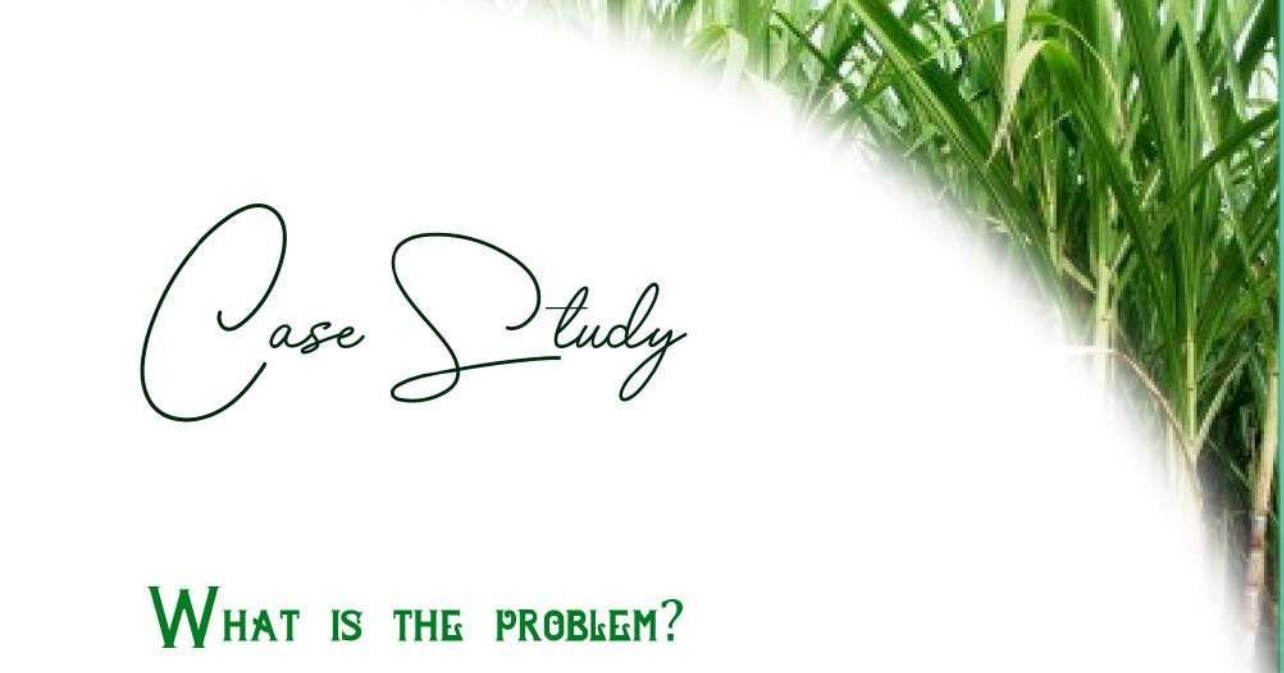
Case Study

Background

Rivandi Pranadita Putra
*Researcher at **ISRI (Indonesian Sugar Research Institute)** Pre-Harvest Department*

ISRI is a research institute based in Pasuruan, East Java, which has the main task to carry out research as well as to produce sugarcane and sweeteners technologies for the advancement of the sugar stakeholders, especially for sugarcane farmers and sugar mills. The institute is also responsible for providing technical assistance to clients.

Based on his experience in working with various clients (cane farmers, private sugar companies, estate sugar plantation companies, and government) in Indonesia, many issues are occurring at the cane field related to **lack of soil fertility**. Indeed, sugar industries in Indonesia often demand a high input (fertilizer, energy, etc.), but at the same time, it generates lots of waste that actually can be used as fertilizer. Therefore, there is a huge opportunity to apply the circular economy at the Indonesian sugar industry to make it more sustainable and profitable.



Case Study

What is the problem?

Sugarcane is one of the essential staple commodities for the Indonesian economy, as it generates employment for many Indonesians. Sugarcane is also being the primary source of raw material for Indonesian sugar industries. In this country, sugarcane is commonly processed to be white crystal sugar. The sugar is usually consumed as an additive to foods and beverages as a sweetener, although to date, some innovations emerged to diversify the sugarcane products, such as liquid sugar, caramel syrup, cane juice, bioethanol, molasses, and many more.

In general, there are various types of waste disposed from sugar cane mills, **both in liquid and solid form**. Liquid wastes include vinasse, sludge, etc. Solid wastes include bagasse fibre, filter cake, boiler ash, etc. If it is not managed properly, surely all the wastes lead to environmental pollution. Oftentimes, sugarcane factories discharge by-products, which can actually be re-used, re-cycled, or even to be sold as new products to minimize the waste.

Currently, several Indonesian sugar mills have actually made use of the waste, such as **bagasse to generate electricity. Molasses to produce bioethanol, and filter cake and vinasse as fertilizer** in cane fields. These ideas have led to a decrease in environmental pollution and have saved costs for the mills to pay electricity and for inorganic fertilizer. However, in Indonesian sugar industries, there is still a lack in research and development regarding the re-cycle and re-use of the waste. For instance, it is not common yet in Indonesia to produce paper, tissue, fertilizer, cattle fodder, or even silica gel from the bagasse. Until now, those products are only for small-scale production.

Case Study

(cont.) What is the problem?

Besides the lack of innovations, the other problem is that not all sugar mills in Indonesia have initiatives to valorise their waste. Some of them just dispose their waste to the environment, creating air, water, and soil quality reduction and leading to societal and health problems. For the short-term, disposal of the waste can be a cheap option. However, at the longer time span, it can be economically disadvantageous for the mills, for example, when the soil and water quality used for the cane plantations will be degraded, which has influence on the quantity and quality of the sugarcane.

FIG 8: *: Liquid Sludge Waste Produced by Sugar Factory*

Case Study

What is the innovation?

There is an enormous potential to gain high-value products from waste of sugar industries, rather than throwing it or keep it as pollutants in the open environment. Minimizing waste as an attempt to adopt a circular economy approach will benefit the environment and boost economic opportunities by turning leftovers in sugarcane industries into usable products (to be used by the mills as much as possible).

Sugar mills often produce sugarcane bagasse, which can be used as a renewable fuel for boilers in sugarcane mills. It is estimated that the energy from sugarcane bagasse can supply 70% of the power requirements at sugar mills. Also, since bagasse is a fibre material (cellulose, hemicellulose, lignin), it can be used as a raw material for the **production of chipboard and paper.** In the future, the disposable "paper" products can even be a better choice since it comes from a “rapidly renewable” sugarcane instead of trees that need more time to be cultivated.

Other than bagasse, sugar industries also produce molasses, vinasses, and filter cake, which often cause environmental pollution. These three forms of waste are commonly used by Indonesian farmers as organic fertilizer. Through innovations, we can also think further about how to make use of those different forms of waste. The following are some examples on how the waste can be converted into useful and valued products:

Case Study

(cont.) What is the innovation?

1. Sugarcane molasse as bioethanol

The easiest way to make bioethanol is from raw materials that contain sugar, such as molasses. Simply explained, bioethanol from molasses can be produced through these following steps:

- ***Dilution of molasses***

The sugar content in molasses is too high for the fermentation process, so it needs to be diluted. Molasses usually has sugar content of more than 50%. The sugar content of around 14% is enough to make bioethanol.

- ***Addition of Urea and NPK fertilizer***

Urea and NPK function as nutrition for yeast. The urea and NPK are mashed up to be a fine particle, then they are added to the molasses. The quantity of urea and NPK needed are respectively 0.5% and 0.1% of the sugar content in the fermentation solution.

- ***Addition of yeast***

An example of yeast that can be used is *Saccharomyces cereviseae*, which can ferment sugar into ethanol. The quantity of the yeast required is 0.2% of the sugar content contained in the molasses.

Case Study

(cont.) What is the innovation?

- ***Fermentation***

The fermentation process will run several hours after all the ingredients are put into the fermenter. During this fermentation process, the temperature should be kept not to exceed 36 °C and maintain pH at 4.5 - 5. The fermentation process lasts for approximately 66 hours or 2.5 days.

- ***Distillation***

After completion of the fermentation process, the fermented liquid should be put into an evaporator or boiler. Then, the liquid is heated at the temperature of 79-81 °C. At these temperatures, the ethanol is evaporated, but the water is not evaporated. Next, the ethanol vapor is supplied to the distillation tools. The bioethanol will come out from the distillation discharge pipe. At the first distillation, the ethanol levels are usually still below 95%. To raise the ethanol level, the distillation process needs to be repeated (reflux) until the ethanol content reaches 95%.

- ***Dehydration or removal of water***

This step can be carried out while the ethanol level reaches 95%. Synthetic lime or zeolite can be added to the ethanol liquid to remove the water, then it is left for some hours. Next, the distillation process can be repeated again until the water content reaches approximately 99.5%.

Case Study

(cont.) What is the innovation?

2. Sugarcane bagasse as livestock fodder

It can be a great source of nutrients and minerals for poultry and ruminant animal species. The process to make the fodder from sugarcane bagasse is not that complicated. It needs to be fermented with probiotics. By fermenting the bagasse, lignin and cellulose content can be reduced, so it will be easier for the livestock to digest and absorb the nutrients.

Besides bagasse and probiotics, some other materials such as urea, TSP or SP36, and ZA fertilizer should be added. These three types of fertilizer help to enrich the nutrient content of the fodder. Urea helps to increase the protein content of the bagasse, while SP36 function as a source of phosphor and ZA as a source of sulphur.

Additionally, the nitrogen contained in urea and ZA also stimulates decomposing microbes so the fermenting process can be more effective.

Sugar cane leaves can also be used to feed livestock. Manure from the livestock could be used on the plantations combined with the leaves. Another option for smallholder farmers is to use sugarcane leaves to fatten calves.

Case Study

(cont.) What is the innovation?

3. Sugarcane bagasse as pulp and paper

Creating pulp and paper not only supports the theory of circular economy, but it is also great for the environment since it can reduce tree logging at forests. There are some steps to make paper from bagasse:

- ***Mashing up the bagasse***

The bagasse is washed and then dried below the sun. The pith of the bagasse is then removed by mashing it up. At the end, we only use the fibres.

- ***Pulp heating***

This step is actually a hydrolysis process which aims to separate cellulose from lignin (delignification). After adding acetic acid and water, about 1000 grams of sugarcane bagasse is put into a rotary digester. The concentration of acetic acid used is various (100%, 80%, and 60%). Ratio of the solution and bagasse weight are 8:1 and 12:1. The maximum temperature for this process is 160 °C.

- ***Pulp washing***

This step aims to separate the pulp from the solution. This step is done until the acetic acid is disappeared.

Case Study

(cont.) What is the innovation?

- ***Disintegration***

By using a tool called disintegrator, this step aims to separate the fibres. The disintegrator has the same work principle as a blender. This step is done for 3-5 minutes until the pulp breaks down into small independent fibres.

- ***Pulp filtering***

The disintegrated pulp is filtered with a hydraulic screener. This tool filters the disintegrated pulp at 80 mesh. Afterwards, the filtered pulp is dried by putting it into a centrifuge.

- ***Pulp milling***

This step is done with a Hollander beater. To make a sheet of the pulp of 60 grams/m2, or a paper with a diameter of 21,5 cm, we need 2,1783 grams of dried pulp. This milling process is done for 15-20 minutes.

- ***Pulp-sheet production***

Pulp sheets are formed at the fineness of 200-300 degrees of freeness. A pulp suspension of 1430 ml is added to the stock chest (stirrer). Next, 10 litres of water are added to make 10 sheets of pulp. Then, the pulp sheet can be produced at each time while taking suspension from the stock sheet.

- ***Paper-sheet production***

This process can be started while the pulp begins to enter the paper machine until the paper sheet is neatly rolled up in a roll.

Case Study

(cont.) What is the innovation?

4. Filter cake as briquettes

The filter cake briquettes can be another source of renewable energy. In short, the production process of this briquettes begins by making the filter cake into small lumps, approximately as big as a fist. Then, the lumps are dried and burned. Next, the charcoals as the result of the combustion are mashed up, glued with adhesive material (such as starch), printed out, and then dried.

FIG 9: *Bagasse Produced by Sugar Factory*

Case Study

Challenges

Although making use of waste is encouraged, especially for mills there are challenges to re-cycle and re-use their waste, such as:

Financial and technological challenge

Treating wastes like vinasse, needs technology such as an anaerobic digester. On a small scale, a simple digester can be made. However, on a larger scale, as from sugar mills, simple tools like that cannot be easily adopted. A mill needs to make a big investment in the required technology for treating waste. Sugar mills in Indonesia, especially small-scale mills, may not have the budget or do not want to invest money for such a technology.

Technical challenge

Even when a mill has the technology, technical challenges may occur. First, people need to be trained on **maintenance issues**, as technology may have less power or will get broken. Secondly, there is still a lack of awareness and skills on recycling waste and of human resources that has the motivation and competency to master it. Therefore, this can lead to confusion on what to do and the technical implementation of waste recycling can be hampered.

Case Study

(CONT.) CHALLENGES

Societal challenge

When the two challenges above can be successfully faced, the re-cycled products may not be consumed by the public society. The reason can be simple, because people are not familiar with these products. For example, bioethanol from molasses is not a common source of energy for Indonesians. Another example, the cattle fodder from bagasse is also not yet common in Indonesia. Indonesian cattle farmers may prefer to feed their cows with fresh grass rather than the processed products from waste. The farmers may feel unsure about the safety of the products.

The circular economy is still a relatively new concept for Indonesia. **Changing behaviour and the "acceptance" of related-stakeholders** are also critical aspects to be regarded in realizing the circular economy in the Indonesian sugarcane industry. A shift of thinking needs to happen from throwing waste into the environment into sorting and recycling it.

Case Study

Business Model

Public-private investments are needed in the sugarcane industry, especially at the mills, for research and development and implementation of technologies to reduce the waste. Cost reductions on electricity and fertilizer inputs are not enough to have a short Return of Investment (RoI) for the mills. Dumping the waste is still the cheapest and easiest option, but **environmental policies** in the future will require investments at some point.

Collaboration with key partners, such as the communities around the mills or other companies are key to set off smaller innovations. Waste can be turned into fodder, and can be bought by local farmers. Filter cake briquettes can be sold to the local community as a replacement for fossil fuel. These smaller innovations can be easily started in order to become more circular step by step.

Case Study

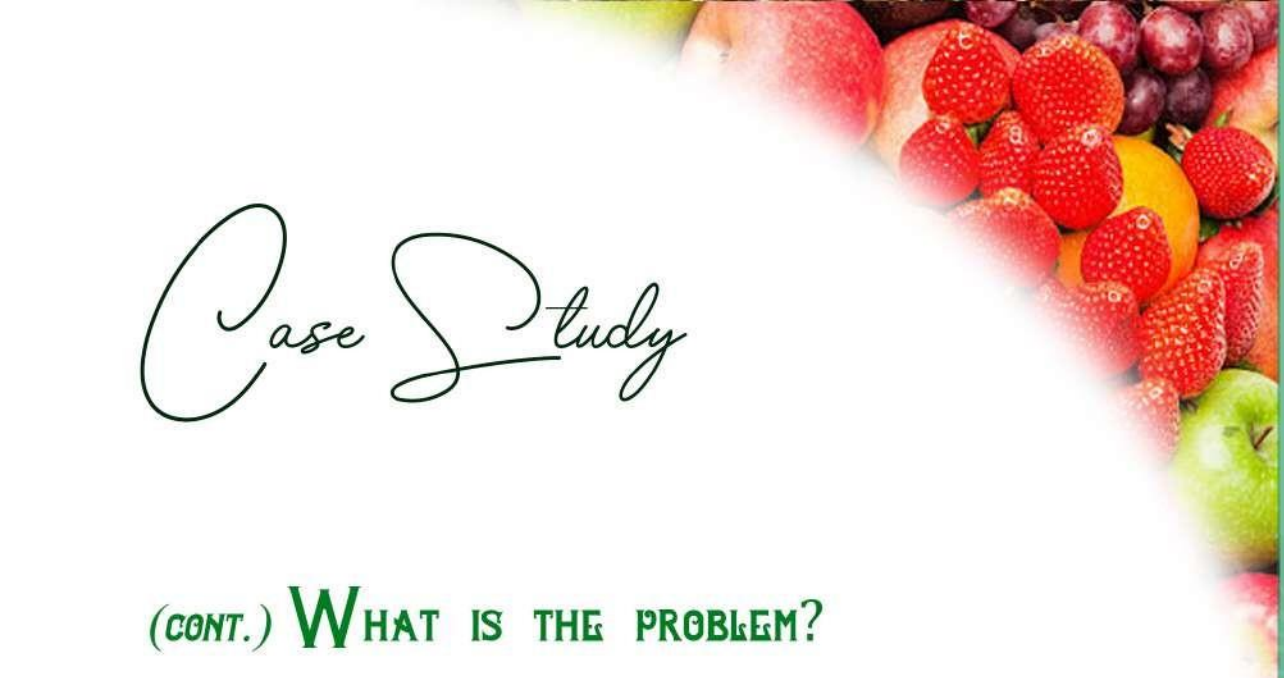
Background

Michael Muliadi
Chief Technical Officer of Bacoat

Bacoat is an agribusiness centric company in Indonesia. **Bacoat** has the mission to provide the world with a solution to combat food loss and waste. In doing so, Bacoat has developed (and still improving) an edible coating, a method to preserve fresh products especially fruits in affordable, effective, and safe way.

What is the problem?

We can observe how circular economy and sustainability in fresh produce sector is interconnected with each other through the practice of postharvest handling, especially in retail level. Major cities in Indonesia have different scope of retail, ranging from minimarkets to supermarkets, consequently covering every customer segment. People living in urban areas have steadily shifted to purchase fresh produce, such as fruits and vegetables, regularly from supermarkets instead from traditional markets. There are many factors which make people favour retail stores, such as; place cleanliness, ease of access, competitive prices, and convenience of having their needs available in one place. In recent years, the number of people aware of healthy and green lifestyle, has keep increasing. This resulted in higher fruit and vegetable consumption per capita. As the supply and demand in fresh produce market increases, it becomes interesting as an object of observation in how retail stores manage their role as the last component at the supply chain before the customers buy it.



Case Study

(cont.) What is the problem?

Throughout the entire supply chain from production to end-consumer, fresh produce suffers significant losses. **Poor post-harvest handling and logistics are two of the main causes of these losses in Indonesia.** The number may vary per area, but the losses range between 30-50%. Fresh produce is perishable by default, hence it requires extra effort and deliberate handling to push the percentage of loss down. Fresh fruit and vegetables continue with biological activities after harvest, resulting in continuous loss of water and solutes, and gaseous exchanges with surrounding environment through respiration and transpiration. Retail is positioned at the end of the supply chain line to provide customers with products they need. Stores need to be innovative and creative in order to meet with costumers' satisfaction and to gain the most profit.

The acceptance and quality standards of fresh produce in retails is set high; irregular shaped, uneven coloured, and below threshold weighted produce will be sorted out and discarded at receiving bay. Customers expect every product on the shelf to be of top quality and they are reluctant to pick even slightly imperfect ones. Produces at the shelf, which have lost their peak freshness, will likely be neglected and end up discarded. This leaves the retail stores to find the best solution to make the most out of perfectly edible yet rejected fresh produce, and keep the ones already at shelves fresh for longer time.

Case Study

What is the innovation?

One of the solutions widely practiced is to "repurpose" the rejected fruits into cut fruits. Cut fruits are often packaged in either a PET plastic box or wrapped in a Styrofoam and PVC wrapper. Even if the shape and colour is out of preference, the fruits themselves are still perfectly edible and appetizing. This way, retail can save the profit by cutting waste. However, the packaging is not environment-friendly, and it often adds up to the waste on a landfill. As for saving vegetables, a handful of retails offer precooked food at a stall inside their store. They manage their own ingredients such as vegetables and herbs from the shelf to reduce amount of waste.

Another form of technology which can be used to preserve freshness in a safe way is called "edible coating". Edible coating is a method to apply a layer of viscous solution to the surface of a fresh produce. Bacoat, a growing start-up from Indonesia, has developed edible coating derived from citrus fruits. The technology works in a simple yet sophisticated concept: the coating acts as barrier to halt oxygen interaction with the fruits, which in return keeps the fruits in fresh condition for a longer time period.

FIG 10: *Examples of Cut Fruit in Styrofoam Packaging*

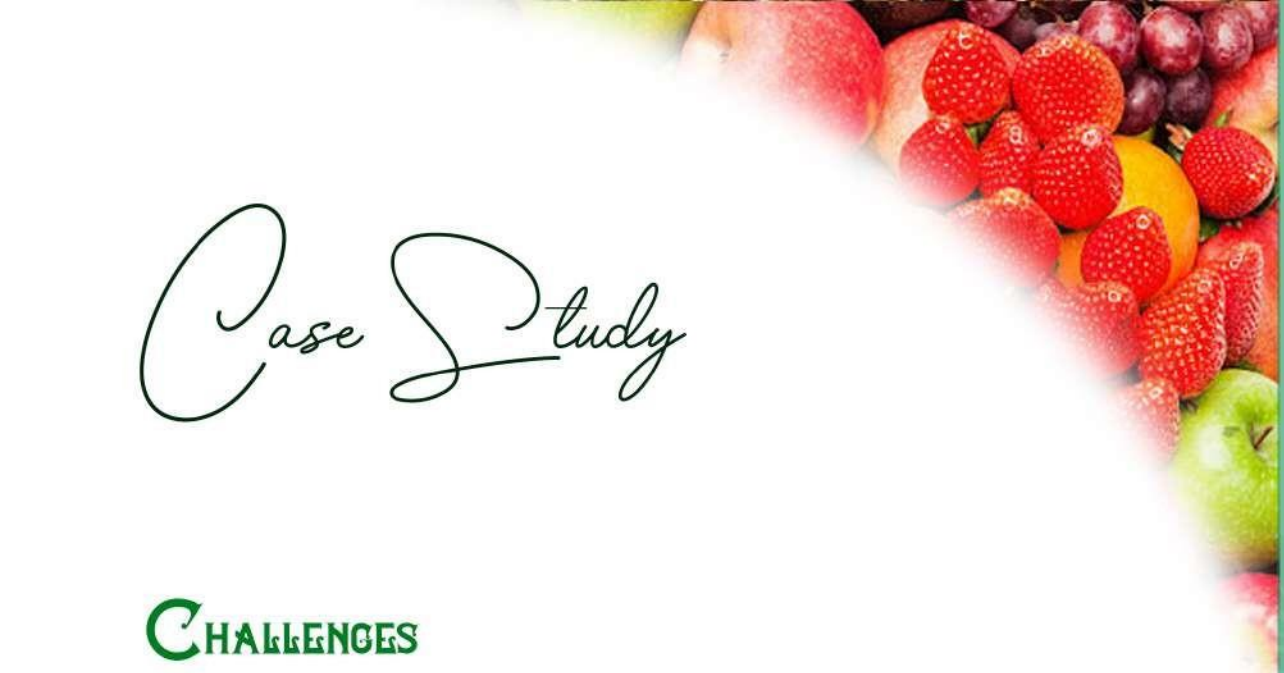
Case Study

(CONT.) WHAT IS THE INNOVATION?

Bacoat uses citrus fruit waste that is still viable from multiple sources, such as a juice processing plant. The citrus fruits then get reprocessed into a formulation which can effectively keep fruits fresh for longer. Recently, some substances included in coating formulations are criticised for their negative residual effects on consumers. However, Bacoat's edible coating is guaranteed to be perfectly safe and cause no negative health impacts to customers. Banana, as the primary focus of Bacoat, gets up to 3x longer shelf life compared to a control group of bananas without coating. Edible coated Cavendish banana in room temperature can last to 11 days, while uncoated Cavendish banana can only last for 4 days but with significant bruises and darkening. At the moment, Bacoat edible coating is applicable to fruits while still in development for vegetable applications as well.

Practicality, as similar result can be accomplished by retail stores. Bacoat can provide the edible coating in concentrated solution form, which the user can dilute with water into 1:10 ratio to meet the ideal concentration. Retail stores can easily apply the coating by dipping their fruits into the solution, brushing or spraying the solution to the surface. The coating process can be done before putting the fruits to the shelf. While the mileage may vary from different kind of fruits, in general the extra days of freshness will significantly reduce the amount of discarded food waste.

FIG 11: *BACOAT's Edible Coating from Citrus Fruits*



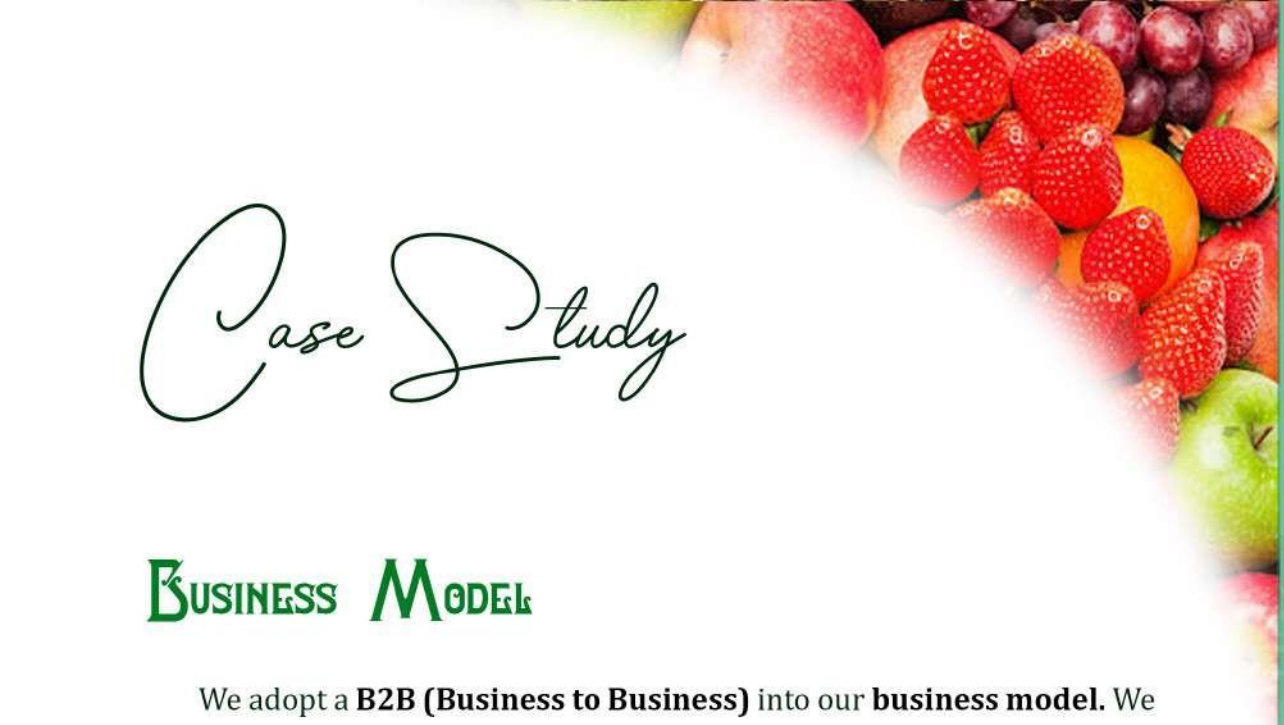
Case Study

Challenges

One of main challenges Bacoat is experiencing, is that **many people are still unfamiliar with edible coating** as a safer alternative method to currently existing preservatives for food. When people hear the word "preserve" or "chemical compounds", they are likely to assume it as something negative. It is our mission to introduce and enlighten more people to this safer and greener method.

Another challenge is that **developing countries tend to underestimate the importance of proper postharvest handling for fresh products.** Local farmers and distributors in Indonesia still utilize traditional methods and technology to process their goods, resulting in less than optimum result in the market. Local products can't penetrate to higher tier market because the quality fails to meet with the higher standards demanded by the modern market. That's why Bacoat aims to introduce the edible coating **to local fruit distributors** as they handle most of fresh product from farmers. Through them, hopefully the products will retain their quality, and will it be easier to reach higher tier market.

The collaboration between local fresh product actors and **retail stores** are essential. The actors in the supply chain surely want to sell their products and get satisfying profit, while retail stores want cheaper products but in high quality. Edible coating might be the bridge we need to unite the two sides.



Case Study

Business Model

We adopt a **B2B (Business to Business)** into our **business model.** We sell our edible coating **mainly to downstream actors in the fresh supply chain, such as distributors and retails.** From our revenue projection, **it is Bacoat's goal to reach a sale of 1 million edible coating products in the coming 5 years.** In our system, we form long term purchasing contract with our clients which mean regular income coming from them. Bacoat is pro-active in reaching new clients every month.

Case Study

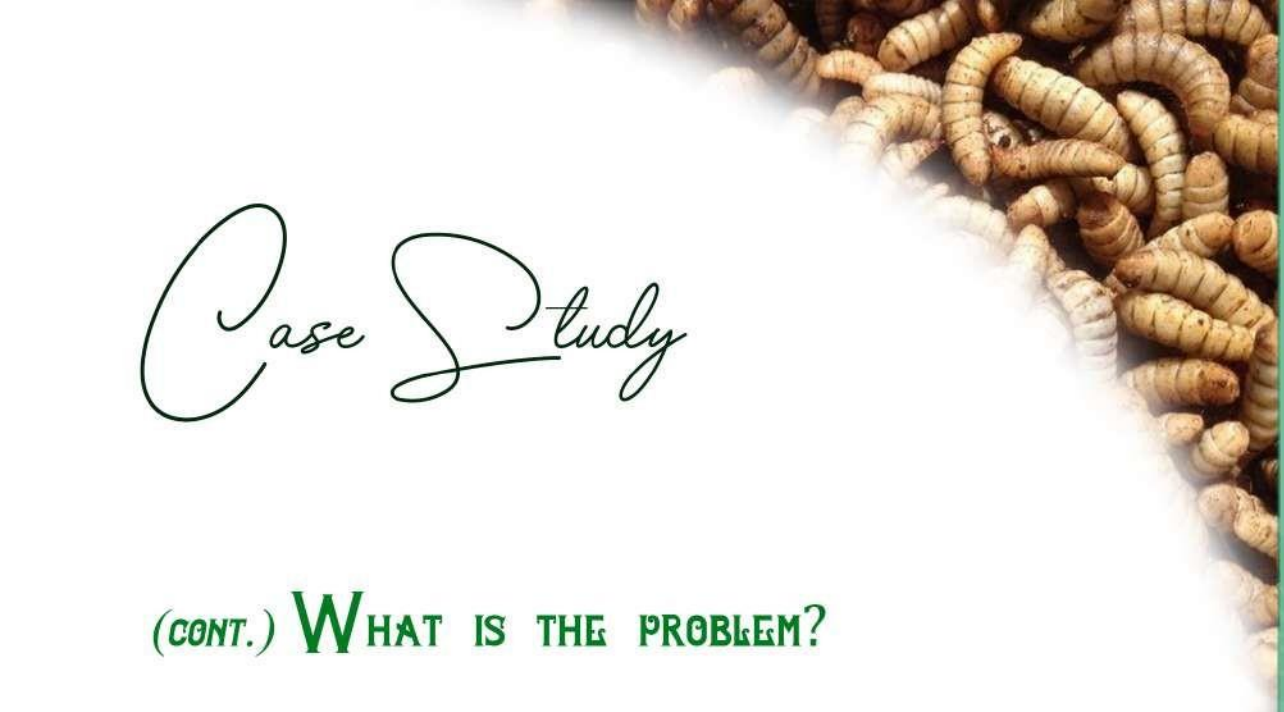
Background

Dr. Ichsan Ichsan
Renewable Energy Expert, Circular Economy Practitioner, and Business Advisor for ***BIOMAGG*** *Sinergi International*

BIOMAGG *Sinergi International* is a Joint Venture between PT Awina Sinergi International (A-Wing Group, a Japanese group of companies) and PT Biomagg Indonesia. It has more than 7 years of experience with BSF's maggots. This company is a start-up company under BPPT. Several waste banks have been trained by **BIOMAGG**. Currently, **BIOMAGG utilizes 2 ton organic wastes/day for feed, food, and fertilizer in Depok, West Java, Indonesia.**

What is the problem?

Solid waste management and especially **organic waste management** is an enormous issue in Indonesia. Organic and kitchen waste may cause odour and sickness if we let it rotten for a long period of time. With the management of organic waste in Indonesia several complexities are involved:



Case Study

(cont.) What is the problem?

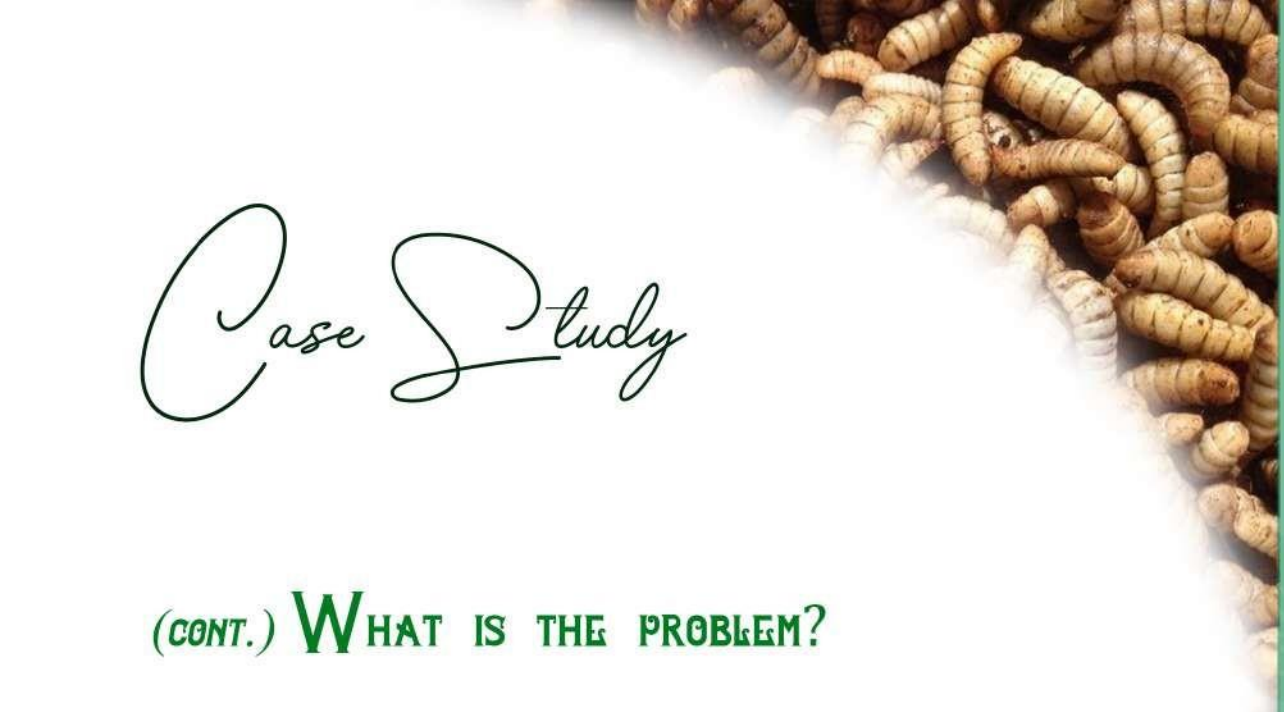
Unprocessed Organic Wastes

In most urban and rural places in Indonesia, the organic waste has not been processed. The organic waste is not only coming from waste dumping sites in residence areas but also from other locations like, the food industry, slaughterhouses, markets, etc. The unprocessed organic waste may cause severe and chronic illness and odour problems. Therefore, the waste has to be processed immediately.

Indonesia is the world's second largest food waster. It is estimated that 300 kilograms of food per person each year is wasted. It happens during wedding parties, daily meals (lunch and dinner), as well as during other occasions. In the bigger cities, more than half of the total Municipal Solid Waste (MSW) is kitchen waste. In a country with a malnutrition level of 7.6% in 2016, it is odd to see so much quality food is going to waste. It will need a change in mindset and more awareness to change the bad food habits.

High Cost in Transportation

The transportation cost for waste in Indonesia is relatively high. For example, transportation cost for Municipal Solid Waste (MSW) in Jakarta is about **USD 62.500/day**. This cost is only to transport the waste to a dumping site. Not all of the MSW can be transported to the dumping sites in Jakarta, because of insufficient budget, difficult access to the waste and insufficient manpower.



Case Study

(cont.) What is the problem?

Centralized Waste Management

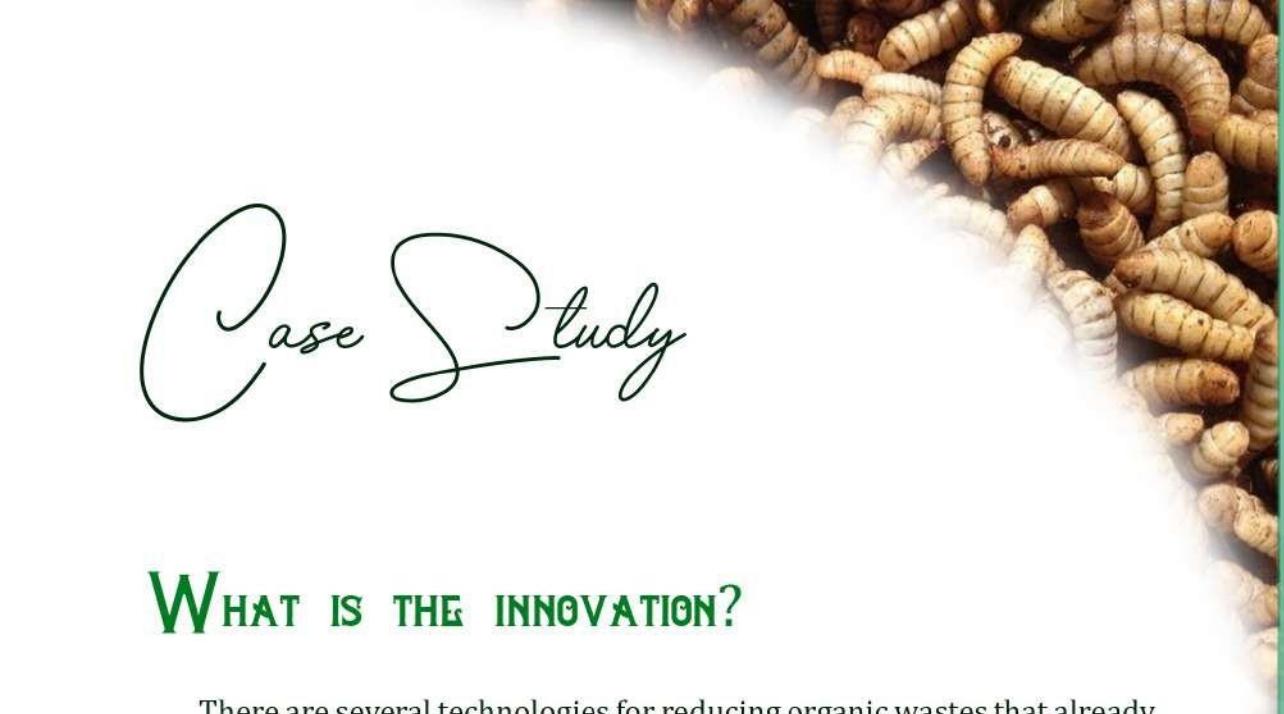
Indonesia has a centralized waste management system. This means that MSW from several "Kecamatan" (a Sub-district Area) is transported to a dumping site. This requires a large dumping area for each city. It is actually recommended that each "Kecamatan" can utilize their own waste. Not only will it reduce the waste processing area, it is also cheaper.

Unprepared Local Regulation

Currently, there are several national regulations related to MSW processing. However, these national regulations, only cover electricity generation. On the other hand, they have not been supported by the revised local regulations yet. This situation will definitely delay the execution of all the bidding processes.

Table 3: *Municipal Solid Waste Quantity for Jakarta and Surrounded Areas*

District	People	Total Wastes [ton/day]	Organic Wastes [ton/day]
DKI Jakarta	13.9 millions	6,700	**2,680**
Depok	2.1 millions	1,200	**480**
Kab. Bogor	5.7 millions	450	**180**
Kota Bogor	1.0 millions	600	**240**



Case Study

What is the innovation?

There are several technologies for reducing organic wastes that already implemented worldwide, from landfill till biogas fermenters. There is still, however, an opportunity to introduce other new technologies that can be integrated with the existing technologies. One of the latest technologies is the use of insects in reducing organic wastes. But it needs to be said, that not all organic waste can be processed by insect technologies.

Black Soldier Fly or BSF (*Hermetia Illucens* sp.) is one of the amazing species that get its momentum in Indonesia, due to their specific character as healthy friendly decomposer. BSF has a unique circle of life → from flies as insect, eggs, larvae, pupa then back to be flies again. They live around 38-45 days only, and in their larvae phase (starts when they are 14-18 days old) they can eat almost any biomass for more than 14 days. BSF is not a toxic or decease agent but a natural decease destroyer with their probiotic content.

Although the BSF is fast growing and has a short cycle of life, it is a very efficient and good converter of organic waste to protein. Due to these good characteristics, the BSF business can be a business on its own or an extra business in an organic integrated farm. By introducing BSF, it can also provide with additional benefits to human beings from the insects itself as an alternative protein source as well as for other non-protein sources (e.g. derivative proteins, minerals, oil, and vitamins).

Case Study

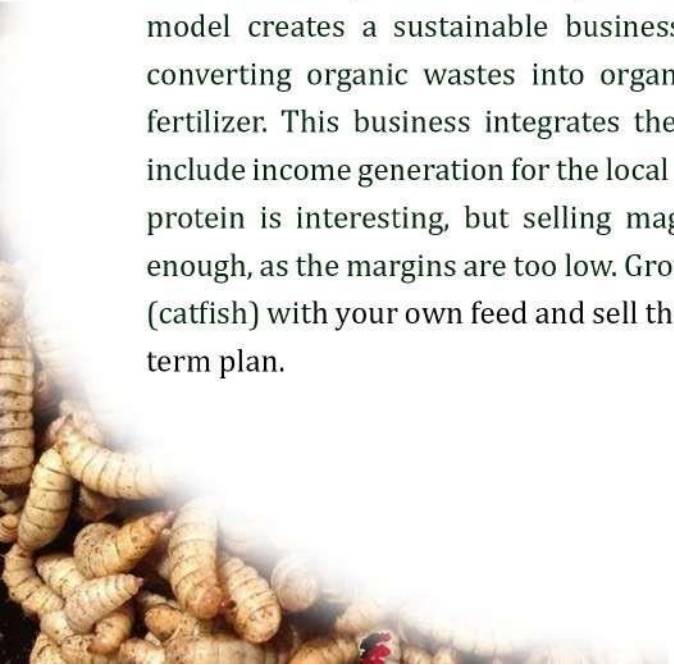
Challenges

Not all organic waste is attractive for the BSF's maggots. These maggots normally eat specific organic waste with high humidity and non-toxic levels. The waste often derives from restaurants, hotels, hospitals, food-processing centres, markets, slaughterhouses, households, and agro-industry. BSF's maggots could consume a variety of sources, from fleshes, fruits, flowers, blood, and many more.

The transport is a challenge, to bring the organic waste to the BSF facility. Nowadays, there is a run on organic waste, so several people around local markets also see a business in it. Normally, the waste was given away for free, but more often a payment needs to be done to obtain the waste.

Business Model

BIOMAGG is using BSF's maggots with a comprehensive business model and has proved to be very effective in reducing organic wastes. This model creates a sustainable business with a circular economy model converting organic wastes into organic feed, organic food and organic fertilizer. This business integrates the organic waste solutions, but also include income generation for the local community. The concept of waste to protein is interesting, but selling maggots only as livestock feed is not enough, as the margins are too low. Growing your own chickens or Lele fish (catfish) with your own feed and sell the livestock is a more viable and long term plan.



Case Study

(cont.) Business Model

The BSF's maggots will convert the organic wastes biologically for their own protein sources. After couple days, these maggots can be harvested and dried as new protein sources in raw forms for animals (cattle, chicken, duck, unagi, etc.) as well as for human beings. These maggots could also be extracted for their derivative proteins, minerals, oil, vitamins, etc. The remaining wastes from the bioconversion process may be used as fertilizer for plants.

FIG 12: *Business Model of BIOMAGG Process*

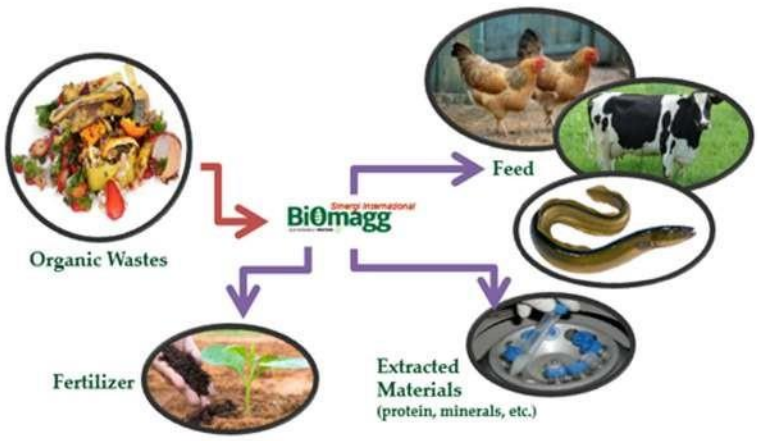


FIG 13: *Business Schematic Model of BIOMAGG'S Products*

Case Study

Background

Fano Alfian Ardyansyah
Universitas Gadjah Mada (UGM) Industrial Engineering Graduate
Founder of Ailesh Power

Derived from a research team named Green Energy UGM in 2018, tackling issues around energy and environment, Ailesh Power continued as a start-up with the same team. The meaning of the name is: powering the world by creating innovation. We have 3 focuses:

1. Providing waste-to-energy solutions
2. Providing affordable clean energy
3. Improving waste management

Over time, Ailesh Power is not only creating a value to businesses, but it also established a research hub which proposes innovative solutions to tackle waste problems. In the few years of existence, we have designed, planned, and assessed waste-to-energy projects from upstream to downstream. In these years, Ailesh Power have been able to grow as start-up and assisted several business and plantations in their waste management, carbon emission control, and the utilization of by-products. The end-products from industrial waste management we have created are solid fuel (bio-pellet and briquette) and biogas. One of the industries we manage upon today is the palm oil industry.

Case Study

What is the problem?

Indonesia is the largest producer of palm oil worldwide and the second largest exporter. Together with Malaysia, they account for 85 to 90 percent of the global palm oil production. Global palm oil demand shows an increasing trend, as an expanding global population gives rise to increased consumption of products derived from palm oil like food and cosmetic products. In 2016, the palm oil production of Indonesia was estimated to be 36 Million metric tons.

Palm oil is key for the Indonesian economy and for millions of households depending on this commodity. According to the Indonesia Palm Oil Association (GAPKI), Indonesia is targeting a production of at least 40 million tons of CPO per year from 2020. In addition, palm oil is the most important industry of Indonesia proven with its contribution of 1.5-2.5 percent of the nation's gross domestic product (GDP). However, over the last decade, number of debates have taken place about the down sides of palm oil production. One elementary issue involves the linkage of palm oil industry with environmental issues. Within those discussions, **solid and liquid waste from the palm oil also plays a role**. The waste can be categorized as lignocellulosic biomass including oil palm trunks, oil palm fronds, empty fruit bunch, palm pressed fibre, palm shells, and palm oil mill effluent.

Case Study

(cont.) What is the problem?

Palm oil mills, which are producing Crude palm oil (CPO) and palm kernel oil (PKO), are also producing waste, like empty fruit bunches (EFB) (which derives during the processing of fresh fruit bunches (FFB). With the mentioned production number in 2016, it means millions of metric tons of EFB is being produced. The presence of this oil palm waste has created a major disposal problem. At this moment, there is a lack of a good strategy and plans to handle the waste. It is often just thrown back in the plantation field as "fertilizer". EFB may cause environmental pollution problems and spread diseases in the environment. They also serve as breeding ground for pests and diseases. However, there are alternatives of what can be done with EFB, especially knowing that the average energy content of EFT is around 10,118 MHJ/ton biodiesel. It means that EFB has the potential to be an alternative solution as supplementary fuel.

What is the innovation?

Currently, the palm oil waste utilized in our production process are empty fruit bunch, palm shell, and palm oil mill effluent (POME). We have developed a solid fuel solution named Brikos, made from mixture of empty fruit bunches and palm shell enforced by POME as binder. **The solid fuel has a pellet and briquette shape and is 3 cm in size. Brikos has a high caloric value of 4,900 kcal/kg and low moisture content and ash content of 3% and 1%, respectively with no pyrolysis process and more environmental-friendly than biochar. Brikos can also be used as supplementary fuel, mixed with coal and other fuel.**

Case Study

(CONT.) WHAT IS THE INNOVATION?

Brikos adopts the concept of circular economy by utilizing industrial palm waste into solid fuel. In the production process of palm oil, crude palm oil and by-products, like solid waste and liquid waste, are the end results. During the process, the energy is sourced from a fossil fuel-fired boiler. Brikos believes, it can create more positive and circular environmental effect by utilizing the waste as alternative fuel source. Empty fruit bunches, palm shell, and POME will be used as supplementary fuel in the palm oil industrial process, and therefore creating a circular approach that minimizes the waste.

It can also reduce maintenance cost from the use of coal by mixing brikos in the coal-fired boiler. These costs can be reduced, because the use of Brikos does not impact to the cracking or other damages in the firing boiler due to low content of ash, chlorine, and potassium. In addition, the CO_2 that is released when Brikos is burned is considered to be carbon neutral; that is, this fuel does not add to or reduce the amount of carbon in the atmosphere. Palm oil trees take CO_2 out of the atmosphere; when the tree dies and is used as fuel, the same amount of CO_2 is released back into the atmosphere. Fossilized fuels, on the other hand, store CO_2 for very long periods of time, so when natural gas or fuel oil is burned, CO_2 that has been out of circulation for thousands of years is released, which is perceived as a net increase in the atmospheric CO_2 concentration.

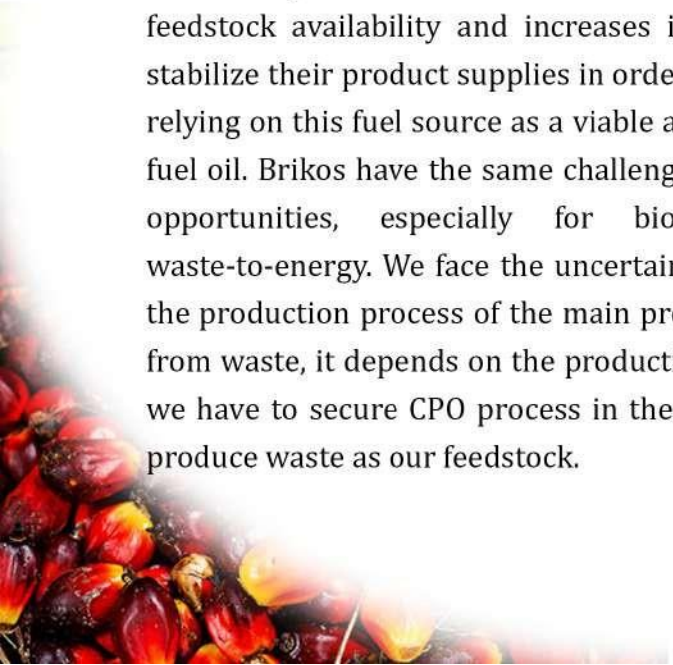
Case Study

Challenges

The first challenge comes from fossil fuel utilization in natural gas. Industrial and institutional facilities from areas that are not served with natural gas pipelines could use liquefied natural gas that is brought in by trucks instead of using Brikos to meet their demand for thermal energy. But, if we compare the net heat rate and price in kWh equivalent between Brikos and liquefied natural gas, the price estimation for LNG and Brikos are respectively IDR 885/kWh and IDR 694/kWh. It means that Brikos is cheaper than liquefied natural gas.

Secondly, by reducing the need for energy, technologies such as variable refrigerant flow heat pumps become an alternative fuel source – and a significant competitive risk for the Brikos market. The heat produced from Brikos is significantly less expensive than heat produced by electric baseboard heaters, fuel oil and propane, but more expensive than heat produced using heat pumps and firewood.

Solid fuel like Brikos has manufacturers that secure their supply of feedstock years in advance to avoid price fluctuations due to dips in feedstock availability and increases in use. So, manufacturers have to stabilize their product supplies in order for consumers to feel confident in relying on this fuel source as a viable alternative to electricity, propane or fuel oil. Brikos have the same challenge as many other renewable energy opportunities, especially for bio-based renewable energy or waste-to-energy. We face the uncertain supply of feedstock in relation to the production process of the main product, or if the feedstock is coming from waste, it depends on the production process that produce waste. So, we have to secure CPO process in the palm oil mill in order for them to produce waste as our feedstock.



Case Study

Business Model

Our business model is classified as contract system. We engage a joint business cooperation with palm oil companies to establish a new entity as Special Purpose Vehicle (SPV). In this arragement, the SPV will be a Brikos mill that runs a production process and manage the overall key activities. In the next model, we also make a joint research and development for Brikos gasification and syngas utilization. Our activities also include to utilize all the palm oil waste, from the root to tree, into **bioenergy and biomaterial** such as bioplastic and fertilizer. In addition, we cover the waste management services in the palm oil mill for the Palm Oil Mill Effluent (POME) to be utilized into biogas (biomethane and biohydrogen). In this area, we are still doing research and development to produce biogas in an effective and more efficient way.

FIG 14: *Final Product*

FIG 15: *Mixing Process*

May 2020, AGRODITE