

壹壹零年度氣候變遷創意實作競賽

## 決賽作品說明書

No.18 妙點子

WastePack 升值廢物包裝

# Waste Pack

參賽學校 國立中興大學

指導教授 程華強

團隊成員 林虹余 周麗慧

# Contents

1. Abstract	P.2
2. Problem Definition and Goals	P.3
3. Product Description	
I. Ingredients	P.5
II. Operating Instructions	P.6
4. Properties	
I. Basic Properties	P.8
II. Additional Features	P.10
5. Application	
I. Packaging	P.13
II. Other Applications	P.13
6. Cost Analysis	P.15
7. SWOT Analysis	P.16
8. Business Model	P.22
9. Work Division	P.22
10. Appendix	
I. Ratio Test	P.23
II. Degradability Test	P.24
III. Antimicrobial Test	P.25
IV. Biocompatibility Test	P.26

## **Abstract**

WastePack 是一款專為長途運輸新鮮水果設計的包材。稻草作為 WastePack 主要成分，對於減碳排放、減塑皆有幫助，更能改善農夫的經濟狀況。WastePack 有四項特性：防潮(PLA 成分)、抗菌(甲殼素成分)、生物材料製成和可生物分解。WastePack 能在滿足人類需求的同時做到友善地球。

WastePack is a biobased fruits wrapping paper specially designed for the long-term distribution of fruits. By using rice straw, WastePack not only reduces emissions and plastic usage, but also takes farmers out of poverty. WastePack is moisture-repellent because of PLA and antibacterial because of chitosan, which is extracted from seafood waste. WastePack fits human needs without harming the earth.

## Problem Definition and Goals

There's no denying that fruit is essential to our lives. Research shows that more than 8.5 percent of produce arriving at distribution centers, and nearly 12 percent of fruits and vegetables arriving at stores in disposable packaging were damaged<sup>1</sup>. Not only is it economically inefficient, but it is also a waste of food.

Freezers are often used in long-distance transportation for fruit. The low temperature in the freezer causes condensation, creating moisture and water droplets on surfaces. Low temperature and moist air create a friendly environment for bacteria to grow. It gets worse when freezers aren't cleaned often. Bacteria like *Escherichia coli* can cultivate on the interior of the freezer or the goods stored in them.

When it comes to fruit packaging, the common and popular choices are plastic and paper. Plastic production growth is expected to continue due to the versatile use of plastic, the growing world population, and the overall rise in consumption<sup>2</sup>. Studies show that Taiwanese farmers use 171.5 tons of plastic wrapping per year<sup>3</sup>. While plastic is moist repellent and cheap, it is undegradable and costlier in the long run. Plastic and climate change are linked in a variety of ways. From air quality to ocean toxicity, plastic causes ecosystem disruption<sup>4</sup>.

As for paper, although it seems like it is a better choice, it costs more energy to manufacture and is not durable. Forests need to be cut down to produce paper, and the carbon footprint of transporting paper is higher because of its

---

<sup>1</sup> Aguirre, L. (2020, December 15). *Stopping Food Waste and Food Loss | IFCO*. IFCO Systems. <https://www.ifco.com/stopping-food-waste-and-food-loss/>

<sup>2</sup> Rhein, S., & Schmid, M. (2020, July 25). *Consumers' awareness of plastic packaging: More than just environmental concerns*. Resources, Conservation and Recycling. [https://www.sciencedirect.com/science/article/pii/S0921344920303803?casa\\_token=HfWnUYBrxLYAAAAA%3AK\\_q4qA7DQG\\_R1yMMapSTs2OONwqG\\_LsYcWy8BmKIrY6WycSrLweO7C1Cl5eqjGrSeltLNNhtzwvU#bib0001](https://www.sciencedirect.com/science/article/pii/S0921344920303803?casa_token=HfWnUYBrxLYAAAAA%3AK_q4qA7DQG_R1yMMapSTs2OONwqG_LsYcWy8BmKIrY6WycSrLweO7C1Cl5eqjGrSeltLNNhtzwvU#bib0001).

<sup>3</sup> 楊紹榮, & 黃瑞彰. (2002). *生物分解塑膠袋在番石榴果實套袋之研究*. [https://kmweb.coa.gov.tw/files/document/18877/fc4bf6155cca9699377372060660ea97\\_v2.pdf](https://kmweb.coa.gov.tw/files/document/18877/fc4bf6155cca9699377372060660ea97_v2.pdf).

<sup>4</sup> 1 Bag at a Time. (2017, March 30). *Plastic Bags & Climate Change*. <https://1bagatatime.com/learn/plastic-bags-climate-change/>

weight.

Rice is the staple food in Asian countries like Taiwan. In Taiwan, rice is planted on 270,066 hectares of farmland — almost 7.5 percent of the country’s land<sup>5</sup>. Taiwanese farmers burn rice straw, contributing to 5% of emissions<sup>6</sup>. But rice straw contains 38% of cellulose<sup>7</sup>, high enough to make paper out of it<sup>8</sup>.

With the rise of environmental consciousness, the attitude toward packaging materials has changed. Farmers are aware of the waste packaging in the production process cause. Studies show that people are willing to pay more money for eco-friendly packaging<sup>9</sup>. It causes a dilemma for customers when the existing packaging materials can’t catch up with the trend of eco-friendliness.

Seeing all of these, we want to solve the problems. Our product, WastePack, uses rice straw as the main ingredient. To give WastePack a better edge, we added other ingredients to guarantee moisture repellent and antibacterial effects. WastePack predicted to decrease 35 tons of plastic wrapping used by farmers. To sum up, the production process of our everyday food causes many environmental problems, we want to reduce these negative effects, realizing the idea of “circular agriculture”.

- 
- <sup>5</sup> 台北時報. (2021, January 7). *Highways & Byways: Chihshang, Taitung’s rice town*. Taipei Times. <https://www.taipetimes.com/News/feat/archives/2021/01/08/2003750156#:~:text=Despite%20urban%20sprawl%20and%20industrialization,slightly%20less%20than%20in%201903>
- <sup>6</sup> 吳作樂. (2020, January 7). 〈時評〉台灣空汙原兇恐非火電 台中市長請看客觀數據. 台灣英文新聞. <https://www.taiwannews.com.tw/ch/news/3851779>
- <sup>7</sup> Hung, N. (2020). *Rice Straw Overview: Availability, Properties, and Management Practice*. SpringerLink. [https://link.springer.com/chapter/10.1007/978-3-030-32373-8\\_1?error=cookies\\_not\\_supported&code=f710fa07-e044-40c6-aabf-b2d0598c3651#:~:text=Rice%20straw%20is%20considered%20a,2013](https://link.springer.com/chapter/10.1007/978-3-030-32373-8_1?error=cookies_not_supported&code=f710fa07-e044-40c6-aabf-b2d0598c3651#:~:text=Rice%20straw%20is%20considered%20a,2013)
- <sup>8</sup> Suseno, N., Adiarto, T., Sifra, M., & Elvira, V. (2019). Utilization of rice straw and used paper for the recycle papermaking. *IOP Conference Series: Materials Science and Engineering*, 703, 012044. <https://doi.org/10.1088/1757-899x/703/1/012044>
- <sup>9</sup> Pro Carton. (2018). *European consumer packaging perceptions study*. <https://www.procarton.com/wp-content/uploads/2018/10/European-Consumer-Packaging-Perceptions-study-October-2018.pdf>

# Product Description

## I. Ingredients

Paper is biobased and biodegradable, it is not moisture repellent. Plastic is moisture repellent, but it's not biobased and biodegradable. Luckily, we found a combination that can keep the advantages of conventional material, while making up the disadvantages of conventional materials. WastePack is composed of three ingredients, rice straw, PLA, and chitosan.

### Rice straw



Figure 1

In the making process, we use semi-purified cellulose extracted from rice straw as the base of the product. Cellulose gives WastePack a paper-like structure and appearance. Unlike trees, which need their own plantation, rice straw is the byproduct of growing rice. WastePack doesn't need a special place to grow rice straw, instead, we collect rice straw from rice fields.

### PLA

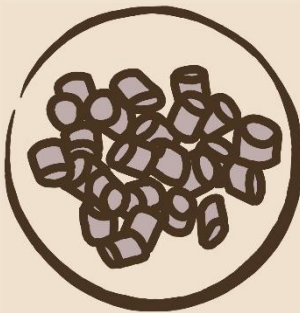


Figure 2

PLA, or Polylactic Acid, is a thermoplastic polyester produced from renewable and natural raw materials. PLA has the properties of plastic, such as water-resistance, easy to shape, recyclable, while being able to degrade easily, unlike common plastic.

### Chitosan



Figure 3

Chitosan is well-known for its anti-bacterial effects. By killing bacteria near it, WastePack can set up a protection layer for the fruit inside. The chitosan we are using can be extracted from shells of seafood, such as shrimps, crabs, oysters. High purity of chitosan is needed in the medical field, while WastePack can act well with less pure chitosan.

## Process of making the product

The simplified process of making the paper is illustrated down below:

1. Adding PLA into the solution.
2. Adding cellulose powder into the solution.
3. Mixing them together.
4. Pouring the mixture into a frame.
5. Adding chitosan into the mixture, coagulating in ethanol.
6. After drying it, the product is like a layer of film.
7. We can adjust the thickness of the final product according to the properties we need by adding layers.

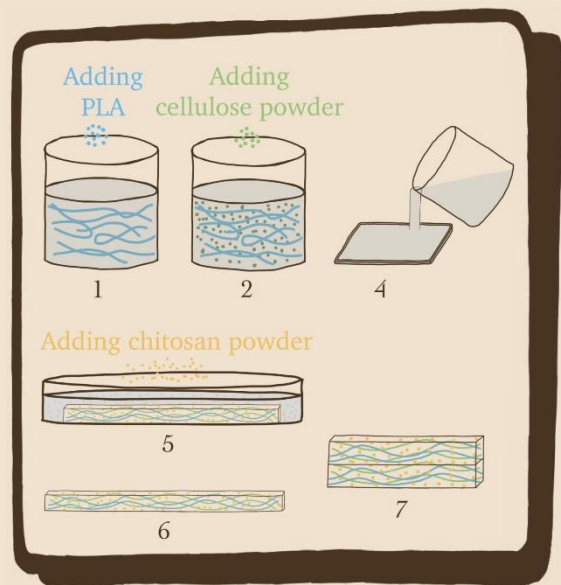


Figure 4

## II. Operating Instructions

To replace the traditional packaging material, our product can be in three different forms, suitable for different needs for packaging. But all are made of the same material. They are: wrapping paper, shredded paper, fruit sleeves



Figure 5



Figure 6



Figure 7



To replace the conventional foam fruit sleeves, we use a special cutting pattern to make a sheet of paper three-dimensional. This design has already been used in the packaging industry. However, since the edge of the paper is sharp and may scrape on the surface of the fruit, a thin layer of wrapping paper is needed to protect the fruit.



Figure 8



Figure 9



# Properties

## I. Basic Properties

Of all the properties we want in a fruit packaging, the most important one is being able to protect the fruit itself. Targeting in the packaging for long distance fruit transport. WastePack is an ideal choice in many ways.

	Paper	Plastic	WastePack
Moist repellent	X	O	O
Antibacterial	X	X	O
Biobased	O	X	O
Biodegradable	O	X	O

Table 1

### WastePack is moisture-repellent



Figure 10

Moist repellent means not allowing moisture to penetrate. By adding PLA, WastePack has moisture-repellent properties. As a result, the packaging creates an isolated environment for the fruit, blocking out the moisture, water droplet, and bacteria.

### WastePack is antibacterial

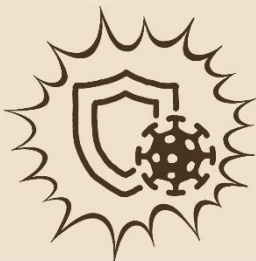


Figure 11

Bacteria is one of the reasons fruits go bad in the transportation process, especially in a freezer. Therefore, it is crucial that a fruit wrapping product has antibacterial effects. However, the materials that are used for packaging don't have this property, which sets WastePack apart. WastePack's antibacterial property comes from chitosan, which is extracted from seafood waste. From the experiment we did, we can tell WastePack has antibacterial properties, the data of the experiment is in Appendix A.

## WastePack is biobased



Figure 12

“Biobased” means that a product is made from renewable materials (like plants, trees, and other organic material)<sup>10</sup>. All the ingredients of WastePack (rice straw, PLA, seafood waste) fits this requirement, making it a biobased product. There are two advantages of using a biobased product. The first is being safer, since it is less likely to be toxic and harmful to human

health. WastePack is tested non-toxic, the data of the experiment is in Appendix A. The second is that biobased materials are often biodegradable, which is our case.

## WastePack is biodegradable



Figure 13

Unlike traditional materials for packaging material, paper and plastic, which take a long time to degrade. WastePack can degrade within months if buried in the soil with suitable environment conditions. Since packages for fruit transportation are usually disposable, it is crucial that we use a material that can degrade after being disposed of to avoid

pollution, to reduce the waste and to achieve sustainability.

## WastePack is nontoxic

Nontoxic means not poisonous or not containing toxic substances. Even Though the manufacturing process of WastePack contains some chemicals, WastePack is a nontoxic product. This is proved by testing with human mesenchymal stem cells. We put the cells on WastePack, and the cell cultivated, which means WastePack is a nontoxic product. The data of the experiment is in Appendix A.

---

<sup>10</sup> Maine, B. (2018, February 1). *What is Biobased and Why is it Important?* Biobased Maine. <https://biobasedmaine.org/2015/01/jan-23-what-is-biobased-and-why-is-it-important/>

## II. Additional Features

### A. Changing the society

It is important to check today's trends before starting a business. Nowadays, Millennials make up around 30% of the world's population and are arguably the most concerned generation when it comes to environmental sustainability and social issues. Millennials are the first generation to have grown up in a world where "climate change is part of the daily international dialogue". This reality has created a generation of people who desire sustainability in mainstream culture. A generation where many feels as though they have no choice but to be actively engaged to drive change. A recent study showed that 87% of millennials "believe that companies should address urgent social and environmental issues."<sup>11</sup> Now is the time for millennials to pass the relay baton to gen Z.

One of the top issues Gen Z cares most about is climate change and sustainability. This has already made a visible impact on the way Generation Z spends their money, where they choose to live, and who they choose as their employer. Generation Z is about to become the largest consumer base in the U.S. and global economy. The passion Gen Z has surrounding a multitude of social and environmental issues has carried over heavily to how they make purchasing decisions<sup>12</sup>.

Packaging is one of the ways companies introduce their product. It is the consumer's first impression. According to research by Trivium Packaging, nearly three-fourths (74%) of consumers are willing to pay more for sustainable

---

<sup>11</sup> SUMAS Editorial Team. (2019, January 22). *Millennials and their impact on sustainability*. S U M A S. <https://sumas.ch/millennials-and-sustainability/>

<sup>12</sup> Furbee, C. (2021, February 8). *Gen Z Makes Sustainability Important for All Businesses*. Sustainable Investment Group. <https://sigearth.com/gen-z-makes-sustainability-important-for-all-businesses/#:%7E:text=One%20of%20the%20top%20issues,they%20choose%20as%20their%20employer>

packaging<sup>13</sup>.

WastePack is a 100% biobased and biodegradable product made of waste and renewable materials. Due to today's trend, we are sure this project will be loved by people and have a good future and more, the earth needs this product to be real as soon as possible.

## **B. Following SDGs**

The UN Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including poverty, inequality, climate change, environmental degradation, peace and justice. Here are the goals WastePack achieve:

- 1.) By paying the farmers for their waste helping for quality life of farmers
- 2.) Burning rice straw is decreasing soil quality. By using rice straw, WastePack could help to increase soil quality in result farmers could have better crops.
- 4.) Educating farmers about the environment and also how to get a better crop. By doing so, we will get a better quality of main raw material.
- 9.) Target 9.2; Promote inclusive and sustainable industrialization. WastePack is going to have a future since it is a sustainable business plan.
- 12.) WastePack is made of agricultural waste, by using seafood waste it is reducing food waste, it is also promoting sustainable lifestyle. WastePack fits all SDGs 12's targets.
- 13.) Reduction of air pollution
- 15.) Sustainable management of rice field

---

<sup>13</sup> Moore, D. (2020, September 17). *74% of consumers willing to pay more for sustainable packaging*. Circular Online. <https://www.circularonline.co.uk/news/three-fourths-of-consumers-willing-to-pay-more-for-sustainable-packaging/>



Figure 13

# Application

## I. Packaging

WastePack is specially designed to keep the fruits fresh and stay longer during the distribution. Since it is a paper, WastePack can be made into different forms:

### A. Wrapping paper

Wrapping paper is the basic and main product of WastePack. This paper will directly contact the fruits.

### B. Shredded paper

Shredded paper is a packaging filler to keep the fruits in place during distribution. It also makes the packaging more aesthetic.

### C. Fruit sleeves

Fruit sleeves are essential products to add to fruit packaging. In distribution, it is protecting fruits from damage to extend the preservation time.

## II. Other Applications

### A. Food Package

A paper form makes WastePack so beneficial. The properties that it has make WastePack be able to fit many human needs. A 2020 study from Shorr Packaging found that two-thirds of shoppers who have made changes in their purchasing behaviors during the pandemic are paying more attention to packaging. Fifty-eight percent of survey respondents reported being "likely" or "very likely" to select products that use recyclable or reusable packaging<sup>14</sup>. During the pandemic, most of the restaurants are using one single used food plate or packaging to be more hygiene and prevent the spread of the virus. WastePack properties which are antibacterial, moist repellent, and

---

<sup>14</sup> Manning, L. (2021, April 27). *Consumer demand for sustainable packaging holds despite pandemic*. Food Dive. <https://www.fooddive.com/news/consumer-demand-for-sustainable-packaging-holds-despite-pandemic/599013/>

biodegradable surely fit the need. It is also nontoxic. To be a food packaging, the formula of WastePack should be changed to fit the needs, but it is not impossible to be done in the future. Making WastePack into food packaging is also a good business especially during the pandemic.

## B. Online Shipping Packaging

45% of Taiwanese get used to shopping online. It means every day, every minute, people are online shopping. To be more sustainable, the Taiwanese government has already established a regulation about this. It points out that before the end of 2020, the material of the shipping package has to be 100% recycled paper or 25% of regeneration plastic particles<sup>15</sup>. Also, another standard set up by the environmental protection agency, it said that before 2022, Taiwan has to use at least 10% of reusable packages in online shipping<sup>16</sup>. WastePack surely could be formed into shipping packaging. By adding more rice straw, the paper will be thicker, and by using the right form of packaging, WastePack could be a strong enough shipping packaging. To get the best formula for making shipping packaging, WastePack needs further research, this is surely not impossible to be done in the future.

---

<sup>15</sup> 農糧署. (2018, June 14). 鼓勵農民稻草處理再利用 台農發公司建立新外銷供應鏈 齊為臺灣農業環境努力 (農委會). 行政院農業委員會.

[https://www.coa.gov.tw/theme\\_data.php?theme=news&sub\\_theme=agri&id=7355](https://www.coa.gov.tw/theme_data.php?theme=news&sub_theme=agri&id=7355)

<sup>16</sup> 農糧署. (2018, June 14). 鼓勵農民稻草處理再利用 台農發公司建立新外銷供應鏈 齊為臺灣農業環境努力 (農委會). 行政院農業委員會.

[https://www.coa.gov.tw/theme\\_data.php?theme=news&sub\\_theme=agri&id=7355](https://www.coa.gov.tw/theme_data.php?theme=news&sub_theme=agri&id=7355)



## Cost Analysis

### -Material cost:

Rice straw \$70 NTD/10 kg<sup>17</sup>

PLA \$30 NTD/10 kg<sup>18</sup>

Chitosan \$255 NTD/10 kg<sup>19</sup>

-Total cost: \$355 NTD/10kg

-Estimated cost for market: \$532.5 NTD/10kg

-Average cost of plastic in today's market: \$500 NTD/10kg<sup>20</sup>

Although plastic wrapping is cheap, the environmental cost is huge, that's why it's not sustainable<sup>21</sup>. Plastic bags are also cheap due to the well-developed plastic industries. WastePack's cost is almost the same as the average plastic wrapping nowadays because WastePack is made of waste. The main ingredient, which is rice straw, is extremely cheap<sup>22</sup>.

---

<sup>17</sup> 農傳媒. (2017, July 28). 這個鄉鎮不燒稻草，每年還用稻草種出最貴的蔥. 農傳媒.  
<https://www.agriharvest.tw/archives/23511>

<sup>18</sup> 可降解塑料 PLA 美國 NatureWorks 3001D 一次性餐具 高生物可降解料廠家/批發價格. (n.d.). 中國製造網移動站. Retrieved May 13, 2021, from <https://3g.made-in-china.com/gongying/shygs123-eqvnABwZrtli.html>

<sup>19</sup> 工農用幾丁聚醣甲殼素一級細粉 1kg - 誠麗實業. (n.d.). 誠麗實業. Retrieved May 13, 2021, from <https://cabco.com.tw/product/%E5%B7%A5%E8%BE%B2%E7%94%A8%E5%B9%BE%E4%B8%81%E8%81%9A%E9%86%A3%E7%94%B2%E6%AE%BC%E7%B4%A0%E4%B8%80%E7%B4%9A%E7%B4%B0%E7%B2%891kg/>

<sup>20</sup> <https://tw.bid.yahoo.com/item/%E8%8A%AD%E6%A8%82%E5%A5%97%E8%A2%8B-1000%E5%80%8B%E8%A3%9D-%E4%BF%9D%E9%BA%97%E9%BE%8D%E5%A5%97%E8%A2%8B-%E8%8A%AD%E6%A8%82%E5%A1%91%E8%86%A0%E8%A2%8B-%E5%85%8D%E9%81%8B%E8%B2%BB-100116989794>

<sup>21</sup> 1 Bag at a Time. (2017, March 30). *Plastic Bags & Climate Change*.  
<https://1bagatatime.com/learn/plastic-bags-climate-change/>

<sup>22</sup> The cost of rice straw is included the labor and transportation cost

# SWOT Analysis

## I. Strength

- ✧ Made from high pollutant waste materials, which reduces CO<sub>2</sub> emissions (from burning rice straw).
- ✧ 100% Biodegradable (made completely out of biodegradable materials in contrast to the PE coated papers. Mixing PLA and cellulose makes PLA more biodegradable).
- ✧ Compatible with future and existing regulations (imposing companies to change to sustainable products)
- ✧ Fit the human needs without harming nature (not making chemicals waste, biobased and renewable materials).
- ✧ Moist resistant (the properties of PLA).
- ✧ Antibacterial (helping to transport and storage fruit while in the freezer).

## II. Weakness

- ✧ Higher costs (due to small and not well-developed manufacturing scale).

## III. Opportunities

- ✧ Regulation and policies for packing materials that are already in place.
- ✧ In Taiwan by the end of 2020, shipping packaging materials have to be 100% recycled paper or 25% of PE plastic.
- ✧ Today's generations of customers are progressively more aware of their carbon footprint and actively choose products that have more benefit for the environment and companies that have renewable products.

## IV. Threats

- ✧ Low entry barrier (bigger and better-established competitors can replicate our product if we do not innovate the product fast enough).

- ✧ Customers may be indifferent towards environment-friendly products (those who choose products that are cheaper or higher quality rather than more eco-friendly).
- ✧ Well-developed packaging industry. Competitor's packaging that is not only extremely cheap to make but also highly versatile, due to their size and long journey in the industry.

	<p><b>Weaknesses</b></p>
<p><b>Threats</b></p>	<p>The worst-case scenario is when the farmers refuse to buy due to high cost, or there are existing products that are more appealing than ours. To minimize the chance of this happening, we will focus on a smaller market first (for example, selected farmer's association in Taichung), in which we have better access to rice straw and seafood waste (drive down the raw material cost). To ensure our product has a competitive edge, we will continue to develop our formulation for other food-related wrapping and products. For example, paper chopstick, paper boxes for fruits and meat.</p>
<p><b>Opportunities</b></p>	<p>One of the main reasons that farmers are still relying on plastic and cardboard boxes for long-distance transportation of their fruits is because the manufacturing process for those two environmental-unfriendly products is well established and thus cheap.</p> <p>However, the recent incident of shortage of cardboard boxes for agricultural practice (which drives up the cost for many farmers) and the growing awareness of the need for environmental-friendly food wrapping have demonstrated there is a need for more reliable fruit wrapping products. Given that Taiwan has a lot of rice straw waste, it is believed our product will become a reliable source of packaging for farmers in Taiwan and many other countries. Moreover, the product is biodegradable and thus will not create a burden on the environment while satisfying the economical need.</p>

	Strengths
Threats	<p>To make our products more appealing to farmers, we have included chitosan (extracted from seafood waste) which will provide antibacterial property to the wrapping. This a novel formulation that many existing environmental-friendly food packing products do not have.</p> <p>Furthermore, it will make the farmers choose our product rather than plastic or traditional paper wrapping or cardboard boxes, since bacterial contamination during long distance transportation creates a huge financial burden on the farmers.</p>
Opportunities	<p>There is a growing awareness for environmentally friendly food packaging. Global companies such as Starbuck and Costco have all started to use environmentally friendly food packaging. European Union has also started to encourage their supermarket to cut down the use of plastics and promote the use of environmentally friendly packaging.</p> <p>Thus, we believe the timing is perfect for our product. Our initial focus would be on the farmers in Taichung, then expand to all the farmers in Taiwan. At the same time, we will continue to optimize our formulation for various food packing products while still using rice straw and seafood wastes as the main component. We desire to expand the market into Asia, then eventually Europe and the US.</p>

Table 2

# Business Model

<p><b>8. Key Partners</b></p> <ul style="list-style-type: none"> <li>✧ Farmers to supply rice straws</li> <li>✧ Seafood store</li> <li>✧ Cooperating farmers' association</li> <li>✧ Council of Agriculture</li> </ul>	<p><b>6. Key Activities</b></p> <ul style="list-style-type: none"> <li>✧ Adjusting formula</li> <li>✧ Finding partners</li> <li>✧ Applying patent</li> <li>✧ Internet marketing</li> <li>✧ Gaining exposure</li> </ul>	<p><b>2. Value Propositions</b></p> <ul style="list-style-type: none"> <li>✧ Effective</li> <li>✧ Low cost (in the long run)</li> <li>✧ Moisture-repellent</li> <li>✧ Antibacterial</li> <li>✧ Biobased</li> <li>✧ Biodegradable</li> <li>✧ Fitting eco-friendly regulations</li> </ul>	<p><b>4. Customer Relationships</b></p> <ul style="list-style-type: none"> <li>✧ Making different eco-friendly food packaging products (using our formulation) according to different customers' need</li> </ul>	<p><b>1. Customer Segments</b></p> <ul style="list-style-type: none"> <li>✧ Farmers</li> <li>✧ Associations</li> <li>✧ Farmers</li> <li>✧ Wholesalers</li> </ul>
<p><b>9. Cost Structure</b></p> <ul style="list-style-type: none"> <li>✧ Ingredients</li> <li>✧ Factory</li> <li>✧ Transportation</li> <li>✧ Machine</li> <li>✧ Labor</li> </ul>	<p><b>7. Key Resources</b></p> <ul style="list-style-type: none"> <li>✧ Brand image</li> <li>✧ Product patent</li> <li>✧ Customers' loyalty</li> <li>✧ Funding</li> <li>✧ Contacts</li> </ul>		<p><b>3. Channels</b></p> <ul style="list-style-type: none"> <li>✧ Gain exposure by cooperation</li> <li>✧ Social media / internet marketing</li> <li>✧ Wholesalers</li> </ul>	<p><b>5. Revenue Streams</b></p> <ul style="list-style-type: none"> <li>✧ Selling the product</li> <li>✧ Patent</li> <li>✧ Funding from programs held by Council of Agriculture</li> <li>✧ Joining innovative competitions</li> </ul>

Table 3

## Our Brand Image

When it comes to reducing food waste or solving environmental problems, there are a lot of products or strategies focusing on the consumers' side. But we want to look at the problem from the production side, which led us to the idea of using rice straw as our main ingredient. Our target market is long distance transportation for fruits, so we added PLA to get the moist-repellent property. To take our product to the level, we added chitosan for anti-bacterial effect. All of our ingredients are made from bio-waste, thus the name of the product.

The core value of WastePack is “Waste to gold.” We want to turn the “waste” created in the production of everyday food into a new “valuable” product.

There are four components in our logo, they are:

-Farmer: The whole logo looks like a farmer because we want to help farmers to be a climate hero.

-Green leaf: Indicating that our product is bio-based, biodegradable, and eco-friendly.

-Braid: The braid of the farmer looks like rice straw, which is our main product.

-Hat: The hat looks like a folded paper, which shows our product is a type of packaging.



Our slogan is “Make an imPack.” Although the thing we are doing looks small, we are sure it could make impacts. We believe everyone could be a climate hero and WastePack is the media.



## Work Division

### I. Proposal :

Most of the social issue : Eunike

Most of the scientific issue : Iris

Design and layouts : Iris

### II. Poster :

Design and layouts : Iris

Contents : Eunike

### III. Video:

Producer : Eunike

Editor : Eunike

Subtitle : Iris

### IV. Interview : Iris

### V. Experiment : Iris and Eunike

# Appendix

## A. Ratio Test

We tested different ratios of the three ingredients and saw which worked best.

1. Cellulose-PLA-Chitosan (Ratio 1)
2. Cellulose-PLA-Chitosan (Ratio 2)
3. Cellulose-PLA-Chitosan (Ratio 3)



## B. Degradability Test

We tested different ratios of the three ingredients in Saline Water at 37°C for 7 days and saw which degrades the fastest.

1. Cellulose-PLA-Chitosan (Ratio 1)
2. Cellulose-PLA-Chitosan (Ratio 2)
3. Cellulose-PLA-Chitosan (Ratio 3)



### C. Antimicrobial Test

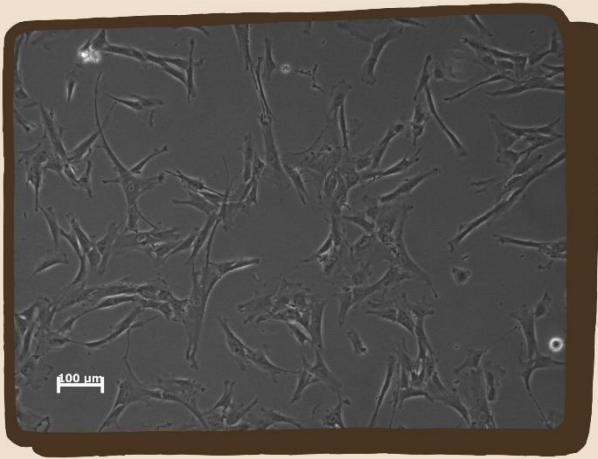
We tested different ratios of the three ingredients, observed the zone of clearing (the green circle), and saw which worked best. The bacteria we used was E. Coli.

1. Positive Control: Antibiotic
2. Negative Control: Saline water
3. Cellulose-PLA
4. Cellulose-PLA-Chitosan (Ratio 4)
5. Cellulose-PLA-Chitosan (Ratio 5)
6. Cellulose-PLA-Chitosan (Ratio 6)
7. Cellulose-PLA-Chitosan (Ratio 7)
8. Cellulose-PLA-Chitosan (Ratio 8)

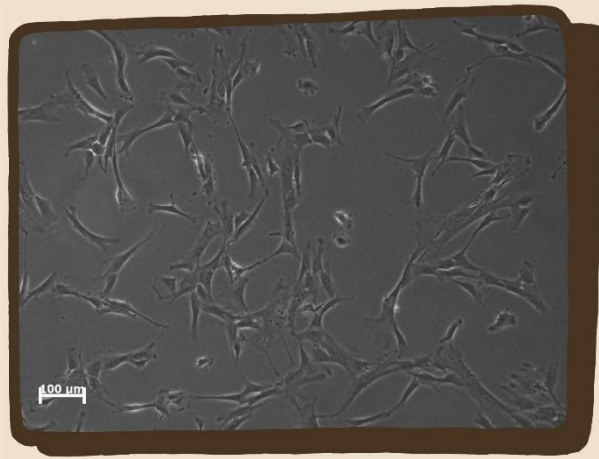


#### D. Biocompatibility Test

We used Human Mesenchymal Stem Cells to test whether WastePack is toxic or not, the cells on the left grows as well the ones on the right, proving that WastePack is biocompatible.



Cell culture plate (Positive Control)



Cellulose-PLA-Chitosan (Sample)