

Application of Regenerative Agriculture in the Development of Organic Farming through a Multicropping Spice System

*among Youth Farmer Groups in Hargomulyo Village,
Kokap Subdistrict, Kulonprogo Regency*



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Of the more than **400** types
of spices in the world, **275** are
found in Indonesia.



SECTION 1

Introduction

Indonesia is recognized as one of the world's spice hubs. According to the Negeri Rempah Foundation, there are more than 400 types of spices globally, with 275 of them found in Indonesia, particularly in Southeast Asia.

One of the regions with high potential for spice production is Kulon Progo Regency, located in the Special Region of Yogyakarta Province. However, this potential has yet to be fully optimized due to several challenges, including a shortage of skilled labor. The younger generation in Kulon Progo has not considered spice farming as a viable livelihood option. Another challenge is the limited market access for spice producers.

Despite having vast agricultural land suitable for spice production, Indonesia's spice production remains relatively unstable. The country has seven primary spice export commodities: vanilla, cinnamon, clove, nutmeg, pepper, cardamom, and ginger. Spice production data is presented in the following table.

Among these seven commodities, only three commodities, namely cinnamon, nutmeg, and cardamom, showed stable and increasing production trends during the period 2020 to 2023. The regenerative multicrop farming system is considered one of the potential solutions to improve spice production.

SSI Indonesia, in collaboration with ChildFund International in Indonesia, works to scale up the practice of regenerative agriculture. This collaboration aims to strengthen the capacity of youth farmer groups in managing regenerative-organic multicrop farming systems.

The target of this program is to provide the younger generation with knowledge and skills in

Table 1. Production of Major Spice Commodities in Indonesia

Plants	Production (tons)			
	2020	2021	2022	2023
Vanilla	1,412	1,957	1,505	1,526
Cinnamon	48,836	52,260	54,748	55,213
Clove	145,984	135,753	137,124	135,178
Nutmeg	38,150	40,639	40,896	43,790
Pepper	86,083	83,816	75,205	70,169
Cardamom	94,490	124,766	128,671	122,360
Ginger	183,518	307,241	247,455	198,873

*Data was obtained from the Directorate General of Estate Crops, Ministry of Agriculture, and the Central Statistics Agency (BPS).

regenerative-organic spice cultivation, along with assistance to practical implementation. Through this series of activities, it is expected that young people will contribute to strengthening local economic resilience and promoting sustainable climate change mitigation and adaptation.

This module has been developed not only as a program publication, but also as a reference guide for farmers in practicing regenerative agriculture, particularly in spice multicrop cultivation.



Figure 1.
Activity Documentation



SECTION 2

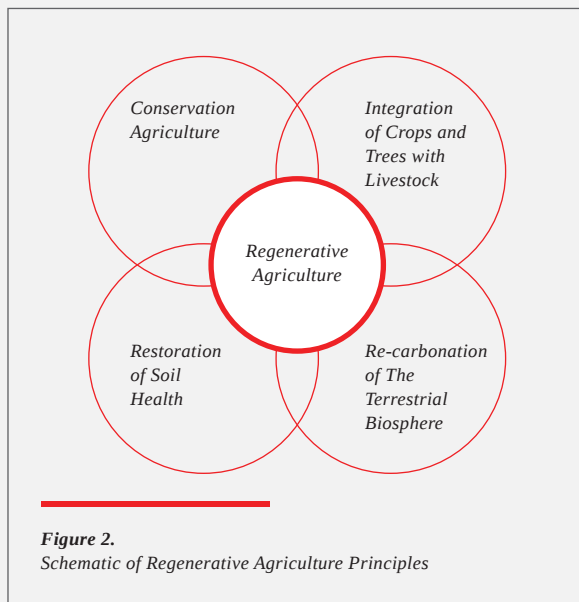
Regenerative Agriculture

This section covers an introduction to regenerative agriculture, including definitions, principles, and benefits.

A. DEFINITION OF REGENERATIVE AGRICULTURE

Regenerative agriculture is a farming system designed to work synergistically with nature while simultaneously increasing productivity by enhancing biodiversity and improving soil health as a means to address climate change (Enabling Farmer-led Ecosystem Restoration, FAO, 2023).

B. PRINCIPLES OF REGENERATIVE AGRICULTURE



According to Lal (2020), there are four key principles of regenerative agriculture:

1. Restoration of Soil Health

Soil restoration is carried out by improving soil conditions and enhancing natural nutrient cycles, for example through the use of cover crops and organic mulching.

2. Conservation Agriculture

Conservation agriculture involves cultivating crops using more environmentally friendly practices, such as crop rotation and integrated pest management.

3. Integration of Crops and Trees with Livestock

Integration is achieved by increasing biodiversity and fostering interactions between species within the farming system, for example by implementing multicropping systems.

4. Re-carbonation of The Terrestrial Biosphere

Carbon sequestration is enhanced through improved agricultural management, such as converting crop residues into compost.

C. BENEFITS OF REGENERATIVE AGRICULTURE

Sher A. et al. (2024) identify three key areas positively impacted by regenerative agriculture:

1. Environmental Aspects

- Improving soil fertility
- Enhancing the resilience of agricultural systems to climate change
- Supporting environmental conservation

2. Economic Aspects

- Reducing production costs
- Supporting product diversification potential and increasing product value

3. Social Aspects

- Improving the sustainability of farming enterprises
- Supporting farmers' livelihoods

SECTION 3

Spice Cultivation Practices with Regenerative Agriculture

Before doing the field practice, participants are provided with 3 series of workshops. Here is a description of the three workshops.

Workshop 1: Organic Production Standards and Internal Inspection

Farmers need to ensure that cultivation practices are carried out according to applicable standards and are well-managed to fully realize the benefits of regenerative agriculture. One of the production standards applied in regenerative agriculture refers to organic production standards, while quality control can be conducted through internal inspection.

A. ORGANIC PRODUCTION STANDARDS

In general, the scope of the organic system includes production units and processing units.

- **Production Unit:** This refers to all farming activities managed by organic farmers, including main commodities, by-products, household consumption within organic land, and livestock management. All production units are subject to internal inspection conducted by the Internal

Control System (ICS) as well as external inspection by an Organic Certification Body (OCB).

- **Processing Unit:** This involves the processing of agricultural products to alter their form and/or preserve them, with the ultimate goal of increasing product value.

One of the regulatory references for organic farming practices, particularly to prevent contamination, is the European Union Standard EU

889/2008 and the United States Electronic Code of Federal Regulations (e-CFR), which govern the following areas:

1. Organic conversion period
2. Seed and seedling use
3. Soil fertility
4. Plant protection
5. Parallel production (separation of organic and non-organic production)

1. Organic Conversion Period

The organic conversion period is the minimum duration of organic farming practice required before certification, during which crops must be cultivated under organic management to be eligible for harvest as organic products. The following table presents the conversion rules based on European and United States standards:

Table 2. Organic Conversion Rules Based on European and United States Standards

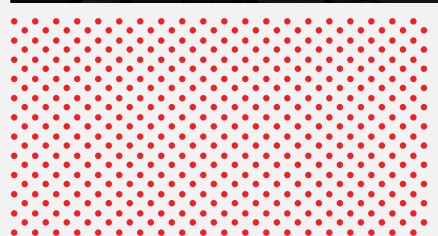
European Union Regulation (EU Regulation)	United States Regulation / NOP-USDA (National Organic Program - United States Department of Agriculture)
<p>The organic conversion period is determined based on the type of crop being cultivated.</p> <ul style="list-style-type: none"> • A three-year conversion period (36 months) applied to perennial crops (e.g., coconut, pepper). • A two-year conversion period (24 months) applied to seasonal crops (e.g., soybean, onion, tomato). 	<p>A three-year conversion period (36 months) is required for all crops before they can be harvested as organic, with no distinction between perennial and seasonal crops.</p>
<p>Products harvested during the early stages of the conversion period are sold as conventional products. During the mid and late stages of the conversion period, products may be marketed as in-conversion organic products.</p>	<p>Products throughout the entire conversion period are sold as conventional products.</p>
<p>Allows retroactive (reduction of land conversion period) if it can be proven that the land has not undergone conventional treatment for the last 3 years (Can be proven by cultivation records and third party declarations with at least recommendations from the relevant government agency authorities or credible third parties).</p>	

Additional Information

- There are certain types of land that do not require an organic conversion period, namely:
 - a. Natural land that has never been used for non-organic farming (e.g., forest plantations or grasslands).
 - b. Land under environmental protection programs that has been managed naturally or traditionally during the past three years.
- For perennial crop commodities, it is recommended that the conversion period be completed before the first harvest.



Figure 3.
Workshop 1 Participants



2. Seed and Seedling Use

The criteria for permitted organic seeds are as follows:

- Local seeds from the surrounding area.
- Sourced from organic seed producers or produced through vegetative propagation from organic plants.
- Seeds that have not been treated with prohibited chemical substances.
- If organic seeds or planting stock are not available, conventional seeds and planting stock may be used with prior approval from the Organic Certification Body (OCB). This is allowed only if organic seed sources are truly unavailable.
- Not genetically modified (non-GMO).
- Under United States organic regulations (NOP-USDA), conventional seeds or planting stock may be classified as organic if they have undergone one year of conversion.

3. Soil Fertility

In general, organic farming practices must include efforts to maintain soil organic matter, ensure soil structure stability to prevent erosion, and prevent soil contamination from waste and plant disease agents. The following are soil fertility management procedures based on organic standards:

- Application of compost derived from plants or livestock manure. The use of manure from commercial livestock operations is not permitted, nor is manure from animals treated with prohibited chemicals.
- Fresh (uncomposted) manure must be applied at least three months before harvest, while composted manure may be applied at any time (based on United States standards).
- The use of live support stakes (living trellises) for perennial crops is encouraged so that prunings from the stakes can be used as natural fertilizer.
- Only fertilizers and nutrients listed in Annex I of the European Union Regulation (e.g., sea salt) are allowed under organic standards.

... organic farming practices must include efforts to maintain soil organic matter, ensure soil structure stability to prevent erosion, and prevent soil contamination from waste and plant disease agents.

4. Plant Protection

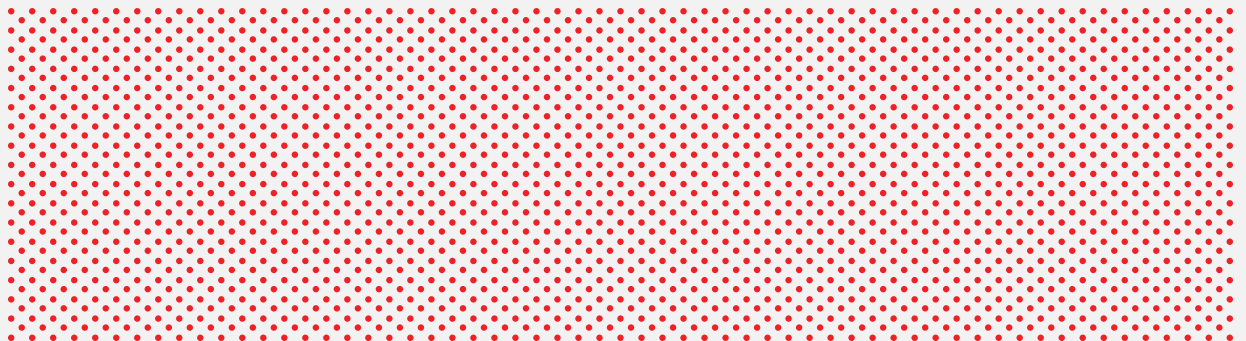
Efforts to control pests, diseases, and weeds in farming areas may include:

- Use of natural enemies or pest predators
- Selection of pest- and disease-resistant crop varieties
- Mechanical control methods for pests and weeds
- Cropping patterns, such as multicropping and live hedgerows

5. Parallel Production

Parallel production refers to the separation of organic and non-organic production areas, which is necessary when not all parts of the land are certified organic. This requires:

- Separation of agricultural tools
- Separate storage facilities and packaging for products
- Clear separation of record-keeping and processing/handling for both organic and non-organic products



B. INTERNAL INSPECTION

Internal Control System

The Internal Control System (ICS) is a documented quality assurance system within the certification process. Through the implementation of this system, external certification bodies can delegate regular inspections of each group member to a designated body or unit within the certified operator.

ICS Principles:

- Inspections must be conducted for all members of the farmer group at least once a year.
- At least one inspection document must be produced per calendar year.
- Inspections must be carried out in the presence of the farmer or their representative. The number of farmers inspected per visit may be determined by the farmer group itself.
- Inspections are conducted to ensure that the applicable standards are being implemented.
- Inspections are typically conducted during the flowering period and before harvest.

ICS inspections cover organic land, non-organic land, seeds, irrigation, livestock, and farmer documentation. The following are key points that farmers need to pay attention to during cultivation, as they represent critical control points during inspection:

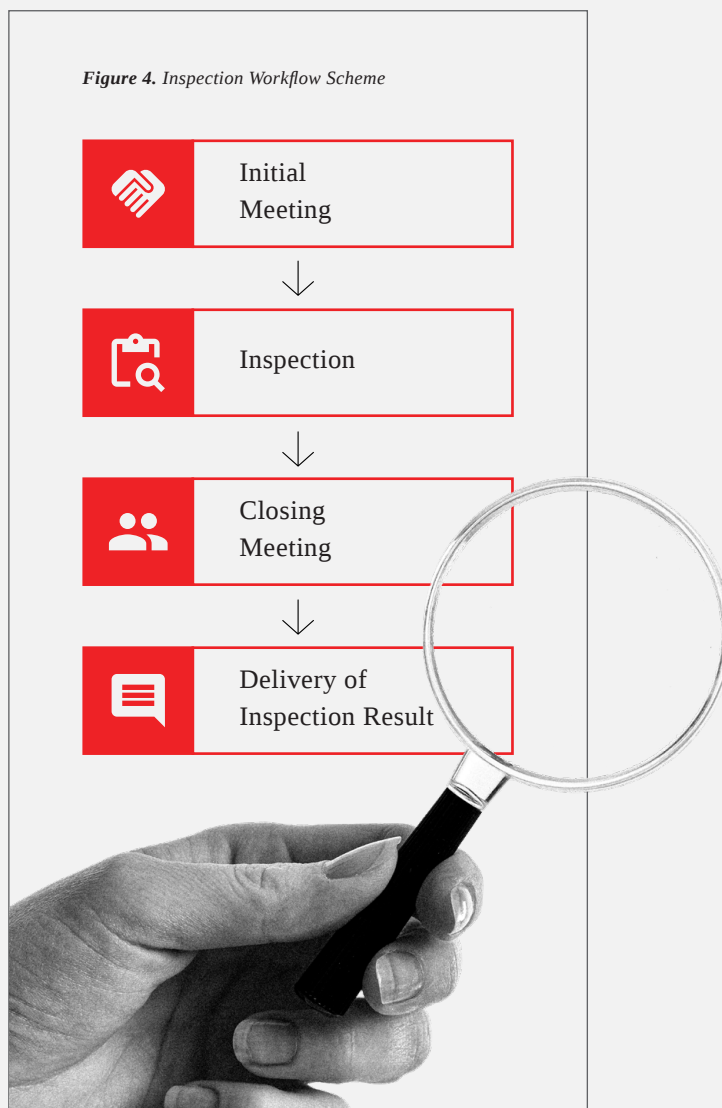
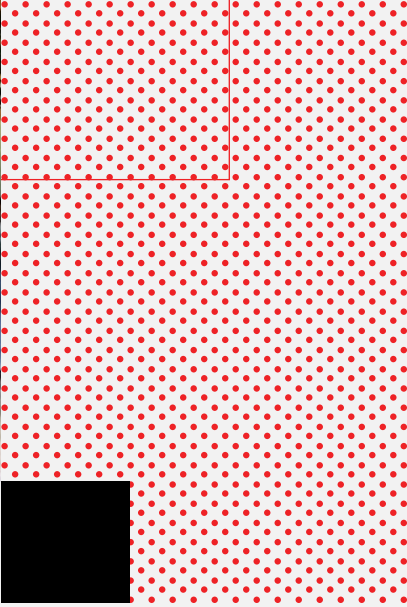


Table 3. Critical Control Points for Each Inspection Aspect

Aspect	Critical Control Points	Aspect	Critical Control Points
Organic Land	<ul style="list-style-type: none"> • Use of prohibited substances (e.g., arsenic, strychnine) • Erosion risk • Condition of multicrop planting 	Non-Organic Land	<ul style="list-style-type: none"> • Tools and materials used • Assessment of contamination risk by reviewing the boundary between organic and non-organic land • Condition of the buffer zone
Seeds	<ul style="list-style-type: none"> • Seeds vulnerability to chemical treatment (e.g., corn, tomato) • Genetically modified seeds, especially those already present in the area (e.g., rice, corn, soybean, cotton) 	Irrigation	<ul style="list-style-type: none"> • Water source • Cleanliness and contamination level of water channels • Water purification efforts undertaken
Livestock	<ul style="list-style-type: none"> • Cleanliness and density of animal housing • Grazing locations • Feed specifications and animal care products (e.g., growth hormones, pesticide sprays) 	Farmer Documentation	<ul style="list-style-type: none"> • Record completion • Record consistency between documents and actuals

Figure 5.
Workshop 1 Activities



Workshop 2: Permaculture

The implementation of regenerative agriculture becomes more manageable when farmers are familiar with mindsets and concepts that emphasize harmony with nature. This section discusses three key topics. First, permaculture as a fundamental guide in practicing regenerative agriculture. Second, the urban food forest concept as a reference for designing agricultural systems. Third, composting as a crucial element in supporting natural cycles within the farming system.

A. PERMACULTURE

Permaculture is a way of thinking and living by mimicking natural processes. The goal of permaculture is to create a productive, efficient, and earth-friendly way of life.

Permaculture is essential because it helps people live more wisely and self-sufficiently, especially in times like today when environmental degradation increases the cost of living. Permaculture is built upon three core ethics: Earth Care, People Care, and Fair Share / Limits to Consumption.

- **Earth Care:** Protecting the environment and living beings (examples: planting trees, reducing the use of synthetic chemicals, conserving water).
- **People Care:** Building a healthy, fair, and supportive community (examples: sharing garden produce, teaching farming skills, developing mutual aid networks).
- **Fair Share:** Using resources responsibly and redistributing or returning the surplus

(examples: composting food waste, donating harvests).

In general, permaculture design consists of three key steps: observation, determining relationships between elements, and plant selection.

1. Observation: This step is carried out to **identify land conditions and potential threats** in determining which elements to include in the farming system. The following are examples of aspects that need to be observed

Land Conditions	<ul style="list-style-type: none"> • Source and availability of water • Water access • Areas with full sunlight exposure (6–8 hours per day) and areas with limited sunlight (less than 6 hours of direct sunlight) • Planting methods: raised beds, mounds, or containers
Potential Threats	<ul style="list-style-type: none"> • Strong winds • Areas prone to waterlogging • Presence of nearby domestic animals or livestock that may enter the farming area

Examples of permaculture implementation in urban land and commercial farming areas are shown in the following figure



Figure 6. Permaculture Implementation in an Urban Backyard Owned by Eric Toensmeier and Jonathan Bates

Area size: 0.1 hectares
After 10 years of permaculture implementation



Figure 7. Permaculture Implementation in a Commercial Farm Owned by Stefan Sobkowiak

Area size: 5 hectares
After 22 years of permaculture implementation

The following is an example of a list of elements to be included in the garden based on the observation results:

- Seedling area
- Vegetable garden
- Duck coop
- Outdoor kitchen
- Compost bin
- Raised beds
- Beehive
- Water tank
- Parkir area
- Fish ponds
- Flower garden
- Others.

2. Determining Relationships Between Elements:

This step involves designing a simple layout or garden plan based on the cultivation activities to be carried out. The following are examples of how relationships between elements can be determined:

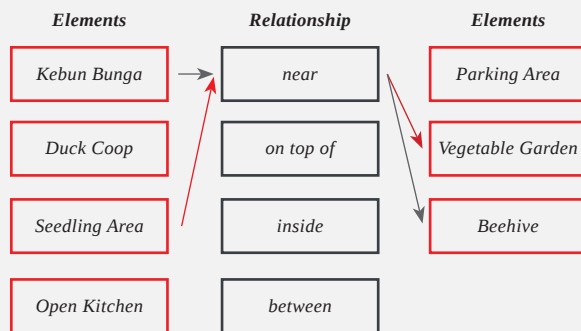


Figure 8. Example of Determining Relationships Between Elements

Explanation:

The seedling area should be located close to the vegetable garden to facilitate the transplanting process.

The flower garden should be located near the beehive to support pollination and enhance honey production

3. Plant Selection: In addition to ensuring that seeds comply with organic standards, plant selection must also be adapted to environmental conditions. The following factors should be considered when choosing plants:

- Duration and intensity of sunlight exposure at the garden site and water availability.
- Availability of time and labor. If the garden will often be left unattended (e.g., due to frequent travel), choose low-maintenance plants such as perennial vegetables and fruit-bearing plants.
- The role of each plant in the garden. Plants interact with one another, so combining species that support each other's functions

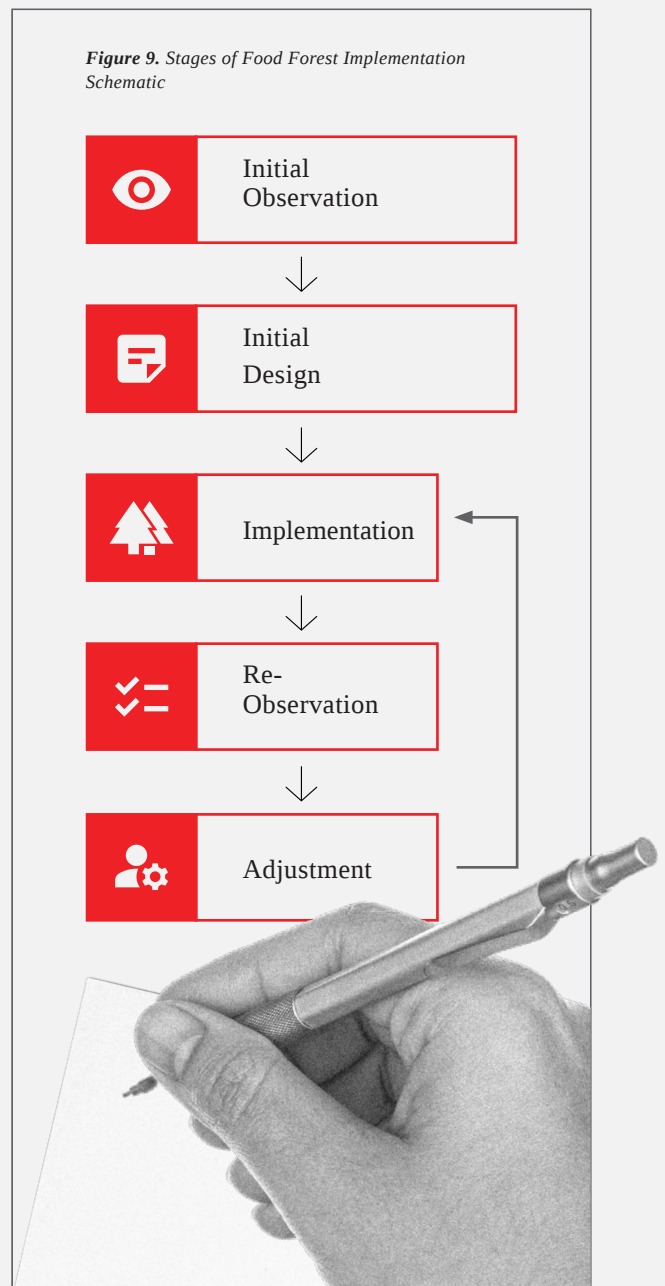
is recommended. For example, cowpea intercropped with corn.

- Site temperature. Some plants require specific temperature ranges for optimal growth. For example, strawberries require a growing environment with an optimal temperature of 17–20°C (Sekardatu, 2020).

B. FOOD FOREST

The design of agricultural systems aligned with the permaculture mindset is carried out by mimicking natural ecosystems and patterns found in nature. This concept is known as the food forest. Food forests are important to implement as they support productivity and enhance the sustainability of agricultural systems.

The stages of implementing the food forest concept are illustrated in the following schematic:



Activities of Workshop 2



Figure 10.
Initial Observation



Figure 11.
Initial Design



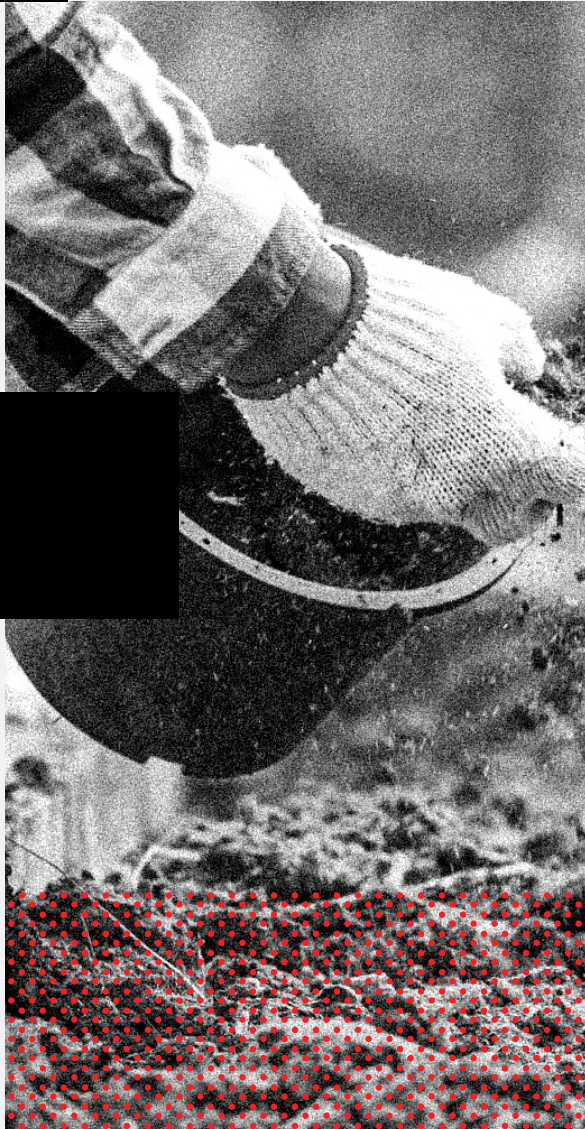
Figure 12.
Implementation



Figure 13.
Re-Observation



Figure 14.
Adjustment



In the food forest concept, there are nine layers of productive plants that interact with each other, resembling the structure of a natural forest ecosystem. Each layer consists of plants that play

different roles within the ecosystem. However, the number of plant layers in a garden should be adjusted to the land conditions. Smaller plots of land may have fewer plant layers.



Figure 15.
The Nine Layers in the
Food Forest Concept
(Source: *Temperate Climate
Permaculture, 2013*)

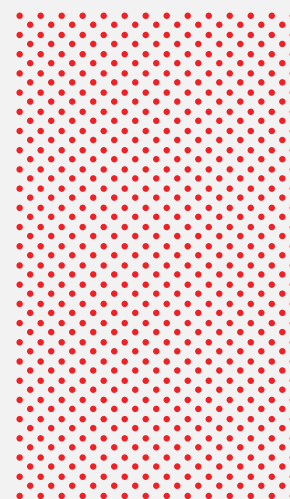


Table 4. Description of Food Forest Layers

Layer Number	Layer	Function/Benefits	Example Plants
1.	Canopy Layer	Provides shade for the layers below	Timber trees (pine, teak), large nut trees (candlenut, cashew), fruit trees (mango, avocado, sapodilla, breadfruit)
2.	Sub-canopy layer	Fills vertical space and increases production diversity	Fruit trees (banana, papaya), coffee, clove, cinnamon, nutmeg
3.	Shrub layer	Occupies the space beneath trees and increases the yield of food and spices	Lemongrass, bay leaf, galangal, turmeric, basil, roselle
4.	Herbaceous layer	Attracts beneficial insects and suppresses weed growth	Water spinach, spinach, taro, ginger, curcuma, aromatic ginger (kencur), coriander, celery, mint leaves
5.	Root yield layer	Stabilizes soil structure and supports soil microorganisms essential for soil health and fertility	Rhizomes (turmeric, ginger, curcuma, galangal, aromatic ginger), tubers (sweet potato, taro, potato), root vegetables (carrot, radish)
6.	Groundcover layer	Protects soil from erosion and helps retain soil moisture	Gotu kola, ground-cover legumes
7.	Vine layer	Maximizes unused vertical space	Grapes, chayote, betel leaf, vanilla
8.	Wetland layer	Enhances water availability	Watercress
9.	Fungal layer	Strengthens plant root systems and increases nutrient absorption for plants	Oyster mushrooms, shiitake mushrooms

Source: *Temperate Climate Permaculture, 2013*

In selecting plant types and placement, it is important to ensure that interactions among species are mutually supportive, not competitive.

Example: When lettuce and broccoli are planted near tomatoes, they may compete for nutrients, causing the tomatoes to grow poorly. In contrast, planting herbal companion plants such as parsley and basil near tomatoes can help protect them from pests, allowing the tomatoes to grow better.

The food forest concept offers several advantages:

- Productive plant guilds that mutually support each other
- Positive interactions among living organisms
- Easier maintenance
- More sustainable system
- Lower input needs, such as fertilizers and pesticides

C. COMPOSTING

Composting is the decomposition of organic materials with the help of microorganisms. Composting methods can be adjusted according to individual needs and lifestyles. One of the commonly used composting methods is aerobic composting. The aerobic composting method requires oxygen and good air circulation. Aerobic composting can be done using simple tools such as pots, earthenware containers, drums, or buckets. Below are the steps for making simple aerobic compost:

1. Prepare a compost starter (such as EM4 or a homemade starter made from the fermentation of rice washing water and molasses) and a compost container with good air circulation (e.g., a perforated bucket).
2. Separate household organic waste into green materials (wet organic waste such as vegetable scraps, fruit peels, green leaves, or leftover rice)

Example of a Food Forest Implementation

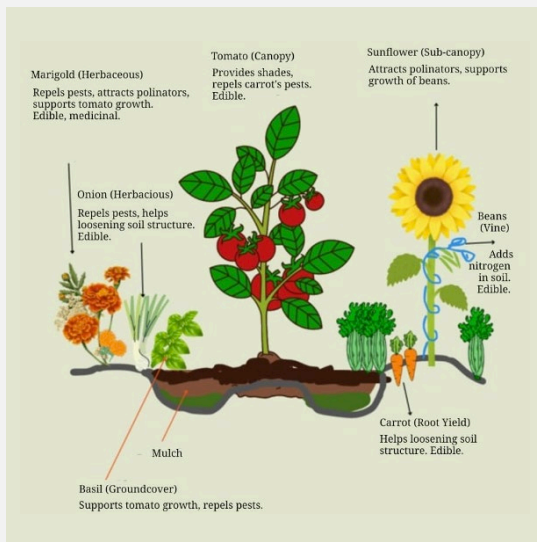


Figure 16. Example of Food Forest Concept Implementation

Implementation in a Small-Sized Plot (Approximately 1 m²)

Explanation:

Utilizing limited space can be done by planting vegetables (such as tomatoes and carrots) for consumption. The growth of these vegetables is supported by various flowering plants that attract pollinators, herbs that repel pests, and mulch to maintain soil structure.

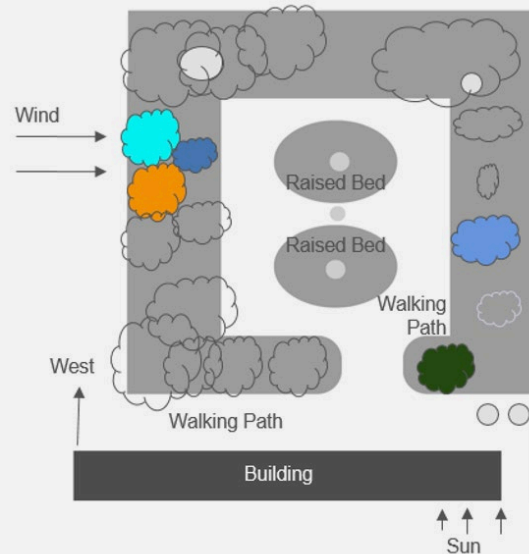


Figure 17. Example of Food Forest Concept Implementation

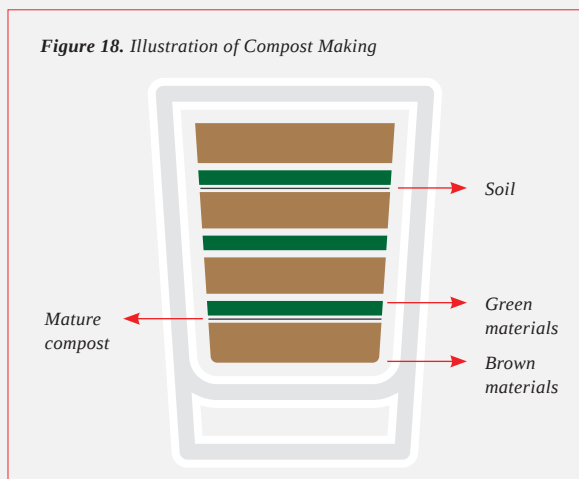
Implementation in a Plot of Approximately 12 m²

Explanation:

Trees surrounding the garden are necessary to protect smaller plants from southern winds. Smaller plants are planted in raised beds in the center of the plot to ensure they receive adequate sunlight.

and brown materials (dry organic waste such as dried leaves, newspapers, used cardboard, sawdust, rice husks, or eggshells). Chop both green and brown materials into small pieces to facilitate faster decomposition.

3. Add brown and green materials in a 2:1 ratio as shown in Figure 18



4. Add the compost starter.
5. Add finished compost and soil (if available).
6. Check the compost container daily. Adjust the composting process based on any problems that arise (see Table 5)
7. Stir and turn the compost every 3–7 days to ensure an even composting process.
8. The composting process takes approximately 1 to 6 months.
9. Good quality, mature compost has the following characteristics:
 - Dark color similar to soil (dark brown to blackish)
 - Crumbly and loose texture
 - Earthy smell, not foul or unpleasant
 - Compost temperature matches the surrounding environment

Table 5. Problems, Causes, and Solutions in Composting

Problem	Cause	Solution
Foul odor	Too wet / excess nitrogen	Add more brown materials until they make up around 70%
Rancid smell	Lack of oxygen	Add dry leaves/sawdust and mix frequently
Dry pile	Lack of starter	Add compost starter
Not heating up	Pile too small	Add more alternating layers of brown and green materials
No decomposition	Lack of nitrogen	Add green materials and starter
Presence of larvae/maggots	Too wet / excess nitrogen	Add more brown materials until 70%, or add ripe fruit as a glucose source to raise compost temperature



Workshop 3: Economics in Regenerative Agriculture

Farming activities need to be carefully planned and accurately calculated to reduce uncertainty. To perform proper planning and calculation, farmers need to understand the concepts of ROI (Return on Investment) and BEP (Break-Even Point). To calculate ROI and BEP, farmers must first determine their total revenue, total production costs, and net profit.



Figure 19. Workshop 3 Activity



In general, production costs represent the sum of all farming expenses, from purchasing seeds, fertilizers, farming tools, to paying for labor and transportation of the harvested crops. Meanwhile, revenue refers to the income received from the sale of all crop types harvested in a single planting season. Once both production costs and revenue are known, net profit, ROI, and BEP can be calculated.

1. Net Profit

$$\text{Net Profit} = \text{Total revenue} - \text{Total production costs}$$

Equation 1. Net Profit Calculation

Net profit is the total revenue minus total production costs. The net profit figure shows how much money the farmer earns at the end of the growing season.

2. ROI (Return on Investment)

$$\text{ROI} = \left(\frac{\text{Net profit}}{\text{Total production costs}} \right) \times 100\%$$

Equation 2. ROI (Return on Investment) Calculation

ROI is the comparison between the net profit earned and the total production costs. ROI calculation is used to assess the farm's ability to generate profit from the investment made.



3. BEP (Break Even Point)

$$\text{BEP} = \left(\frac{\text{Total production costs}}{1 - \frac{\text{Total revenue}}{\text{Total units sold}}} \right) \times 100\%$$

Equation 3. BEP (Break-Even Point) Calculation

The BEP represents the break-even point, which is the point at which the profit earned equals the total production costs. Simply put, BEP is the point where the farm covers its costs. After reaching the BEP, any revenue from the harvest becomes net profit.

Conclusion:

Through the above analysis, we can conclude whether a farming project is profitable and feasible to continue or whether it needs further evaluation. A combination of profitability, investment efficiency, and time to reach BEP provides an indication that [insert context-specific note, e.g., this farm business has good medium-term prospects].

Farming Business Profitability Simulation



Cost and revenue calculations for a regenerative, organic, multicrop spice farming system can be performed using the following assumptions:

A. BASIC ASSUMPTIONS

Component	Value
Effective planting area	... m ²
Duration of planting cycle	... days
Number of cycles per year	... times

B. NUMBER OF PLANTS (PER 1.000 M²)

Crop Type	Number of Plants	Harvest Age (days)	Estimated Weight per Plant (kg)
Crop A
Crop B
Crop C

C. ESTIMATED PRODUCTION COSTS (PER 1.000 M² PER CYCLE)

Component	Estimated Cost (IDR)
Seeds	...
Organic fertilizer & compost	...
Botanical pesticides & plant growth-promoting bacteria	...
Labor (planting, maintenance, harvesting)	...
Operational & irrigation	...
Tools (stakes, sprayers, etc.)	...
Total production cost	...

D. ESTIMATED REVENUE (ONE CYCLE)

Crop	Production per Plant	Total Production	Price per kg	Revenue
Crop A	Rp...	...
Crop B	Rp...	...
Crop C	Rp...	...
Total

E. FINANCIAL ANALYSIS (PER CYCLE)

Component	Value (IDR)
Production cost	...
Revenue	...
Net Profit	...

ROI (Return on Investment)

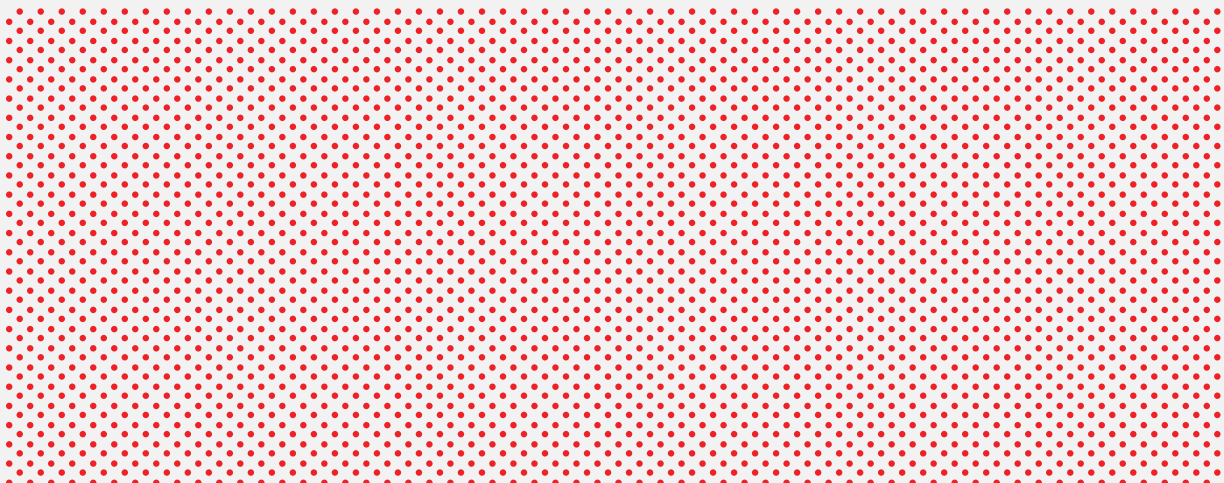
$$\text{ROI} = (\text{Net Profit} / \text{Production Cost}) \times 100\% = \dots$$

BEP (Break-Even Point)

$$\text{Minimum revenue required to break even} = \dots$$

BEP in terms of product output is reached when sales reach ... units

Component	Value
Total production cost	Rp...
Total revenue	Rp...
Net profit	Rp...
ROI	...
BEP	...



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REGENERASI PETANI

Regenerasi Masa Depan



Application of Regenerative Agriculture in the Development of Organic Farming through a Multicropping Spice System among Youth Farmer Groups in Hargomulyo Village, Kokap Subdistrict, Kulonprogo Regency

