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Systems Thinking for a
Sustainable Food System Booklet Series

Agroecology

3

Foreword

Food is inseparable from agriculture, and agriculture is inseparable from the preservation of nature. Maintaining environmental sustainability will increase agricultural productivity and lead to economic benefits for farming families. This is because agriculture, environmental sustainability and the economy are interconnected within the framework of the food system.

Systems thinking allows us to not only understand these relationships, but also find comprehensive solutions to food issues. Without systems thinking, food issues cannot be addressed comprehensively, which will only lead to further problems and impact other sectors.

Koalisi Sistem Pangan Lestari (KSPL), part of Food and Land Use Coalition (FOLU), has produced this booklet to invite readers to apply systems thinking not only in looking at food issues, but also in finding solutions. This booklet is a part of the Systems Thinking for a Sustainable Food System Booklet Series, which consists of five volumes:

Volume 1: Understanding the Food System and the Systems Thinking Framework

Volume 2: Healthy Diet

Volume 3: Agroecology

Volume 4: Reducing Food Loss and Waste

Volume 5: Environmental Sustainability within the Food System Framework

This booklet, Volume 3, is divided into four sections. The first section introduces the concept of agroecology. Readers can explore agroecology and other agricultural models. Readers are expected to understand not only the concept of agroecology, but also other sustainable farming models.

The second section of this booklet discusses the concept of agroecology within the framework of the food system. Readers can see the general relationship between agroecology and other elements in the food system. In this section, the author invites readers to view agroecology within the framework of the food system.

The third section of this booklet discusses the benefits of agroecology. Readers can learn about the benefits of agroecology as well as domestic and international agroecology practices.

The fourth and final section of this booklet discusses the steps that can be taken to adopt agroecology. This includes learning from the steps taken by Pesantren Ekologi (Islamic Boarding School in Ecology) Ath-Thaariq in Garut to implement agroecology. These steps should only be taken as examples for learning and initial guidance and can be modified according to the socio-ecological conditions in each area.

This booklet draws on training materials on systems thinking for a sustainable food system and other relevant literature. KSPL would like to express our gratitude to all those who have assisted in the publication of this booklet.

We understand that this booklet may not be perfect and there is always room for improvement. We welcome any feedback or constructive criticism that can help us enhance the quality of this booklet in the future.

Ultimately, we hope for this booklet to be a valuable resource for readers who are interested in learning about the application of systems thinking in building a sustainable food system.

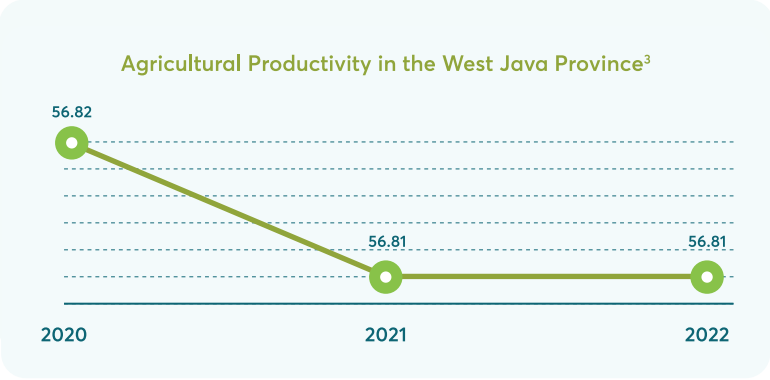
Jakarta, January 2023

I. Understanding Agroecology

A. Green Revolution and Its Adverse Impact

From 2011 to the end of 2020, agricultural production in Indonesia has continuously decreased, as reflected in the Total Factor Productivity (TFP), a measurement used in the agricultural sector. According to data from the Institute for Development of Economic and Finance (INDEF), the agricultural sector has been recording negative TFP growth since 2011 to 0.36 percent in 2011-2015 with slight improvement to minus 0.05 percent since then. Previously, the agricultural sector recorded positive TFP growth at 1.71 percent in 2006-2010[1].

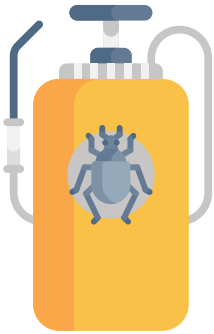
The decline in land fertility is a major factor contributing to the decrease in agricultural productivity. In West Java, a food estate in Indonesia, some agricultural regions have been seeing a fertility decline since early 2021[2], making it difficult to increase food crop productivity. If not addressed immediately, such soil fertility decline will not only disrupt food availability, but also pose a risk of poverty for farmers in West Java.



Sumber: Luas Panen, Produksi, dan Produktivitas Padi Menurut Provinsi 2020-2022, BPS

How is agricultural soil fertility declining? According to Suswono, the Minister of Agriculture during the era of President Susilo Bambang Yudhoyono, chemical fertilizers have been massively used for agricultural lands in Indonesia since 1970. "As a result, soil fertility has declined over time," said Suswono[3].

The use of chemical fertilizers and pesticides was initially perceived as a solution to increase agricultural production.



It is now widely recognized that these practices have negative environmental impacts.

The massive use of chemical fertilizers is part of the Green Revolution, a term used to describe the program to increase food production per hectare of land that started in Mexico in the 1940s. The Green Revolution has radically changed the global agricultural system by focusing on the cultivation of high-yield varieties of rice, wheat and maize that ironically cannot be successful without the help of pesticides and chemical fertilizers[4].

The Green Revolution has undoubtedly been successful in increasing food production and addressing hunger crises in various parts of the world.

However, the negative impacts of the Green Revolution, such as the extinction of biodiversity, ecosystem degradation and climate change[5], are now taking their toll on humanity.

Not only has it led to the decline in soil fertility, the Green Revolution has also led to the loss of local knowledge in society. Local knowledge encompasses the collective knowledge held by a community living in a specific area[6]. During the Green Revolution, farmers who previously relied on local knowledge to manage their agriculture were encouraged to adopt modern global farming methods[7]. As a result, farmers have become increasingly dependent on fertilizer and pesticide. Declining soil fertility and the loss of local knowledge ended up forcing farmers into poverty[8].

B. Agricultural Extensification and Its Adverse Impact

Agricultural extensification or the expansion of agricultural land was previously seen as a solution for increasing production. Like the Green Revolution, this practice also led to the conversion of previously virgin lands, such as forests. In the long term, agricultural extensification does not only diminish forest area, but also has adverse effects on agricultural productivity and yields[9].

A study in Zambia showed that agricultural extensification can decrease soil organic carbon by 23 percent and soil nitrogen by 22 percent, as well as reduce agricultural yields by up to 35 percent.

The decrease in agricultural yields will inevitably lead to an increase in poverty, as food prices increase[10].

From this, we can see the cause-and-effect relationship of one of the problems in the agricultural sector. The fertilizer and pesticide-intensive Green Revolution model and land-intensive agricultural extensification have given rise to various negative impacts not only on nature, but also on farmers and food consumers.

C. Agroecology

The various issues in the agricultural sector that have led to declining soil fertility finally gave rise to the idea of reintroducing ecological principles to agriculture. This idea is now commonly known as **agroecology**. Simply put, **agroecology is the environmental science of agriculture, in which ecological knowledge is applied to agricultural management design**. Agroecology is now practiced through the application of ecology in the study, design and management of food agricultural systems[11].

The contrast between agricultural systems that adhere to agroecology principles and those that do not is evident in their practices, such as the use of chemical fertilizers.

These practices directly eradicate local resources potential, such as the use of organic fertilizers from compost made of bacterial materials readily available in the environment that can be autonomously produced by farmers and enhance soil fertility. In practice, agroecology-based agricultural systems do not eliminate local resources, such as the knowledge of local farmers and the potential of the local area. Instead, they are built on the co-creation of knowledge, where scientific-based agricultural knowledge is combined with traditional knowledge and practices as well as local farmers' wisdom. Agroecology systems place farmers and local communities as the main agents of change[12]. Thus, agroecology-based agricultural systems can increase farmers' autonomy and enhance their capacity to adapt.

D. How Do Ecological Principles Work within Agroecology??

According to **Barry Commoner**, four principles serve as the foundation of how ecosystems work (in the book ***The Closing Circle*, 1971**),:[13]

1. **Everything is Connected to Everything Else.** There is only one earth for all living creatures. Therefore, something that affects something will also affect everything else.
2. **Everything Must Go Somewhere.** There is no way out of this earth so something that is disposed of will go somewhere.
3. **Nature Knows Best.** Although many technologies have been created by humans, nature always knows what is best for it.
4. **There is No Such Thing as a Free Lunch.** Exploitation of nature inevitably involves changes in the natural object being exploited from something useful to something that is no longer useful for nature.

These four principles are the foundation of agroecology, which differentiate it from the agricultural practices under Green Revolution.

E. Differences between Industrial Agriculture and Agroecology

In general, these are the differences between industrial agriculture and agroecology-based agriculture.

Characteristic	Industrial Agriculture	Agroecology
Crops	Rice, wheat, corn and little else	All food crops
Planting area	Flat land, irrigation area	All lands
Dominant Planting System	Monoculture	Polyculture
Dominant Inputs	Chemicals, machinery and external inputs	Nitrogen use, biological pest control, organic, nature dependent
Environmental Impact	Moderate-high (chemical pollution, erosion, resistance to pesticides, etc.)	Low-moderate (nutrition)
Cost	Relatively high	Relatively low
Expertise and Resources Requirement	Conventional plants and one scientific discipline and expertise	Ecology and combined scientific disciplines

Source: Alteri (1991)[14]

II. Agroecology within the Food System Framework

The application of agroecology in the food system framework has a significant impact on increasing agricultural productivity, which in turn leads to economic improvements for farmers.

In this context, we can learn from the experience of Budi Santoso as a member of the Indonesian Farmers' Union in Lampung. Agroecology has enabled him to reduce agricultural input costs by 50 percent. Another advantage is that he is now able to cultivate tomato and coffee in the same field[26].

According to Budi Santoso, he was able to reduce the production input costs for the tomato plants he grows on an area of 60 x 40 meters by more than 50 percent after applying agroecology. Typically, he would need up to IDR6 million for such a large area, but with agroecology, only IDR3 million[27] was spent.

Additionally, agroecology has a positive impact on the environment, as demonstrated by the successful application of agroecology by Pesantren Ekologi Ath-Thaariq Garut.

One of the environmental benefits of agroecology is biodiversity and ecosystem preservation. Such local biodiversity reduces the amount of water required for processing. Many local food crops can be produced without a significant amount of water and even generate water for the area[15].

Furthermore, the application of agroecology in the Islamic boarding school has increased food security and reduced the risk of starvation. The Ath-Thaariq Garut community has not experienced crop failure after implementing agroecology practices, as the crops protect and strengthen each other. As a result, the community effectively eliminated the risk of food shortages[16].

Agroecology practices also promote healthier diet within the Islamic boarding school community. Every day, the community consumes diverse food. As a result, the community avoids many diseases as they consume nutritious food without exposure to harmful chemicals (organic)[17].

In summary, agroecology can revolutionize our food production system and increase food availability, consumer access to food and behavior. Such revolution will ultimately improve health and economic status for farmers and consumers as well as impact state policies regarding the food sector.

III. The Benefits of Agroecology

A. The Benefits of Agroecology

By implementing ecology in the agricultural system, agroecology offers benefits not only for farmers but also for the environment. Here are some benefits of agroecology:

1.

Strengthening farmers' local knowledge. Instead of eliminating local knowledge, agroecology strengthens it by combining local knowledge with modern knowledge. Examples of farmers' local knowledge are natural pesticides productions and proven local seed development methods.[18]

2.

Preserving soil fertility and increasing productivity. Agroecology practices that preserve soil fertility and maintain or increase organic matter can reduce the adverse effects of drought as well as increase productivity[19].

3.

Reducing costs. With the application of agroecology, farmers are free not to rely on the agricultural industry (chemical fertilizers, pesticides, etc.). This will reduce production costs, thus benefiting farmers economically[20].

B. Agroecology Practices: Learning from the Odesa Indonesia Foundation in Bandung

The Odesa Indonesia Foundation practices agroecology in the Cimenyan Sub-district, Bandung Regency. At first, agroecology was adopted to address the internal issues faced by local farmer in relation to poverty[21].

Cimenyan is rich with fertile, soft soil lands covered by bamboo trees. Many of them remain unutilized by farmers.

Most farmers rely on only two substances for soil fertilization: manure and chemical fertilizers. They also rely on rainwater or manual watering for irrigation. Collecting soil around bamboo trees is necessary to maintain soil fertility over the long term. By leveraging local knowledge, they have successfully maintained soil fertility and developed seeds significant[22].

Photo source: http://odesa.id

C. Foreign Agroecology Practices: Learning from the Indian Farmers

India has Zero Budget Natural Farming (ZBNF), an agroecological farming system introduced by Subash Palekar, a researcher, author and farmer. ZBNF not only rejects the use of chemical fertilizers, but also maximizes the use of natural resources on the land[23].

ZBNF is grounded in two fundamental aspects:[24]

1. Intercropping multiple crops in one plot of land, such as coconut, betel nut, banana, legumes, gliricidia (rain tree), marigold (a type of orange flower), drumstick (a type of Chinese bean) and other intercropping plants that mutually support each other to increase the humus content in the soil.
2. Mulching, which involves spreading plant residue, such as leaves, straw and branches, on the surface of the land.

Photo source: https://drreddysfoundation.org

IV. The Steps towards Agroecology

Agroecology is one of the solutions to the issues in our current food production system. Agroecology not only restores agricultural land fertility, but also plays a part in reviving the diminishing knowledge of farmers in the era of industrial agriculture.

So, how to begin practicing agroecology? There is no one definitive answer to this question. The implementation of agroecology can vary depending on the specific context of each region, as it is based on local knowledge.

However, we can draw lessons from the experiences of communities that have practiced agroecology. These experiences should be modified to suit the local context rather than replicated as is.

One community that has implemented agroecology is Pesantren Ekologi Ath-Thaariq[25]. The boarding school is located in a highly productive rice field in Garut. Initially in 2008, the boarding school practiced monoculture with IR64 rice. However, over time, the rice yield decreased, mice infested the field and none of the fields produced maximum yield . This prompted the boarding school to adopt a new agricultural method.

Photo source: https://nu.or.id

Below are the steps taken by Pesantren Ekologi Ath-Thaariq:

1 Identifying Problems through Reflections

Upon the emergence of mice that caused damage to their crops, the management of the boarding school reflected on the issue. They then conducted research and found that monoculture disrupts the food chain and ultimately causes chaos.

2 Reconnecting the Disrupted Food Chain

After conducting a serious study of the ecosystem, the management of the boarding school decided to leave some of their land uncultivated and instead turned it into shrubs. The aim was to attract snakes as natural predators.

As a result, the mice that had previously dominated the area slowly disappeared within a year, with only one or two mice remaining. The presence of snakes successfully balanced the population of mice.

3 Changing the Planting Pattern

The garden of the boarding school was then planted with a variety of food, medicinal and hardwood plants with the aim of preserving the established ecosystem. This process took about a year, during which the management of Pesantren Ekologi Ath-Thaariq became increasingly aware that maintaining ecological balance and biodiversity is the main principle in farming. As a result, the land is now ecologically balanced, and the boarding school has gained significant economic benefits.

4 Planting Local Seeds

Understanding the importance of ecosystem balance and biodiversity, the management of the boarding school decided to increase the variety of rice planted. They realized that different rice varieties would work to protect and strengthen each other. The five rice variants that were planted and mixed together were:

Sanggarung, Ciherang, Sarinah, Raja Lele, Panawuan.

Planting local seeds not only preserves the ecosystem, but also revives local knowledge. Based on the experience of the older generations who were farmers in Pesantren Ekologi Ath-Thaariq, locally specific rice varieties are usually more resistant to drought, require minimal fertilizer and water and are weather-resistant. Therefore, local rice is more adaptable to climate change. With various local rice varieties, the boarding school has multiplied its profit since minimum maintenance is required for maximum yield.

5 Applying Spatial Planning for Agriculture

The management of the boarding school implemented spatial planning for agriculture after completing the steps mentioned above. According to them, the planting system at Pesantren Ekologi Ath-Thaariq Ecology was improved by dividing a 10,000 square meter land into different zones. These zones include a Settlement Zone, Rice Field Zone, Seed Saving Area Zone, Aquaculture Zone, Short-Term Plant Garden Zone and Small Forest Zone for birds.

Thanks to the above five steps, the boarding school has successfully minimized agricultural damage caused by pests and diseases as the land has achieved ecological balance.

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