



## Integrated Sustainable Agriculture To Realize Biodiversity-Based Food and Energy Sovereignty

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### Abstract

Sustainable agriculture is the management and conservation of natural resources; oriented towards technological and institutional changes which carried out in such a way as to ensure the fulfillment and satisfaction of human needs in a sustainable manner for present and future generations. Food independence is the ability of the state and nation to produce diverse food from within the country which can ensure the fulfillment of sufficient food needs. Basically the food must be available at all times and to be able to meet the criteria for food security. Food availability is determined by 3 main aspects, namely production (quantity), distribution (accessibility), and consumption (nutritious and safe). In addition, renewable energy can come from agricultural materials. The energy crisis that occurs today is caused by an imbalance in the demand for energy that continues to increase with energy supply that is dependent on non-renewable fossil fuels, such as oil, coal and natural gas. This dependence is a serious threat to the world because of the known depletion of petroleum reserves, the instability of oil prices, and the pollution of greenhouse gases due to the burning of fossil fuels. The energy crisis will result in losses, both material and immaterial, such as loss of investor and consumer confidence, hampered creativity, inefficiency, and the risk of social unrest. The solution that is usually offered to overcome the energy crisis that occurs is the development and use of alternative energy sources, one of which is biofuels or biofuels.

**Keywords:** biodiversity; energy crisis; food independence

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### Introduction

Integrated agriculture is an agricultural system that is in harmony with natural principles, namely seeking a balance in nature by building a pattern of mutually beneficial and sustainable relationships between each component of the agricultural ecosystem involved, by increasing biodiversity and utilizing organic waste materials. Basically nature was created in a balanced state by the creator, so that nature has its own way to meet human needs for food and humans as part of the natural elements have the task of managing natural resources and the environment properly and proportionally. Increasing biodiversity is important in controlling pests and diseases, reducing risk, while the use of organic waste is

necessary to create a balance of energy cycles (especially nutrients) that is sustainable, as well as for the benefit of soil and water conservation (1,2).

Integrated farming patterns are a combination of traditional farming patterns with modern science in the field of agriculture that continues to develop. In the implementation of integrated agriculture, more utilize the potential of the existing land by taking into account the impact on the surrounding environment as well as with modern management that is managed professionally and in an integrated manner (3).

The purpose of the integrated farming system, among others, is to promote the integrated farming system as sustainable

agriculture where the location of the land is considered and improved to ensure the continuity of a continuous cycle (4). Forming a farming community that is independent and cares about the environment and is aware of its identity as a guardian of nature. Improving the standard of living of the welfare of the community in a fair and equitable manner with a forward mindset and a simple lifestyle (5). Forming a cooperative bond in the form of people's core agriculture and building equal cooperation in meeting the needs of the agricultural sector. Meet the market need for healthy and pollution-free food in order to improve quality in competition (6).

In practice, integrated farming systems are not as easy and simple as many people think. Accurate strategies are needed so that the objectives of the integrated agricultural system can be achieved in accordance with what has been expected. The strategy that must be developed is an integrated farming business that is market-oriented and the preservation of traditional cultural values with a modern management activity system. The strategies that need to be developed are, the first is traditional agriculture by utilizing the wealth of resources owned and managed with modern management which aims to reduce dependence on inorganic fertilizers (7). The mechanism system is in the form of procurement of production facilities, storage of agricultural products, product processing technology, and integrated agricultural laboratories (8). The second strategy is cultural and spiritual mental development by creating a system of role models, kinship, openness and honesty. The third strategy is to use an independent farming system that is managed by themselves by utilizing the resources they have. The fourth strategy is to build supporting facilities that are very adequate and can be used optimally. The purpose of this article is to review efforts to realize integrated sustainable agriculture to realize biodiversity-based food and energy sovereignty.

### **Sustainable Integrated Agriculture**

Agriculture can be interpreted as an effort to harvest sunlight, or the transformation of solar energy into organic energy. In terms of commodities, agriculture consists of food crop agriculture, plantations, forestry, horticulture, animal husbandry and fisheries, while in terms of the science that builds it, agriculture is built from hard sciences and soft sciences both at the strength of basic, applied and advanced

sciences as well as the sciences of marriage (9).

Based on this understanding of agriculture, it can be seen that agriculture is a science and product of a commodity with a very broad scope. Based on this scope, the development of agricultural sciences cannot stand alone. All activities must be combined to produce a technology that is able to provide food for this nation in a sustainable manner. Thus, in turn, the resulting technology will no longer be confined to one field of science, but is already a frontier technology. Therefore, in terms of the sciences that build it, agricultural science that must be developed is integrated agricultural science (10).

Although in terms of commodities, the scope of agriculture is very broad, but actually each interacts with each other in an ecosystem. These ecosystems make up agriculture as a whole, hereinafter referred to as agroecosystems. According to Qaim, (2020), an agroecosystem is a community unit of plants and animals and their chemical and physical environment that has been modified by humans to produce food, fiber, fuel, and other products for human consumption and processing. A simple example is if corn is planted in an area, then when the corn is harvested, the crop residue is waste that does not have to be thrown away and can be used as fertilizer by farmers. Likewise, if ruminant livestock are available in the area, the waste is a blessing because it will become food for the ruminant animals. A reciprocal relationship will occur when livestock excrete manure which is used as fertilizer for crops grown in the area.

The term agricultural system refers to a specific arrangement of farming activities (e.g. crop cultivation, animal husbandry, processing of agricultural products) which are managed based on the capabilities of the physical, biological, and socioeconomic environment and in accordance with the objectives, capabilities and resources of the farmers (12). These agricultural systems vary widely in terms of productivity and efficiency in the use of land, labor and capital and their impact on the environment (13).

If the agricultural system is developed independently, crop residues, or manure from livestock, are waste that can cause problems and their handling requires high costs so that it will increase the production costs of agricultural businesses. If this is the case, it is the same as in the development of agricultural

science, in terms of production, agriculture also requires integration or integrated agriculture. Therefore, integrated agriculture is the main pillar of the rise of the Indonesian nation because it will be able to provide actual food for this nation in a sustainable manner (14).

Production in the field of integrated agriculture is essentially utilizing all the potential energy so that it can be harvested in a balanced way. In order for the utilization process to occur effectively and efficiently, it is better if integrated agricultural production is located in an area. In this area there should be a crop production sector, livestock and fisheries. The existence of these sectors will result in the area having a complete ecosystem and all production components will not become waste because they will definitely be utilized by other components. Besides, there will be an increase in production output and suppression of production costs so that production effectiveness and efficiency will be achieved (15).

### **Food Sovereignty**

Food sovereignty is the right of every nation and every people to produce food independently and the right to establish a system of agriculture, animal husbandry and fisheries without any subordination from international market forces. Food sovereignty is a prerequisite for food security. It is impossible to create food security if a nation and its people do not have sovereignty over the process of food production and consumption. Therefore, it is a must for every nation and people to be able to have the right to determine the food they choose and the agricultural policies they carry out, local food production capacity at the local level and trade at the regional level (16).

The food crisis is a classic problem for this nation, an irony for an agrarian country whose land is fertile and gemah ripah loh jinawi. The current food crisis occurs where Indonesia's food needs have depended on imports, and prices have risen uncontrollably. However, it must be noted that the food crisis that occurred in Indonesia is not a cause that will have an impact on other things such as poverty and unemployment (17).

Law of the Republic of Indonesia Number 18 of 2012 concerning Food, food sovereignty is the right of every citizen to produce food independently and the right to establish agricultural, livestock and fishery

systems without any subordination from international market forces. Several articles in it are ambiguous and further weaken the position of local food producers: Food Availability Article 12 paragraph 3 "In realizing food availability through local food development, local governments determine the type of local food". This means that the community cannot be involved in determining the type of local food because the government will determine the type of local food (18).

Indonesia's food security, independence and sovereignty are considered not yet strong, this is indicated by the high imports of food products. This condition shows that food security efforts are still focused on availability and consumption, and have not been oriented to the production, self-reliance and food sovereignty side. Facing the challenge of food security requires several strategies. Starting from increasing food security in terms of availability, stability, accessibility, consumption so that the progress of economic growth can be assessed, and that of an individual and a nation (19).

### **Biodiversity-Based Energy**

Seeing the reality of the global environment with the impact of global warming; several things that must be done besides seeking adaptation to minimize the risk of potential disasters that may occur. First, look for cleaner fuel alternatives. Second, looking for fuel diversification solutions so that in the future our country will not depend on fossil fuels whose availability is dwindling. Third, developing new and renewable fuels that have the potential to become a competitive advantage for Indonesia in the international market (20). With the awareness that petroleum as the main source of transportation fuel in Indonesia is running low and the price of oil is high in the world, the development of renewable energy sources must be carried out. Energy sources can be obtained from all fields. One of them is agriculture. Agriculture can be used as a source of fuel. We know the terms bioalcohol, biomass, and biodiesel which can replace the use of fossil fuels. With bioenergy, this biofuel will never run out as long as the sun still emits light, there is water, oxygen, and agricultural cultivation (21).

The use of alternative energy that has been intensively promoted lately is not without reason. In 2010, it is estimated that 23 million kL of gasoline is needed to meet the needs of the community. However, Pertamina is only

able to supply around 16 million kL/year and tends to be constant, even though every year people's needs continue to increase by 10%. As a result, the government is unable to meet domestic fuel needs. In addition, the depletion of fossil fuel supplies and carbon emissions are also one of the main drivers (18).

Indonesia as a tropical country has many plants that can be processed into fuel oil from palm oil, coconut, jatropha, kesambi, sunflower, sugar cane, corn, cassava. From agricultural production, Indonesia can develop energy agriculture, so that the position of farmers is better than before. Utilization of production that is still not consumed by the community becomes an opportunity in creating bioenergy (22).

Until now, Indonesia is still very dependent on fossil-based fuels as an energy source. Based on data from the Ministry of Energy and Mineral Resources, it shows that with crude oil inventories in Indonesia, which is around 9 billion barrels, and with an average production rate of 500 million barrels per year, these supplies will run out in 18 years. To reduce dependence on petroleum and meet global environmental requirements, the only way is through the development of environmentally friendly alternative fuels (23,24).

Bioenergy also serves to improve the welfare of the community (especially farmers). Productivity of agricultural products in an area is the main point of energy development. By disseminating various knowledge and progress at various scales of bioenergy development, it is certain that there will be many direct benefits for the community; including the absorption of labor, and the fulfillment of the necessities of life. Rural scale factories will be the main support for energy independent villages in various regions. The community will be able to meet their energy needs for transportation fuel or fishing boat motors. Community-by-community energy (25–27).

Bioenergy is alternative energy that comes from biological sources. The advantages of using bioenergy are improving environmental quality, increasing economic growth, and reducing dependence on fossil fuels (28,29). Currently, the development of bioenergy has reached the fourth generation, namely converting vegetable oil and biodiesel into gasoline. The first generation of bioenergy development is considered unethical because it competes with food and feed ingredients into vegetable oil, biodiesel, bio-alcohol, biogas,

solid biofuel, and syngas. Utilization of materials other than food and feed started in the second generation including using waste, cellulose and plants dedicated to energy development (dedicated energy crops), which converts biomass into liquid technology. The third generation of biofuel development is algae derived from algae. The current use of bioenergy has even reached the development of aircraft fuel. The Embraer EMB 202 Ipanema is the first ethanol-fueled aircraft and is widely used in agricultural fields (agricultural aircraft). In addition, wood-based syngas has also been developed which is used as a generator (30).

In Indonesia, there are 49 types of plants that can be used as a source of energy. Some of the potential crops as bioenergy producers are oil palm, coconut, jatropha, cotton, kapok randu for biodiesel, as well as cassava, sweet potato, sugar cane, sorghum, sago, sugar palm, nipah, and palm palm for bioethanol (31,32). In addition to their potential as bioenergy producers, some of these commodities, such as oil palm, coconut, cotton, cassava, sugar cane, and sago, are also sources of food and feed commodities. The development of food source commodities as raw materials for bioenergy is seen as unethical because it competes with food and feed ingredients (33).

One alternative fuel that is easily managed is biodiesel. Biodiesel is a diesel motor fuel in the form of alkyl esters/alkyl fatty acids (usually methyl esters) made from vegetable oil through a trans or esterification process. The term biodiesel is synonymous with pure fuel. Mixed biodiesel (BXX) is biodiesel as much as XX% which has been mixed with diesel in the amount of 1-XX%. Research in the field of biodiesel so far continues to develop by utilizing a variety of vegetable and animal fats to obtain biofuels and can be renewed (renewable). Biodiesel is a fuel that has properties similar to diesel/diesel oil. This fuel is environmentally friendly because it produces exhaust gas emissions that are much better than diesel/diesel, which is free of sulfur, low smoke number, has a higher cetane number, combustion is more complete, has lubricating properties for engine pistons. and can be decomposed (biodegradable) so it does not produce toxins. Making biodiesel from vegetable oil is done by converting triglycerides (the main component of vegetable oils) into fatty acid methyl esters, using a catalyst in the methanolysis (esterification)

process. In Indonesia, the potential for biodiesel raw materials is very abundant. Currently, Indonesia is the largest vegetable oil producer in the world, the raw materials for

vegetable oil include fatty acids from palm oil, jatropha, coconut, soursop, sugar apple, and kapok.

Table. Plants or plants that can produce bioenergy

Local Name	Latin Name	Oil source	Fill % Dry Weight
Jarak Pagar	<i>Jatropha curcas</i>	seed core	40-60
Jarak Kaliki	<i>Ricinus communis</i>	seed	45-50
Kacang	<i>Arachis hypogea</i>	seed	35-55
Kapok Randu	<i>Ceiba pantandra</i>	seed	24-40
Karet	<i>Hevea brasiliensis</i>	seed	40-50
Kecipir	<i>Psophocarpus tetrag</i>	seed	15-20
Kelapa	<i>Cocos nucifera</i>	seed core	60-70
Kelor	<i>Moringa oleifera</i>	seed	30-49
Kemiri	<i>Aleurites moluccana</i>	seed core	57-69
Kusambi	<i>Sleichera trijuga</i>	fiber	55-70
Nimba	<i>Azadiruchta indica</i>	seed core	40-50
Saga Utan	<i>Adenanthera pavonina</i>	seed core	14-28
Sawit	<i>Elais suincencis</i>	fiber and seed	45-70 + 46-54
Nyamplung	<i>Callophyllum lanceatum</i>	seed core	40-73

The fulfillment of energy needs must be supported by alternative energy as a solution to dependence on fossil energy which can lead to an energy crisis. Problems and solutions so that alternative energy can develop are rooted in the subsidy policy. If alternative energy can be commercialized, the next step is diversification so that energy needs can be fulfilled evenly and efficiently. It is necessary to change the mindset that taking public transportation, cycling, or walking does not mean less respectable, but on the contrary, because it will save the country's foreign exchange for oil imports. For this reason, it is necessary for lecturers and students to actively socialize to the public about energy in Indonesia, for example by writing articles in the mass media or holding alternative energy seminars. Lecturers and students can conduct research on energy, the results of which can be implemented by the government and investors. With research by experts including students, technology will develop along with the widespread implementation of alternative energy in Indonesia (34).

### Conclusion

Sustainable agriculture is basically a concept involving challenges for producers to begin to consider the long-term implications of the way of cultivation, the interaction of farming systems, and the dynamics of agricultural systems. This conception also encourages consumers to be more involved as active participants in the food system. Based

on the Law of the Republic of Indonesia Number 18 of 2012 concerning Food, Food Sovereignty is the right of the state and nation to independently determine food policies that guarantee the right to food for the people and which gives the community the right to determine a food system that is in accordance with the potential of local resources. Bioenergy is alternative energy that comes from biological sources. The advantages of using bioenergy are improving environmental quality, increasing economic growth, and reducing dependence on fossil fuels.

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