Indonesian Environmental Challenges toward Sustainable Agriculture

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Summary: The challenges of future agricultural developments in Indonesia are strengthening food security, food self-sufficiency, income increase and welfare of farmers and, conservation of natural resources and environmental dynamics. These challenges are also written in the Millennium Development Goals (UN, 2004) that specifically focus on the reduction of poverty, unemployment, and food insecurity. The successful efforts to overcome these challenges may be pursued by global warming due to the increase of atmospheric greenhouse gas emissions (GHG) concentrations, and by degradation of natural resources. The threat of climate change and natural resource are addressed at the national levels through development of environment friendly farming strategies which include carbon efficient agriculture or green agriculture practices (green farming). Rice is the staple for 3.5 billion people, approximately half of the world's population, many of them impoverished or disadvantaged. About 2.7 billion rice farmers and consumers depend upon the sustainable productivity of irrigated rice ecosystems. The Indonesian agricultural development policy is aimed at reaching sustainable self-sufficiency in rice, soybean, maize, meat and sugar by the end of 2015. Nevertheless, with the increasing rate of the population growth, we need to have an increasing production of agricultural crops in order to keep pace with the increasing demand. The sustainability of agriculture in Indonesia is now facing challenges due to land conversion, increase use of agrochemicals, and increasing degraded land areas. On the other hand, climate change is also becoming a serious threat to Indonesia agriculture sustainability.

1. Introduction

Rice is a strategic crop for Indonesia, playing a vital role in national food and nutritional security. The country is the world's third-largest rice producer, and is also one of the world's largest rice consumers; in 2014, imports reached 425,000 tons. To minimize its dependence on imports and achieve its goal of rice self-sufficiency, President Joko Widodo recently announced a new rice policy goal to make Indonesia self-sufficient in rice by 2017. Under the plan, the rice area is to be expanded to 15 million ha. At present, the total area of paddy fields (*sawah*) is approximately 7.8 million ha; thus, an additional 7.2 million ha will be needed to meet this target. Based on Ministry of Agriculture estimate, the total suitable area for *sawah* is 8.3 million ha, of which 3 million ha is swamp land (including mineral wetland and peatlands).Rice is the staple food of most of the population of Indonesia (± 95%). Thus, stabilization of the rate of increase in rice production is a priority of food crops development. Since the Green Revolution on rice has been launched in 1960's, rice production rose 40% from the early period of rice intensification program, but the rate of increase was highly volatile due to extreme climate anomalies (El Nino / La Nina) and pest incidences. Therefore, target of rice production increase to achieve self-sufficiency, especially in obtaining rice production of 80 million tons in 2019 will be hampered by heavy obstacles; in fact, negative impact of climate change have been observed in recent years in the form of drought or flood and pest / disease incidences. The remaining 5.3 million ha comprises convertible upland. The Ministry of Agriculture also plans to increase the area under the Integrated Crop and Resource Management (ICM) program from 100,000 hectares in 2011 to 1.5 million hectares in 2015. This implies expanding the program from an estimated 250,000 participant growers in 2011 to 3.75 million in 2015. Acknowledging an increasing water scarcity, the Government also approved construction of 47 new irrigation dams and renovation of existing canals. Moreover, the Government's recent decision to increase the "*Government Harga Pembelian Pemerintah (HPP)*" (Government Rice Purchasing Price) by 10 percent aims to support farmers' incomes as well as achieve its rice procurement target of 3.2 million tonnes in 2015.

Such planned expansion in the country's rice area carries significant implications for biodiversity and landscape management, especially if it occurs at the expense of protected forest areas or other areas of high conservation value. An integrated approach will thus be critical to accomplishing the country's food security goal while conserving the country's

rich and unique biodiversity, at the same time maintaining the ecosystem services provided by rice fields at a landscape level.

As an agricultural and developing country, Indonesia needs to enhance and sustain the crop productivity to feed the growing population of which now approaching nearly 250 million people. However, at the same time, agriculture sector also plays an important role on GHG emission reduction to support the national GHG reduction target. Although some practices in agricultural sector could contribute to the reduction of GHG, the government policy is still putting adaptation programs as the main priority in agriculture. Furthermore, mitigation of GHG emission in this context is considered as the co-benefit of adaptation practices. All of the efforts on adaptation and its co-benefits are now packed and integrated into a program called "Sustainable Agricultural Bio-Industry", which involves crops intensification, management practices of crops and livestock, waste management, precision farming, soil and water conservation, and pest management. With this effort, the agricultural sector is expected to be more resilient with the changing climate.

Sustainable farming systems orientation is to improve productivity and production of agriculture that should consider the long-term carrying capacity of natural resources, such as soil and water. The ideal farming systems are regarded as a model of environment friendly farming or regenerative farming or biodynamic agriculture. Environment friendly and sustainable agricultural model is consisted of ten basic principles, namely (1) Increase crop productivity, (2) Conservation of soil and water, (3) Zero waste, (4) Conservation of biological diversity, (5) Control of pesticide residues and heavy metals, (6) Utilize local natural resources, (7) Adaptive to climate change, (8) Integration between crop and livestock, (9) Low heavy metal pollutant, and (10) Low greenhouse gases emission.

2. Contamination of Pesticide Residues and Heavy Metals

Pollution of pesticide residues and heavy metals in agricultural lands and water is a serious problem. Pesticide residues are found in intensive agricultural lands while heavy metal contaminations are found in almost all types of industrial wastes. Agricultural lands contaminated by pesticide residues are harmful to human and animal health, while the heavy metal contamination in the long term decrease in soil fertility due to the ability to inhibit soil microbial activity, reduce the capacity of soils to adsorb nutritional elements and inhibit mineralization. It can also lead to accumulation of toxic elements in the soil. If the concentrations are greater than permissible limit it can be toxic to living organisms.

Pesticide is a substance or compound that is used to control detrimental organism to plants (pests, diseases, weeds) and therefore they inflict losses to farmers, animals and plants. Kinds of pesticides are insecticides, fungicides, herbicides, nematicides, termiticides, bactericides, etc. Continuous use of pesticides may cause the accumulation of pesticide residues and hence they degrade the quality of the environment. The high pesticide residues is driven by its use at the farm level that are generally lack of attention to the rules of good and right practices or either incorrect target, method, type, dose, time and place.

Based on data released by Directorate of Fertilizer and Pesticide, Ministry of Agriculture, pesticide formulations registered until October 2012 were as much as 2,987 formulations with details as shown in Figure 1. The pesticides use is increasing from year to year even though Field Schools of Integrated Pest Management were initiated from 1985 to 1998/1999 (Figure 2). This suggests that there are chances of high contamination occurrence, so that it is necessary to counter measures wisely to improve the quality of the agricultural environment in support of sustainable agriculture systems.

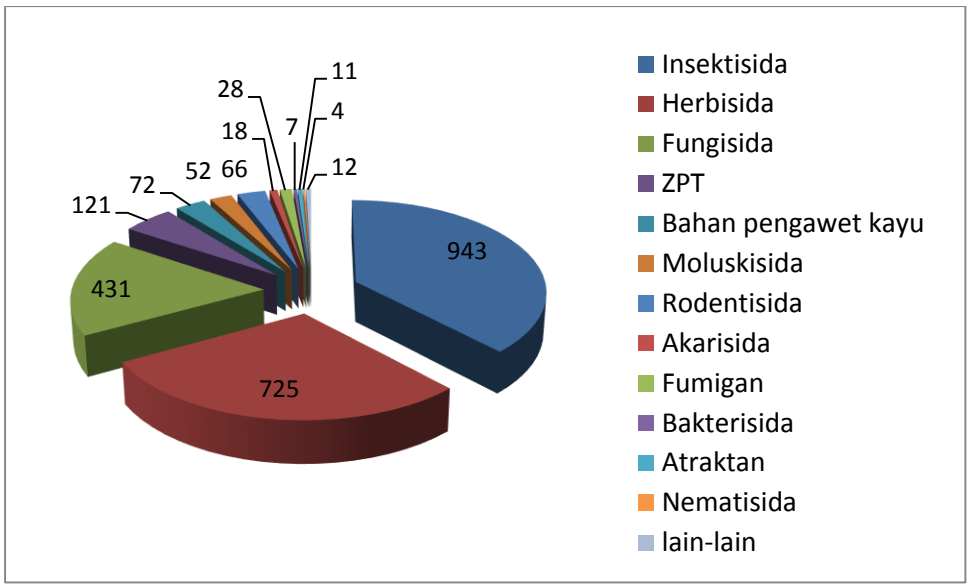

Fig. 1. Number and types of pesticides registered in Indonesia in 2012
(Source: Directorate of Fertilizer and Pesticides, Ministry of Agriculture, 2012)

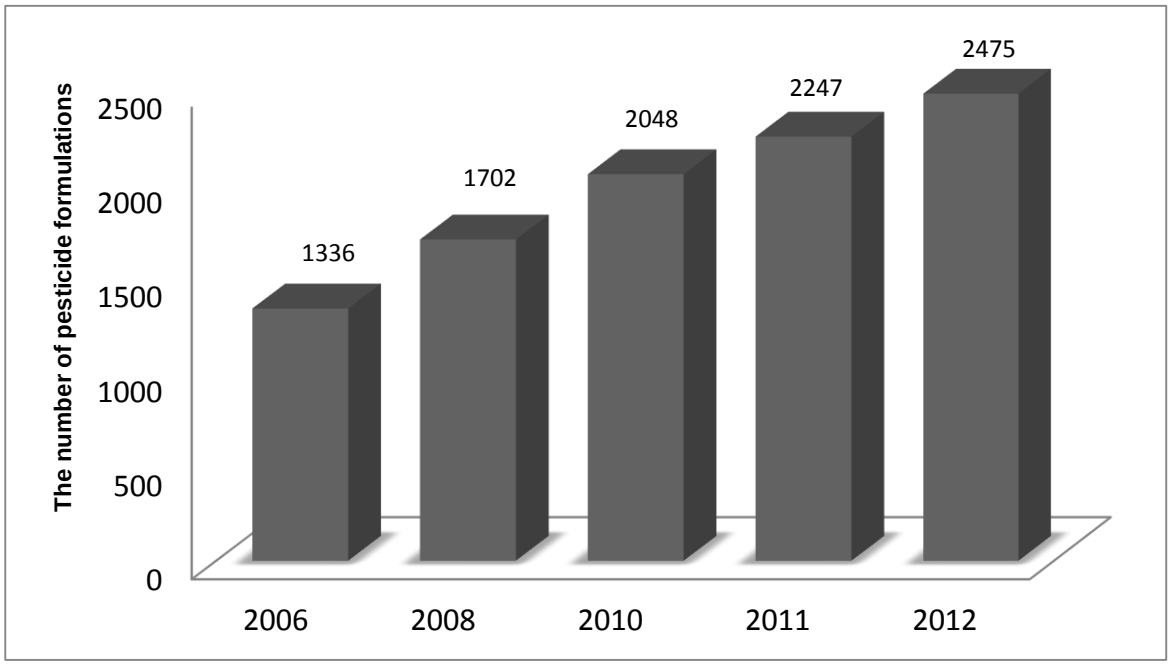

Fig. 2. The increasing number of the pesticide formulations in Indonesia during 2006-2012
(Source: Directorate Fertilizer and Pesticide, the Ministry of Agriculture, 2012)

3. Climate Change

The devastating impact of global warming is already noticeable in Indonesia and will likely worsen due to further unsustainable economic development and human-induced climate change. Increasingly frequent and severe floods, extreme weather events and prolonged droughts in some regions will lead to further environmental destruction and degradation, human injury and illness. The continuation of warmer temperatures will also increase the number of malaria

and dengue fever cases and lead to an increase in other infectious diseases as a result of poor nutrition due to food production disruption.

Indonesia is estimated to have emitted 1.415 Giga tonnes of CO2 equivalent in the year 2000 with a significant proportion of emissions due to deforestation and land-use change at 1.1 million hectares per year, which accounts for 51 % of the country's annual greenhouse gas emissions. Despite the large emissions from the forestry sector, energy and other sectors contribute only 0.594 Giga tonnes of CO2-equivalent which is still below the global average. Regulations regarding environmental protection of the Republic of Indonesia mandate the government to promote and adopt policies that maintain its environment for the benefit of present and future populations. Addressing the challenge of climate change is one of the Indonesian Government's highest priorities, which has committed to a national emission reduction target and is implementing a comprehensive response to climate change in achieving this target, including adaptation to unavoidable climate change. Through its various government agencies and in partnership with the private sector and non-governmental organizations, Indonesia seeks to develop and adopt pre-emptive and corrective actions and activities to address the predicted and actual impacts of climate change.

Thirty percent of GHGs in the atmosphere comes from natural sources and 70 % of which are caused by human activities (anthropogenic). Combustion of fossil (oil) in plants and motor vehicles as well as industrial accounts for 65% of total anthropogenic GHG; conversion of forests to plantations, agriculture / livestock and municipal waste accounts for18%, 14 % and 3% respectively. GHG from peat land conversion accounts for about 45 % of all GHG emissions in Indonesia today.

The peatlands contribution to global warming has become an international concern. Indonesia is positioned on the order of 15^{th} to the highest GHG -producing countries in the world with annual emissions of 378 million tons (Mt) of CO_2 -equivalent (UNDP, 2004). Even Indonesia Wetlands International put it in the third largest carbon emitter in the world after United States and China; the quantity of carbon emissions of 3000 Mt per year, accounted for 10% of carbon emissions in the world. Peat forest clearing by slash and burn method is estimated to generate as much as 1,400 Mt CO_2 per year, while the peat decomposition produces about 600 Mt CO_2 per year. International attention focuses on GHG emissions from the burning of oil and gas. Indonesia is highlighted as among the largest contributor of GHG emissions, derives from conversion in forest in peatlands to plantations and rice cultivation.

4. Conclusion

Environment friendly agricultural systems combine synergistic, harmonious and sustainable roles of lithosphere, hydrosphere, biosphere and atmosphere (ecosystem services), in an effort to increase agricultural production in long-term while maintaining the carrying capacity of ecosystems to ensure sustainability of natural resources for community welfare. Efforts to achieve this target are facing more severe challenges because of climate change as well as tougher global market competition. The steps followed should be comprehensive and holistic, through synergistic and harmonious cross-disciplinary, cross-sectoral/sub-sectoral and cross-ministrials.

Government policy is still oriented towards short-term goals and encourages all stakeholders (policy makers, technician and farmers) have so far ignored the degradation of natural resources and the environment. Development with environmental orientation and law of sustainability should be perceived equally by all parties at the national, regional and local levels.

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