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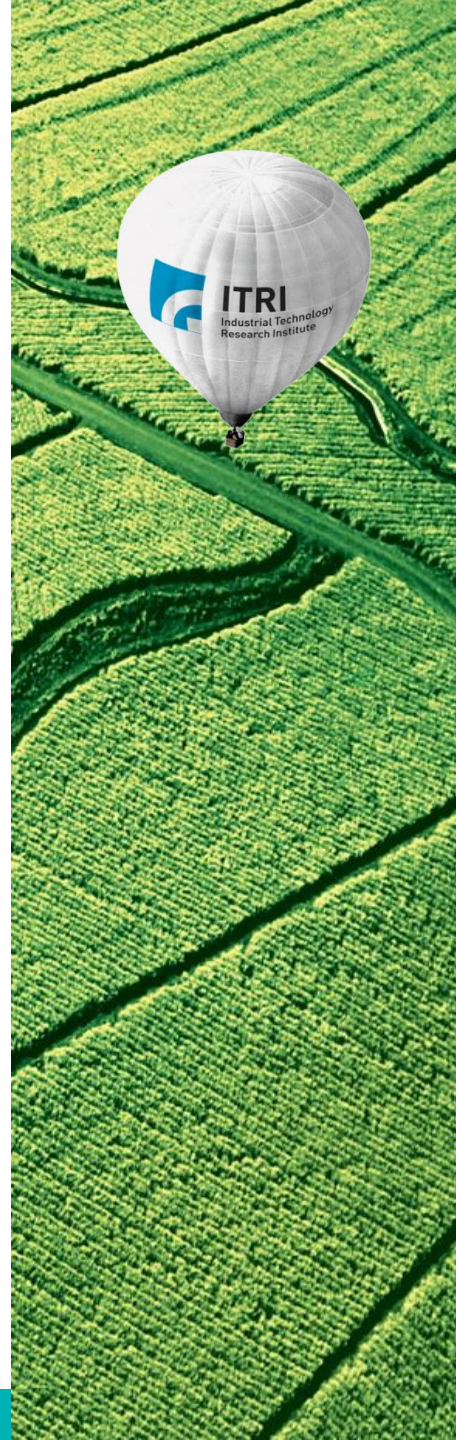

The remaining bamboo materials are recycled for horticultural cultivation media board development

莿竹剩餘資材循環利用於園藝栽培介質板開發

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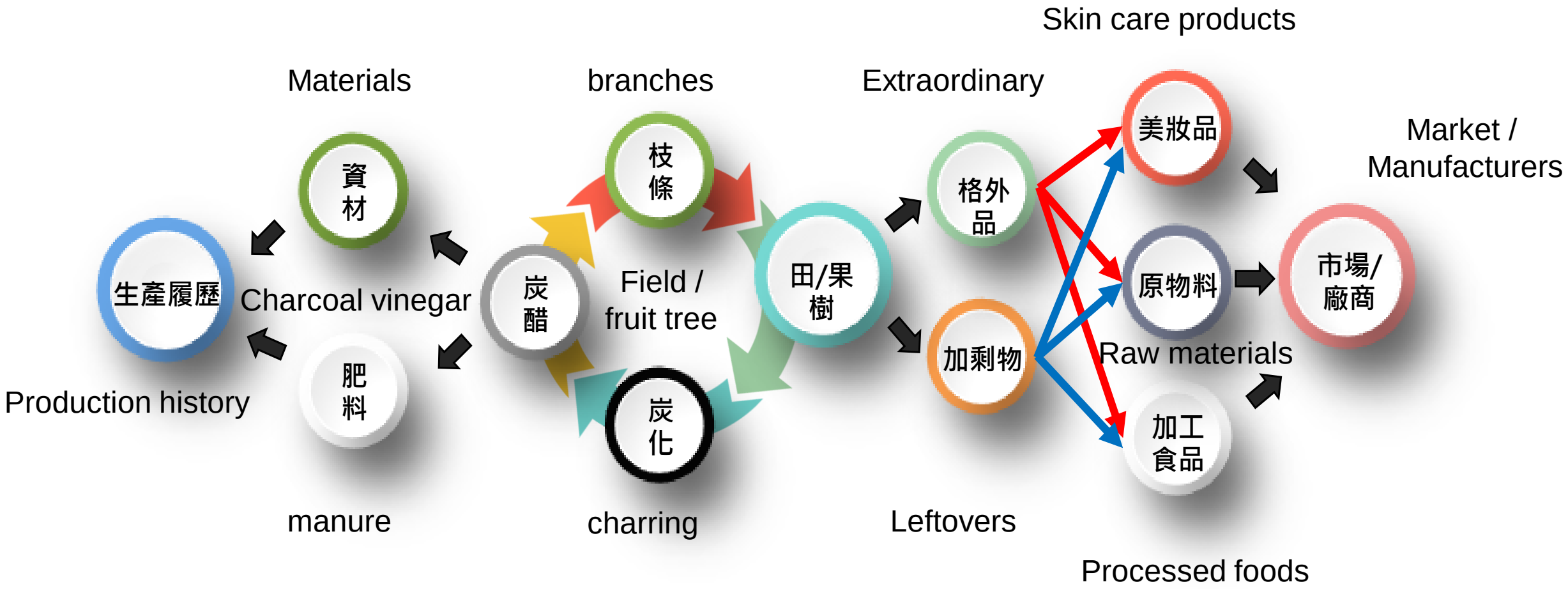
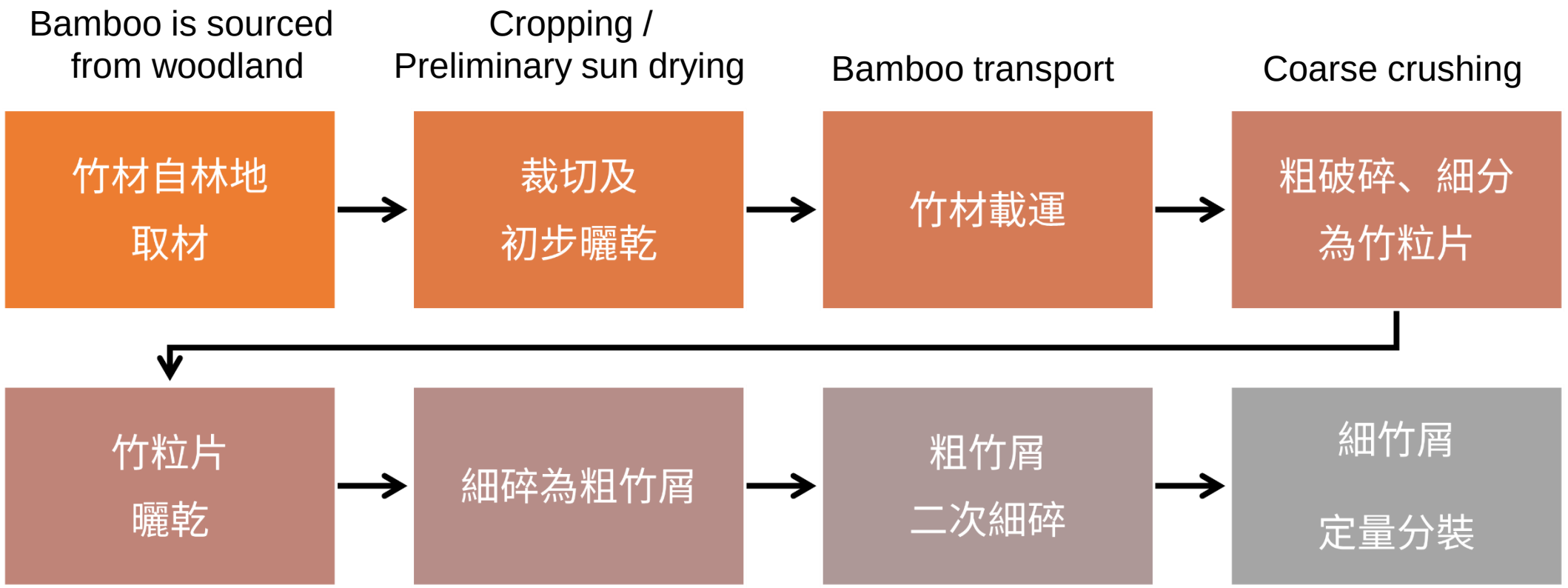
Circular economy concept for agricultural materials
農業資材循環經濟概念



Establishment of bamboo material production process
莿竹資材製作流程建立



Thorny bamboo production pre-production process
莿竹資材前置製作流程:

lop

（圖 1.1）竹材砍伐

Consistent material

（圖 1.2）竹材取材一致性

Cropping

（圖 2）竹材裁切

Dried

（圖 3）曬乾

transport

（圖 4)載運

transport

（圖 5）粗破碎

（圖 6-1)莿竹粗破碎

Bamboo grains are flake-like

（圖 6-2)莿竹粗破碎後呈粒片狀

Dry outdoors

（圖 7)莿竹粒片於戶外曬乾

Fine sieve cutting

（圖 8）莿竹進行細篩裁切

Completion of raw material specifications

（圖 8-1）莿竹再進行第二次細篩裁切

（圖 10）定量分裝

（圖 9）完成原料需求規格

（圖 11）成批運送

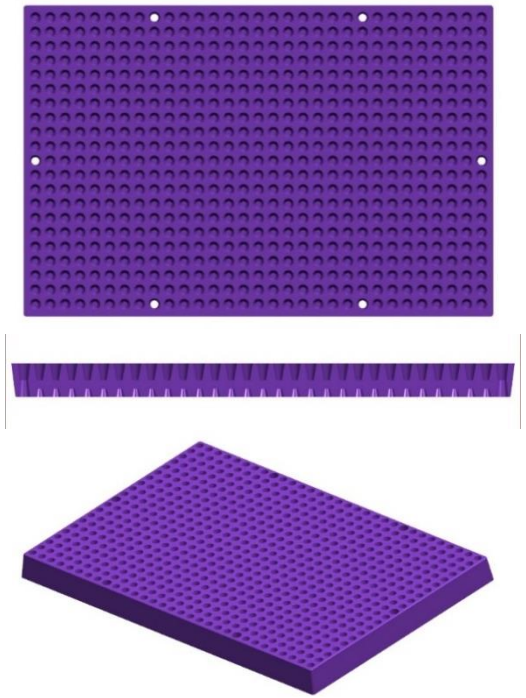
Quantitative dispensing

上述工作項目之相關照片說明，如圖所示:

Bamboo gardening board forming design and molding
莉竹園藝板成型設計及開模

1. 凹凸點設計： 可增加表面張力保水，亦有助於植栽生長及攀附之作用。
2. 凹凸點規則對齊的安排，使用時增加板材之美觀效果。
3. 凹凸點可以手工具穿透，無需動用電動工具，便於單品吊掛或將其拼接。

1. Bump design ： It can increase surface tension and retain water, and also aids plant growth and clinging.
2. The regular arrangement of concave and convex points increases the aesthetic effect of the board when used.
3. The bumps can be pierced by hand tools without the need for power tools, making it easy to hang or splice pieces.



造型構想設計為150×200×15 mm

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Production process and cultivation test of bamboo horticultural board
莉竹園藝板生產過程及栽培試驗

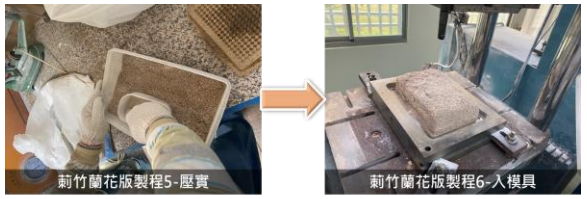
Weighing material

Weighing glue

mix

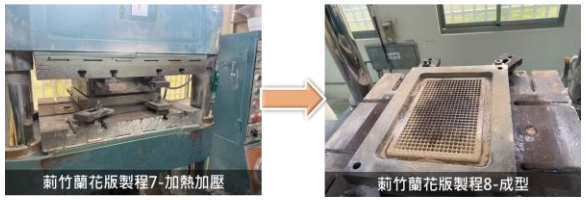
Cartoning

Compaction



into the mold

Heating and pressurization



molding

Remove burrs

finished product

Cultivation trials
栽培試驗

Bamboo gardening board production process 莉竹園藝板生產過程

Physical and chemical properties of bamboo gardening boards
莉竹園藝板物理化學特性

檢測項目樣品sample	竹園藝板Bamboo gardening boards	備註 (試體形狀Specimen shape)
含水率 moisture content	8.75±0.16	粉狀 Powder
容水量(%) Water capacity	31.5±0.30	塊狀Block
酸鹼值 pH(25℃)	6.46±0.03	粉狀Powder
電導度 EC(ms/cm)	3.65±0.03	粉狀Powder
陽離子交換容量 CEC(m.e./100 g)	20.08±1.38	粉狀Powder
充氣孔隙度(%) Inflatable porosity	4.62±0.23	塊狀Block
總體密度(g/cm^3) Bulk density	0.83±0.05	塊狀Block
保水力(%) Water retention	26.49±1.39	塊狀Block

備註：
1. 測試值低於方法偵測極限(MDL)之測定以未偵測(N.D)表示，並註明其方法偵測極限值。
2. 測試值低於檢量線最低濃度而高於MDL濃度時，以<檢量線最低濃度值表示。

Comparison of various types of horticultural board products
各類園藝板材產品比較

	實木或拼接園藝板 Solid wood/patchwork horticultural version	莉竹園藝板 Bamboo Gardening Edition	園藝蛇木板(筆筒樹) Cyathea lepifera
成分 ingredients	天然木材(100%) timber	莉竹粉bamboo (85%) 樹酯Resin esters (15%)	天然蛇木Cyathea lepifera (100%)
使用過程型態 Type of use	易變形及拼接處脫膠deformation / degumming	穩定不變形 Stable without deformation	鬆軟易崩解 Soft and easy to disintegrate
耐久性 durability	差 difference	佳 good	中 medium
料源 source	進口/在地 import/domestic	在地原料及樹酯domestic	進口原料(禁伐) import(logging prohibited)
碳足跡 Carbon footprint	中 medium	中 medium	高 high
環境友善度 Environmentally friendly	中 medium	中 medium	低 Low
保水性 Water retention	中 medium	中 medium	佳 good
風化速度 Aging rate	中 medium	低 Low	中 medium
物理強度 Physical strength	中 medium	高 good	低 Low
防蟲性 Insect repellent	低 Low	高 good	中 medium
防霉性 Mold resistance	低 Low	高 good	中 medium
總體密度 Overall density	中 medium	高 good	低 Low
孔隙度 porosity	中 medium	低 Low	高 good
外型可朔度 Scalability	中 medium	高 good	低 Low
各類上板植物種類 Planting species	中 medium	高 good	低 Low
表面完整性 Surface integrity	中 medium	高 good	低(越來越少)
上板操作度 Operability	高 good	高 good	低 Low
環保再利用性 Eco-friendly reuse	天然原木 log	農業循環再利用 Recycling	保育植物禁止採集 No logging
生產方式/量產度 produce/Mass production	人力拼接/低 No logging/Low	工廠半自動化/高 semi-automatic/good	保育禁伐/低 No logging/Low
產品售價 selling price	高(原木越來越少) high	低(可工廠生產) Low	高(原料越來越少) high

Comparison of bamboo horticultural board products
竹類園藝板材產品比較

	莉竹園藝板 Bamboo gardening boards	***改良場 ***Agricultural Improvement Farm
竹材種類 Types of bamboo	莉竹 (*Bumbusa stenostachia* Hackel) ; Thorny Bamboo	綠竹 (*Bambusa oldhamii); Green Bamboo*
竹屑尺寸 Bamboo shavings size	0.5 cm	5~10 cm
竹屑含水率 Hydrous green	15%	13~20%
製板前處理(殺菌) sterilization	無 / No	有 / Yes
膠合劑種類Types of adhesives	三聚氰胺甲醛樹脂 Melamine formaldehyde resin	環氧樹脂膠 Epoxy resin
膠合劑占比 Glue ratio	15%	8~10%
熱壓時間 Hot pressing time	3分鐘(以175公斤/平方公分的壓力) 3 minutes(175 kgf/cm^2)	10分鐘(以100公斤/平方公分的壓力) 10 minutes(100 kgf/cm^2)
板材尺寸 Plate size	20 cm×15 cm×1.5 cm	20 cm×15 cm×3 cm
板材重量 Plate weight	400 g-500 g	600 g~800 g
pH值(25℃)	6.46	6.2
ECElectrical conductivity (電導度)值	3.65 dS/m	1.2 dS/m

Conclusion 結論

1. 竹子老化時固碳能力會下降，因此適當砍伐有其必要性：「竹子與一般樹木不同，具有生長快速、繁殖力強、生育期短、更新容易等特性，可以善加利用。」
2. 本研究將原生(疏伐)或加工（邊腳料）之竹材副資材升級再造(upcycle)，並依園藝栽培需求及商品之循環經濟模型，量身打造含少量美耐皿樹脂基底的膠合配方，將廢竹材膠合製成栽培資材，可提升資源效率並使產品生命周期各階段皆有所用。

1. Bamboo has a declining ability to sequester carbon as it ages, so proper cutting is a must: "Unlike conventional trees, bamboo has the characteristics of fast growth, strong fecundity, short growth period and easy renewal, which can be put to good use.“
2. Upcycling the bamboo waste from thinning or processing(scraps), and tailoring a gluing formula containing a small amount of melamine resin substrate according to the horticultural cultivation needs and the circular economy model of the product, can improve resource efficiency and make all stages of the product life cycle useful.

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Conclusion 結論

3. 產品壽命結束、不堪使用時，可輕易破碎為小塊，可作為保持土壤水分、肥沃土壤用的覆蓋物料，且因美耐皿樹脂在完全燃燒後不會產生有毒氣體，可進一步作為燃料使用，而燃燒後的灰燼含氮量高，亦能再作為肥料使用，符合本研究期望達到的循環農業目標。

3. At the end of the product's life and unusable use, it can be easily broken into small pieces, which can be used as a mulching material for maintaining soil moisture and fertile soil, and because the melamine resin does not produce toxic gases after complete combustion, it can be further used as a fuel, and the ash after combustion has a high nitrogen content and can also be used as a fertilizer, which is in line with the circular agriculture goal expected to be achieved in this study.

感謝聆聽　敬請指教