

TJF Agrifood Booklet Series 2

Sustainable Agriculture





The Problem with Agriculture

Rising global population demands for larger food production. While it brings benefits to food access and availability, the whole process of providing food on our plate can also create negative impacts to the environment.

Why does agriculture have a massive impact on many environmental aspects? Think about a slice of pizza. It seemingly only consists of basic ingredients like dough, tomato sauce, and cheese. The farmers need hundreds of gallons of water to grow the wheat and tomato, and to feed the cattle to produce cheese. More water to process the wheat into flour, yeast to make the dough, and water again to produce the gooey mozzarella.

Other than that, the production required energy during the farming process. It involved electricity and fossil fuels to process and distribute the ingredients, and even the energy that was required to manufacture the pizza oven¹. Not to mention the fertilizer and pesticides waste runoff that contaminated the river and sea which lead to eutrophication. Among others, food and agriculture are the major contributors to multiple ecosystem degradation



Each resource is interlinked within the food production process which is known as food, water and energy nexus. While most of these resources are finite, calls to implement a more resource-efficient are inevitable. This notion is embodied into sustainable agriculture principles.

Defining Sustainable Agriculture

The FAO in 1998 defined sustainable agriculture as "the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations". Therefore, sustainable agriculture is not an end, it is a means/approach.

The first aspect is to prevent degradation on soil, water, and biodiversity. The high yields of food production for providing global needs are the result of a variety of factors. These include the increasing use of fertilizer, pesticide, new varieties, water, and innovative cultivation methods. Unfortunately, those kinds of agricultural practices also come at a high cost that harm the community and the environment. For example, pesticides or fertilizer may pollute the water system. Without proper management, agriculture will also experience soil erosion that degrades soil fertility.

The concept of sustainability generally consists of three components of environment, economic, and social.



As for the socio-economic aspect, it aims to ensure the farmers' prosperity, social security, and their capabilities in producing quality yields at optimum rate. Agriculture should provide prosperity to the farming community across generations². In this sense, economic sustainability is generally viewed as economic viability that may be driven by variability in output and input prices, yields, market access, and assistance³. Further components on each aspect can be seen in the following figure.



Factors Affecting Sustainable Agriculture

ndustrialized and mechanized agriculture have been increasing food productivity since the 1960s. Although this had generated a large amount of the food, the future of food production is in peril due to agriculture's problem.

Generally, there are three main categories that affect the sustainability of agriculture: water, land, and climate change.

Water is one of the most important renewable natural resources that let the ecosystem thrive. Water associated with agriculture, without water, no agriculture area was built. Seventy percent of water runs to the agriculture sector and competes with domestic and industrial needs. Global demand for water is predicted to increase by 55% between 2000 and 2050. In Indonesia, the total water requirement for agriculture is estimated to be around 3,500 billion cubic meters (m³) per year, or 11,000 m³ per second (s), which equivalent to:



x 1400 billion international olympic-standard swimming pool

However, most agriculture is rain-fed. Only about 17–20% of agriculture relies on irrigation.



Hence agriculture is very vulnerable to the changing seasons and climate.

To produce one kilogram of rice, we need 2,500 liters of water. So, can you imagine how many waters are required to feed 7 billion people?

In the ecosystem, this resource is allocated unevenly in different forms. Around 97.5% of the global water exists as saltwater and 2.5% as freshwater. Without a proper irrigation system, the water will be lost to the sea. The World Bank estimates that 25–30% of freshwater is wasted.

Many countries built dams to prevent water loss. Dam and irrigation systems are connected to provide water to crops in both rainy and dry seasons. Large capacity of storing water made dams have enough water to irrigate the paddy field in the dry season. Despite the ecosystem risk, China has built more than 22,000 dams over 15 meters tall, this amount made half of the total dams in the world⁵.

and.

The second category is land. Around 11% of land Earth's surface is converted to produce food. Today, large part of arable lands is already utilized, this causes a competition of land conversion between infrastructure and agriculture purposes.

Multiple solutions have been proposed to create new crop lands, but it also involves the risk of adverse impact to biodiversity, water resources, and environmental issues. We are also facing loss of agricultural land due to erosion, lack of water, and desertification. With these issues, how can we provide more food if we don't have enough land to plant?

In terms of cropping methods, irresponsible practice such as slash and burn has also degraded the land. This methods begin by clear-cutting of forest or wood area, and burn them to reduce soil acidity. This technique contributes to deforestation in protected forest areas. After 2–5 years, the soil's nutrient-depleted and hampered the production. The farmer will then start new cycles of slash and burn agriculture, turning the old farming area into abandoned land that is vulnerable to fire.

Other Land Issues



These problems needs to be addressed to approach sustainable agriculture.

Another major issue is identifying effective ways to cope with climate change. Global crop production is predicted to decline between 2–6% in 2030 due to changing temperature and rainfalls. Meanwhile, the world population will increase to 9% in 2030 to 8.5 billion people, this unbalanced situation is a serious threat to food security.

limate Change



When the dry season is too long, it causes drought. Drought drives shortage of water for crop production and raises the temperature above the optimal condition to crops grow. On the other hand, warmer climate will lead to heavier rainfalls. This results in flood that damages agriculture and causes crop failure.

The indirect impact of climate change is the fast growing of pests and plants disease. Pest (insects, fungi, and bacteria) contribute to global crop production loss around 10–16%. The impact of raising global temperature includes the acceleration of pests metabolism, boost their appetites, and increase their reproduction rate⁶. Farmers often experience harvest failure not only because of pests, but also because of the low seed quality that cannot adapt to the changing temperature. More extensive research is needed to create new varieties of seed using genetic engineering that can be resilient under climate change effect.

Way Foward

The main aspect of food security is food production. Food production highly depends on healthy functioning ecosystems that provide services to agriculture. Global food supply needs to keep up with the growing population. FAO projected to feed a world of 9.1 billion people in 2050, it would require raising overall food production by around 70%⁷.

In the last 50 years, the intensification of agriculture has been the driving force behind the rapid growth of food supplies globally. However, this method also has limitations. Intensification practice will degrade soil quality, once it reaches maximum capacity, the harvest yield will hardly generate maximum rate. When fertile land is decreasing, suboptimal land can be an alternative to produce food. Further discussion regarding suboptimal land potential can be found in another edition of this booklet series.

^{6.} Curtis A. Deutsch et al., 2018. Increase in crop losses to insect pests in a warming climate. Science 31, 916-919.

^{7.} FAO. 2009. High Level Expert Forum - How to Feed the World in 2050.

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