Biodiversity conservation through sustainable agriculture, its relevance to climate change: a review on Indonesia situation

D Harnowo*, FC Indriani, GWA Susanto, Y Prayogo, and I M J Mejaya
ILETRI (Balitkabi) Malang, Jln. Raya Kendalpayak Km 8, PO Box 66 Malang, 65101, Indonesia Phone: 0341-801468, Fax.: 0341-801496,

*Email: didikharnowo.kabi@gmail.com

Abstract. A productive agriculture depends on diversity of biodiversity that extends from crops (including food crops) and livestock to their wild relatives, and beyond this to a vast array of other flora and fauna. There is a close relationship among agriculture productivity, biodiversity conservation and livelihood objectives. Biodiversity loss have significant impact to agriculture and economic development. Since sustainable agriculture in Indonesia has not yet been well implemented, our challenge today is how to push such agriculture so as to promote agrobiodiversity, and it is clear that sustainable agriculture both promote and is enhanced by biodiversity. Or, biodiversity conservation can be implemented through sustainable agriculture. Agriculture, ecosystem, and biodiversity are affected by climate change which is now ongoing. Ecosystem play a major role in reducing the impact of climate change. Since biodiversity and agriculture are in it, thus best management of ecosystem can play an important role in climate change mitigation and social adaptation, but will only provide benefits if deployed in conjunction with a reduction in fossil fuel emissions. Thus, sustainable agriculture can also contribute to conservation and sustainable use of biodiversity, and also to reduce the impact of climate change.

1. Introduction
Biodiversity is a very valuable asset for the long term that needs to be continuously studied, researched and conserved. According to Rosichon Ubaiddillah (in Handoko [1]), the status and trend of Indonesia's biodiversity has made Indonesia as one of the world's agrobiodiversity centers with 10% of the world's total plant species. The Ministry of Environment and Forestry [2] has reported that Indonesia ranks seventh in the world in the richness of flowering flora. Part of those Indonesia's rich biodiversity has been utilized and provided economic value. A number of important agricultural crops of national and global originate from Indonesia, including black pepper, cloves, sugarcane, several types of tropical fruits and food crops. Furthermore, more than 6,000 types of plants and animals are used by the Indonesian people to meet their daily needs, either directly or indirectly harvested from nature or cultivated crops. Many research institutions, including The Indonesian Institute of Science (“LIPI”), The Indonesian Agency for Agricultural Research and Development (“IAARD”) and Universities, have made use of biodiversity for bioproducts, including bioprospection in the form of herbal immunomodulators for Covid-19 and other bioproducts to support national bioeconomic development [1, 3, 4, 5]. Therefore, it is clear that Indonesia's biodiversity is a very important resource for national development, even for the sustainability of human life in the future.
In line with the above opinion, Mittermeler et al. (1998 in Supriatna [6]) stated that Indonesia is one of the megadiversity areas on earth. However, many areas in Indonesia are now considered as hotspots, characterized by an extraordinary level of endemism which results in serious habitat loss. The hotspot is Sundaland, which consists of large islands, namely Sumatra, Java and Kalimantan; and Wallacea, which consists of the Sulawesi Islands and Lesser Sunda Islands, and Maluku. Apart from having high levels of endemicity, these areas are increasingly under threat as a result of large-scale land conversion and increased habitat loss, particularly under pressure from economic priorities. Gore [7] also stated that Indonesia has an important role in protecting the balance of the earth because its forests are large carbon reserves, known as "the lungs of the earth". As much as 40% of the excess carbon dioxide (CO₂) that now accumulates in the atmosphere is due to deforestation in places like Indonesia. Its self-repairing nature is the main advantage of biodiversity to be used for sustainably. In relation to these matters, the conservation of biodiversity is very important and decisive for the sustainability of sectors such as forestry, agriculture and fisheries, health, science, industry and tourism, and other related sectors.

In the framework of implementing national development, coordinated policy and steps are needed to address issues of biodiversity management for development purposes. Biodiversity management is not only the responsibility of the government, but all parties have interest and obligations. In the Law Number 5/1990 concerning Conservation of Living Natural Resources and their Ecosystems[8], it was stated that those are the responsibility and obligatory of government and community. The same thing has also been conveyed by several environmental scientists [9, 10]. Realizing the benefits and importance of the diversity of biological resources, it cannot be denied that there are individuals, communities, or even associations taking actions which cause the erosion or damage of these biological resources [11]. Recognizing the importance of agricultural sustainability to maintain and conserve Indonesia’s biological natural resources, proposals for the revision of Law Number 5/1990 have been submitted i.e. regarding the need for firm action for those who destroy biological natural resources. The main point is that what the government want to put forward is whether the policy being pursued is more towards development or environmental protection [12].

Biodiversity is defined as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine or other aquatic ecosystems and the ecological complexes of which they are part. This includes biodiversity within species, between species and of ecosystems'. This is the single legally accepted definition of biodiversity adopted by the UN Convention on Biological Diversity [13, 14]. The most straightforward definition of biodiversity is the variation of life at all levels of biological organization. It includes diversity of forms from the molecular unit to the individual organism, and then on to the population, community, ecosystem, landscape and biosphere level. In the simple sense, biodiversity may be defined as the sum total of species richness, i.e. the number of species of plants, animals and microorganisms occurring in a given region, country, continent of the entire globe. Broadly speaking, the term biodiversity includes genetic diversity, species diversity, ecosystem diversity and habitat diversity [14]. Therefore, biodiversity is vital to the healthy functioning of ecosystems. Healthy ecosystems provide a flow of valuable services including the provision of food, fuel and medicines, the regulation of water and air quality, nutrient cycling and many other services from which we benefit directly or indirectly. Whilst human-made changes to ecosystems have often generated large economic gains, biodiversity loss damages the functioning of ecosystems and leads to a decline in essential services, which may have severe economic consequences, particularly in the longer term.

Biodiversity plays a crucial role in food security, nutrition, livelihoods and in the provision of ecosystem services [15]. Furthermore, agriculture sectors are major users of biodiversity but also has potential to contribute to the protection of biodiversity. Agricultural biodiversity includes all the components of biological diversity of relevance to food and agriculture together with the components of biological diversity that constitute the agro-ecosystem. This diversity has been shaped by farmers and communities for millenia and remains a key element of the livelihood strategies of poor, small-scale farmers throughout the world. Biodiversity conservation can be carried out both in-situ and ex-
situ. Both, in-situ and ex-situ means of conservation are equally important. They are to be considered complementary and may constitute an integral part of programmes aiming at improved use of genetic resources available in nature [14, 16]. In this paper we discuss biodiversity conservation through sustainable agriculture and its relevance to climate change, as a review on Indonesia situation, with the following topics: economic impact of biodiversity loss, the concept of sustainable agriculture, biodiversity conservation in Indonesia, and relationship among climate change, biodiversity conservation, and sustainable agriculture.

1.1 Economic impact of biodiversity loss
Smith [9] have already reminded that biodiversity become the world’s economic backbone. He stated that biodiversity crisis was really happening, and even might occurred long before that time. Swaminathan and Kesavan [17] also observed that the green revolution or exploitative agriculture began to show production fatigue since the 1990s and led to reduced biodiversity, clean water and degradation of soil health. Therefore, smart thinking about a sustainable agricultural revolution or "Evergreen Revolution" was needed. According to Niesenbaum [18], biodiversity is critical for ecosystem function and services on which humans depend, and is directly linked to the economic, social, and environmental components of sustainability. Latest information given by OECD [19] is that biodiversity loss is one of the greatest risks of the 21st century. It undermines human health and well-being, societal resilience and progress towards the SDGs (Sustainable Development Goals). It places severe cost on world economies and makes addressing other global challenges such as climate change, much more difficult. The organization (OECD) also claimed that humans have transformed the majority of the world’s ecosystems, destroying, degrading and fragmenting terrestrial, marine and other aquatic habitats, and undermining the services they provide. Even, Arora [10] stated that the biodiversity loss is at its highest rate since the arrival of Homo sapiens on the blue planet. Since last a decade, Smith [9] have reminded that it can no longer be 'business as usual’ without there being serious consequences for all life on earth.

A large number of sectors of the national economy depend directly or indirectly on the diversity of flora and fauna, natural ecosystem and the environmental functions they produce. However, the damage to biodiversity is likely to continue. In relation to those phenomena, Rhodes [20] stated that soil is mainly degraded by human activities, principally those of agriculture. Land-clearing, irrigation, the spraying of chemical fertilizers and pesticides, overgrazing and the mechanical effect of heavy farming equipment passing over the soil, all take their toll. The degradation of soil drives the loss of biodiversity, and also impacts on global warming through changes in the local albedo and the emission of GHG (green house gases) such as methane and nitrous oxide, as the oxygen tension of the soil becomes diminished. Thus, it is clear that biodiversity loss affecting economic development of the countries.

Information on the impact of direct economic loss which is stated in number (rupiah value) due to damage or even loss of biodiversity in Indonesia is still difficult to find. This may be due to detailed and comprehensive research on this matter have not yet been done, though, according to Stern [13], not all values of diversity can be addressed through an economic approach. The intrinsic value of biodiversity – recognised in the opening clause of the CBD (Convention on Biological Diversity) – cannot be monetised, but should also be taken into account in decision-making.

Based on the research concerning the relation of biodiversity loss and economic growth, Asafu-Adjaye [21] concluded that: (a) biodiversity loss belongs to a special category of environmental degradation because it involves the irreversible loss of valuable ecosystem, (b) while economic growth has an adverse effect on biodiversity, the type or composition of this growth can also be significant for biodiversity loss, and (c) countries with a higher component of agricultural output in total output, which tend to be the low-income countries, experience relatively greater biodiversity decline, meaning that there is the negative effects of economic growth on biodiversity loss. OECD [19] also stated that ecosystem services delivered by biodiversity are vital to human well-being. Globally, these services are worth an estimated USD 125-140 trillion (US dollars) per year, i.e. more than one and half times
the size of global GDP. The costs of inaction on biodiversity loss are also very high. Between 1997 and 2011, the world lost an estimated USD 4-20 trillion per year in ecosystem services owing to land-cover change and USD 6-11 trillion per year from land degradation. Thus action to halt and subsequently reverse biodiversity loss needs to be scaled up dramatically and urgently because biodiversity protection is fundamental for achieving food security, poverty reduction, and more inclusive and equitable development.

1.2 The concept of sustainable agriculture

According to Sumarno [22], the definition of sustainable agriculture for Indonesia is: an agricultural business that is able to provide optimal yields in terms of quantity and quality, accompanied by efforts to preserve the quality of agricultural and environmental resources so that agricultural resources remain productive and environmental quality is maintained for the lives of future generations. Economic aspects and farmer welfare are not explicitly included in the definition, but implicitly covered by “optimal yields in terms of quantity and quality”. Furthermore, he stated that sustainable agriculture generally refers to four main points of interest, namely: (a) present and future food sufficiency, (b) the present and future economic viability of agricultural business, (c) environmental sustainability and quality of natural resources, and (d) preservation of biodiversity.

In line with the above concept, UCS [23] explained that a growing number of innovative farmers and scientists have already taken a different path, moving toward a farming system that is more sustainable—environmentally, economically, and socially. This system has room for farms of all sizes, producing a diverse range of foods, fibers, and fuels adapted to local conditions and regional markets. It uses state-of-the-art, science-based practices that maximize productivity and profit while minimizing environmental damage. Besides, some proponents of industrial agriculture claim that its impacts are the price we must pay to “feed the world”. In fact, a growing body of scientific evidence has debunked this claim, showing that a more sustainable model can be just as profitable—and can meet our needs for the long haul. Thus, in agriculture, sustainability is a complex idea with many facets, including the economic (a sustainable farm should be a profitable business that contributes to a robust economy), the social (it should deal fairly with its workers and have a mutually beneficial relationship with the surrounding community), and the environmental. In the practical aspect, environmental sustainability in agriculture means good stewardship of the natural systems and resources that farms rely on. Among other things, this involves: (a) building and maintaining healthy soil, (b) managing water wisely, (c) minimizing air, water, and climate pollution, and (d) promoting biodiversity. There is a whole field of research devoted to achieving these goals: agroecology, the science of managing farms as ecosystems. By working with nature rather than against it, farms managed using agroecological principles can avoid damaging impacts without sacrificing productivity or profitability. With the mean which was not contrasting with the above definition, according to Arora [10], agricultural sustainability can be achieved through the use and implementation of agricultural technology that is able to increase crop production to meet the needs/demands for the growing population, while at the same time maintaining and protecting the environment and natural resources.

Sustainable agriculture is closely related to the concept of agroecology, because there are many agroecological practices in it. According to Wezel et al. [24], agroecological practices are aiming to produce significant amounts of food, which valorise in the best way ecological processes and ecosystem services in integrating them as fundamental elements in the development of the practices, and not simply relying on ordinary techniques, such as chemical fertiliser and synthetic pesticide application or technological solutions, such as genetically modified organisms. Thus, agroecological practices contribute to improving the sustainability of agroecosystems while being based on various ecological processes and ecosystem services such as nutrient cycling, biological N fixation, natural regulation of pests, soil and water conservation, biodiversity conservation, and carbon sequestration. Some of these practices have already been applied in varying degrees in different regions of the world for years or decades, while others were more recently developed and still have a limited rate of
application. Over decades of science and practice [23], an example of several key sustainable agriculture/farming practices are:

a. Rotating crops and embracing diversity. Planting a variety of crops can have many benefit, including healthier soil and improved pest control. Crop diversity practices include intercropping and complex multi-year crop rotation.

b. Planting cover crops. Cover crops, like clover or hairy vetch, are planted during off-season times when soil might otherwise be left bare. These crops protect and build soil healthy by preventing erosion, replenishing soil nutrients, and keeping weeds in check, reducing the need for herbicides.

c. Reducing or eliminating tillage. Traditional plowing (tillage) prepare fields for planting and prevents weed problems, but can cause a lot of soil loss. No-till or minimum tillage can reduce erosion and improve soil health.

d. Applying integrated pest management (IPM). Arrange of methods, including mechanical and biological controls, can be applied systematically to keep pest populations under control, while minimizing use of chemical pesticides.

e. Integrating livestock and crops. Industrial agriculture ends to keep plant and animal production separate, with animals living far from the area where their feed is produced, and crops growing far away from abundant manure fertilizers.

f. Managing whole systems and landscapes. Sustainable farms treat uncultivated or less intensively cultivated areas as integral to the farm-polinators and other biodiversity.

Sustainable agriculture is related to sustainable agroecosystem because in managing agriculture human/farmers effort their farm to mimic natural agroecosystem. In relation the those concept, Pretty [25] have shown the properties of natural ecosystem, modern and sustainable agroecosystem. Based on many linked literatures, then he explained that agricultural sustainability emphasizes the potential benefits that arise from making the best use of both genotypes of crops and animals and their agroecological management. Agricultural sustainability does not, therefore, mean ruling out any technologies or practices on ecological grounds (e.g. genetically modified or organic crops)—provided they improve biological and/or economic productivity for farmers and do not harm the environment. Agricultural sustainability, therefore, emphasizes the potential dividends that can come from making the best use of the genotypes (G) of crops and animals and the ecological (Ec) conditions under which they are grown or raised. The outcome is a result of this G x Ec interaction, suggesting that it focus on both genotype improvements through the full range of modern biological approaches, as well as improved understanding of the benefits of ecological and agronomic management, manipulation and redesign. However, realizing the importance of sustainable agriculture, its implementation in Indonesia has not yet been fully met the target [26, 27].

Furthermore, agroecosystems are amended ecosystems that have a variety of different properties (Table 1). Modern agricultural systems have amended some of these properties to increase productivity. Sustainable agroecosystems, by contrast, have to seek to shift some of these properties towards natural systems without significantly trading off productivity. Modern agroecosystems have, for example, tended towards high through-flow systems, with energy supplied by fossil fuels directed out of the system (either deliberately for harvests or accidentally through side effects). For a transition towards sustainability, renewable sources of energy need to be maximized and some energy flows directed to fuel essential internal tropic interactions (e.g. to soil organic matter or to weeds for arable birds) so as to maintain other ecosystem functions.
Table 1. Properties of natural ecosystems compared with modern and sustainable agroecosystem.

| Properties                        | Natural Ecosystem | Modern Ecosystem | Sustainable Ecosystem |
|-----------------------------------|-------------------|------------------|-----------------------|
| Productivity                      | Medium            | High             | Medium-high           |
| Species diversity                 | High              | Low              | Medium                |
| Functional diversity              | High              | Low              | Medium-high           |
| Output stability                  | Medium            | Low-medium       | High                  |
| Biomass accumulation              | High              | Low              | Medium-high           |
| Nutrient recycling                | Closed            | Open             | Semi-closed           |
| Trophic relationship              | Complex           | Simple           | Intermided            |
| Natural population regulation     | High              | Low              | Medium-high           |
| Resilience                        | High              | Low              | Medium                |
| Dependence on external input      | Low               | High             | Medium                |
| Human displacement of ecological processes | Low           | High             | Low-medium            |
| **Sustainability**                | **High**          | **Low**          | **High**              |

Source: Gliessman (2005 in Pretty [25]).

1.3. Biodiversity conservation in Indonesia

Biodiversity conservation activities are considered important in order to maintain and at the same time to inhibit the extinction of existing genetic resources which is potential for foods, raw materials for chemical and pharmaceutical industries. Several example concerning the implementation of biodiversity conservation activities in Indonesia are as follow, especially for food crop commodities.

a. In-situ conservation of biodiversity is in home gardens by farmers/communities [28]. Basically, this has been done for a long time, especially by people in rural areas. They realize that if this is not done, there will be scarcity, or even extinction of those type of plant. Thus, what is cultivated, apart from those being harvested as food, also means as a form of biodiversity conservation. The types of plants cultivated are influenced by the preferences of the owners of the yards, the area of the yards, the agroecosystem conditions, the socio-economic and the culture of the local community. In Wonosari, Yogyakarta and several areas in Central Java, for example, the variety/types of food crops cultivated in the home gardens are generally the same as those cultivated on “tegal” (upland) area. Cereal crops, as a source of carbohydrates, commonly found in home gardens were the same as found on dry land (upland) agroecosystem, including upland rice, maize, sorghum, and also ‘jali’ and ‘jujawut’. Food crops that are sources of fat and protein found include peanuts, ‘gude’ (Cajanus cajan), ‘kacang koro’, dan ‘kacang nasi’ (Vigna umbelata), while plants from the tubers group are cassava (Manihot utilisima), sweet potato (Ipomoea batatas), ‘ganyong’ (Canna indica), ‘garut’ (Maranata arundancea), ‘talas’ (Colocasia esculenta), ‘keladi/sente’ (Xantosoma sp.), ‘uwi, gembili, gadung’ (Dioscorea sp.) and ‘suweg’ (Amorphopallus sp.).

b. Nirmala et al. [29] reported that based on an inventory of the genetic resources of home garden plants in three agroecologies (low, medium, and high altitude) in West Sumatra, the proportion of food crops (together with fruit crops, ornamental, medicinal, and vegetables plants spices) ranged from 3.0 to 5.5%, while for medicinal and ornamental plants, the ranges were 11.0 - 17.2% and 32.8 -46.2%, respectively. The types of food crops found were carbohydrate sources, namely cassava, sweet potato, and taro. Several researchers [30, 31] argued that managing home garden is a form of mini-farming and serves as a reserve for diversity of agricultural plant species, as well as a concrete form of in-situ conservation of biodiversity. The Sustainable Food Reserve Garden/SFRG or what is known in Indonesia as ‘Kawasan Rumah Pangan Lestari/KRPL, which was developed since 2011[32], in addition to functioning as a source of healthy food in the context of supporting food security, it also serves to conserve in-situ biodiversity (including food crops).
c. Another example of in-situ biodiversity conservation is on swamp land areas. Swamp land in Indonesia are quite extensive, among others, are scattered in South Kalimantan, Central Kalimantan, South Sumatra, and Lampung. In swamp agroecology there are many agricultural biodiversity, including food crops. From these various locations, Khairullah et al. [33] reported that there were 221 rice accessions, 176 of which came from tidal swamp land and 46 came from lowland swamps, and it is estimated that more than 300 rice accessions were found in swamp land. Apart from rice, the lowland swamps of South Kalimantan also contain genetic resources of local tuber crops, for example, ‘ubi Alabio’ (Dioscorea sp.) and sweet potato (Ipomoea sp.). The various types of Dioscorea sp. found included ‘ubi habang harum’, ‘ubi kesumba’, ‘ubi tongkat’, ‘ubi ketan’, ‘ubi niur’, ‘ubi jawa’, ‘ubi cina’ ‘ubi putih’, dan ‘ubi habang carang’; while the local types of Ipomoea batatas were ‘kyai lama’, ‘kyai baru’, ‘labu’, and ‘nagara’ [34]. These genetic resources have special characteristics which are potential for tailoring of new superior varieties through plant breeding. Unfortunately, it is not explained how to cultivate this biodiversity. Because it has already been there for a long time and it is exist there today, it is certain that the local community cultivates those of local cultivars according to indigenous knowledge, and thus is a way of in situ conservation.

d. A form of genetic resource conservation is also done in Sumba Island. Those was carried out by the community (especially in Central Sumba Regency) in the built environment, which is known as the ‘Kaliwu System’. The Kaliwu System is an integrated farming system that integrates various types of plants in a dry land unit. Based on evaluation conducted by Njurumana et al. [35], local communities view plant biodiversity as a source of life because it has four advantages, namely those related to economic aspects (increased income), ecological aspects (conservation of plant genetic resources), socio-cultural aspects, and religious/ belief aspects. Some of the existing plant species as food producers include: ‘talas’ (Colocasia esculenta), ‘gembili’ (Dioscorea aculeata). Beside food crops, especially tubers, the ‘Kaliwu System’ also has a high contribution to local community income due to the production of several species of fruit crops, such as: coffee (Coffea arabica), ‘kemiri’ (Aleurites moluccana), ‘pinang’ (Areca catechu), ‘avocado’ (Persea gratissiana), pineapple (Ananas comosus), orange (Citrus maxima), and coconut (Cocos nucifera). It was reported that, using seven indicators as a criterion for the perspective of the community of Sumba Island towards the ‘Kaliwu System’, the economic contribution aspect from the preservation of plant species to their benefit to the community was the highest, namely 99%; meanwhile, the contribution from the conservation aspect (in this case for maintaining the balance of nature) was 84%, and the contribution from the religious/spiritual aspect was the smallest, namely 71%. The little external inputs (especially agrochemicals) indicates that crop/agricultural management in the ‘Kaliwu System’ leads to a sustainable agricultural system. Thus, this is an additional evidence of sustainable agricultural practices managed by the local community based on indigenous knowledge and technology.

e. Tisnawati and Aziz (2014 in Saleh [36]) reported crop management that leads to a sustainable agricultural system that is associated with biodiversity conservation. It was reported that the application of perimeter trap crop in tobacco plantations using Crotalaria juncea was able to conserve and even significantly increase the diversity of natural enemies (predators and parasitoids) in all growth phases of tobacco plants compared to those in tobacco plants without perimeter trap crop. Saleh et al. [37] also reported the effectiveness of trap crops (cucumber, long beans, and tomatoes) in suppressing the attack of leaf miners in the Palu Valley. Furthermore, Saleh et al. [38] also reported that the combination of trap crops with mycorrhizae was effective in controlling the leaf miners of shallot and was significantly able to suppress the use of synthetic insecticides. The above informations indicate that sustainable farming (sustainable agriculture) is able to conserve biodiversity from damage so as to provide significant economic benefits for the community/farmers. Those was in line with the statement in the Convention on Biological Diversity [39] that sustainable agriculture promoted biodiversity.
1.4. Relationship among biodiversity conservation, sustainable agriculture and climate change
Climate change is a change in average weather conditions that lasts for decades or more, including increases and decreases in air temperature, shifts in rainfall, the occurrence of certain types of weather extremes, and changes in other features of the climate system. Some types of extreme weather include: long periods of high temperature, prolonged heavy rain, floods, and droughts. The rise in Earth's average temperature causes sea levels to rise and glaciers and Arctic ice to melt. In addition, the oceans are becoming more acidic as they absorb more CO₂ from the atmosphere. This is mainly due to the increase in greenhouse gas (GHG) concentrations. It cannot be denied that climate change has an impact on biodiversity and the agricultural sector. Thus, climate change also affects food production and supply, water resources, infrastructure, ecosystems and human health [6, 40, 41].

According to OECD [40], agriculture contributes a significant share of the greenhouse gas (GHG) emissions that are causing climate change – 17% directly through agricultural practices and an additional 7 – 14% through changes in land use. SAN [42] stated that globally, agriculture and cattle production accounts for 25% of global GHG emission. NSAC [43] also stated that agriculture is on the front lines of changing climate. Climate change is also considered as one of the greatest threats to humanity, and agriculture is one of the sectors that is already seeing in negative effects of climate change. There were also statements [6, 40, 41] that climate change has an impact on biodiversity and the agricultural sector. Thus, climate change also affects food production and supply, water resources, infrastructure, ecosystems and human healths. However, OECD [40] also stated that under the right management, agriculture can provide a multitude of environment services that can help mitigate against climate change. This includes carbon sequestration, watershed protection and biodiversity conservation. And, sustainable farming practices help farmers to adapt, to maintain production, and to improve practices without resorting to harmful techniques, and thus, this enables companies to manage and reduce climate-related risk in their supply chains.

![Diagram of ecosystem services and their relationship with biodiversity conservation, sustainable agriculture, and climate change.](image)

**Figure 1.** Ecosystem services are a key to the synergies between conservation, sustainable agricultural and sustainable livelihoods.
Source: Redrawn from Scherr and McNeely [44] with slight modification.
Ecosystems can also assist in the mitigation of, and adaptation to, climate change. Good Management of ecosystem (for example in case of agricultural sector which is agriculture should be manage into sustainable agriculture) can conserve biodiversity and thus to enhance their resilience to climate change, their ability to transform under climate change, and also to adapt to climate change [41]. Thus, it is clear that biodiversity conservation through sustainable agriculture, and making agricultural landscape to become sustainable are one of the ways in improving resilience of agricultural sector and biodiversity conservation to the negatif impact of climate change. However, they suggested that those need to be applied together with a reduction or minimization in fossil fuel use. Figure 1 shows the relationship among climate change, biodiversity conservation, sustainable agriculture, ecosystem services, and sustainable livelihoods.

The main direct agricultural GHG emissions are nitrous oxide emissions from soils, fertilizers, manure and urine from grazing animals; and methane production by ruminant animals and from paddy rice cultivation. Both of these gases have a significantly higher global warming potential than carbon dioxide. Furthermore, The commond examples of climate smart practices that can increase productivity and resilience, and reduce GHG emissions include: (a) reduce and improved used of chemical fertilizer, (b) apply crop diversification, (c) soil management techniques, (d) water saving, harvesting and retention systems, and (e) implementation of agroforestry system, including planting native plant species.

2. Conclusion
Agriculture sector is very important because those become a key motor of the global economy. Biodiversity loss become the most prominent form of modern environmental change, and it has been heavily driven by terrestrial habitat loss, in particular due to the spread and intensification of agriculture. The decline or more over the extinction of biodiversity in the country will have an impact on economic losses and the progress of the state and nation through the lack of supply and availability of food, feed, fiber, material for renewable energy, and also material for the chemical and pharmaceutical industry, and others within the country.

Biodiversity conservation is a shared responsibility and obligation (government and society). We are not really against increasing agricultural production (especially for food) because it is a necessity, but at the same time we must also concern on the development of sustainable agriculture because there are aspects of biodiversity conservation for the future. Biodiversity and agriculture are strongly interrelated because while biodiversity is critical for agriculture, sustainable agriculture can also contribute to conservation and sustainable use of biodiversity. Thus, sustainable agriculture both promote and is enhanced by biodiversity.

Climate change is ongoing. Ecosystem play a major role in reducing the impact of climate change. Extensive and connected ecosystems, species and genetic diversity, trophic intactness and habitat heterogenity, can buffer the impacts of climate change. And, best ecosystem management and restoration, can play an important role in climate change mitigation and social adaptation, but will only provide benefits if deployed in conjunction with a redution in fossil fuel emissions. Thus, sustainable agriculture can also contribute to conservation and sustainable use of biodiversity, and also reduce the impact of climate change.
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