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Management of Natural Resources in Agricultural System Supporting Agro industry in Indonesia

By

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Abstract

Agro industry has been promoted to developed in all country of Southeast Asia. As consequences, a sufficient amount of raw materials is required. To supply the raw material, agro industry can cooperate with group of farmers through contract farming. In this system contract agreement has to provide advantages to both side. Agricultural practices such as tillage, irrigation, fertilizing and crop protection involve some natural resources directly or indirectly. Soil and water for irrigation are natural resources used directly for crop production, whereas fossil fuel was natural resources used indirectly for example as energy support in fertilizer and pesticide production or as energy motor for operating agricultural machine. As intensive agricultural practices without considering the sustainability of natural resources and appropriate conservation practice led to the degradation of natural resources and environment. Whenever crops are harvested, significant quantities of nutrients from the soil are removed as they have been incorporated into the growing plant material. In recycling these nutrient, livestock manure, compost, or green manure offers a traditional substitute presently being used. To reduce the risk of soil destruction due to an intensive tillage, reduce tillage or minimum tillage combined with mulching can be applied. The frequency of soil tillage in annual crops can be reduce by mulching.

In Indonesia, intensive irrigation system are concentrated for rice fields or certain crops such as onion, chilly and string bean. Most horticulture and estate crops production are partly rain fed and partly irrigated cultivation. In this system, crops are partly dependent upon precipitation but irrigation is also conducted by farmers particularly during dry season. With increasing awareness of the negative impacts of an intensive use of pesticides and the importance of sustainable agriculture, pest control have been directed to an integrated pest management. The increase of public awareness to environmental pollution and food safety has encourage the agro industries to use the raw materials which are free from pesticide residues. Natural resources that make agriculture so location specific create the need for Assessment Institutes for Agricultural Technology to provide leadership in their adoption to optimize local resources to enhance productivity and farmers income.

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1. Introduction

Agro industries have been promoted to develop in all countries of southeast Asia. As consequences, a sufficient amount of raw materials is required. To supply the raw materials, agro industries can cooperate with a groups of farmers through contract farming. In this system, contract agreement has to provide advantages to both side. The farmers, as supplier, obtain advantage of marketing guarantee, while the industries obtain advantage from guarantee of supplies. To obtain expected quantity and quality of the yields to the industry, in co-operation with farmer leader, plays as innovator, donator, crop input and supplier. Examples of contract farming in Indonesia are co-operation between British American Tobacco and tobacco farmers, Indofood and potato farmer, Nucleus Estate Small Holder in tea industries cooperate with tea farmer, etc.

The production levels in many high-yielding farming systems depend on the utilization of externally derived inputs. The high yields obtained is the result of modification of agro-ecosystem in such away to remove or diminish natural limitation upon productivity and to provide a more favorable environment for crop growth. These modification include the introduction of new species or varieties of crop plant, the elimination of competing plant and other organisms by the use of pesticides, the use of high levels of fertilizers, manipulation of soil structural condition by tillage and control of soil moisture by irrigation and drainage. An intensified agricultural production inputs have had consequent socio-economic, agronomic and environmental problems such as the need of high energy consumption, pollution, water shortage and soil erosion.

The inventory, assessment, utilization, and conservation (i.e. management) of natural resources such as land, climate (air, temperature, and water) are obvious requirement for sustainable farming systems. The increase of public awareness on the food safety and environmental damage have encouraged agricultural practices to be wiser through appropriate management of natural resources and waste products as well as an appropriate pest control. Mulching organic amendment can be used for water and soil conservation, improving soil nutrient as well as utilizing the agricultural waste products. The application of Integrated Pests Management reduces the dependence on Pesticides. The implementation of appropriate technology of irrigation, cropping system and soil cultivation can help the water and soil conservation.

2. Negative Impacts of Agricultural Practices

Like any natural system, agricultural system may be described as open system, receiving inputs from outside and losing energy and matter as outputs. Inputs to the system occur naturally such as solar radiation (energy), precipitation (water and nutrient elements) or because of deliberate inputs by the farmer in the form of seeds, manures, fertilizers, pesticides, and fuel energy.

Agricultural practices such as tillage, irrigation, fertilizing and crop protection involve some natural resources directly or indirectly. Land (soil) and water for irrigation are natural resources used indirectly for example as energy support in fertilizer and pesticide production or as energy motor for operating agricultural machinery.

An intensive agricultural practices without considering the sustainability of natural resources and appropriate conservation practices lead to the degradation of natural resources and environment (Briggs and Courtney, 1989). Some negative

impacts of agricultural practices on environment and natural resources is discussed below.

2.1 The impacts on soil structure

As well as its beneficial means, in some cases soil tillage especially the one using tractor has some detrimental effects . In general, while tillage is loosening the soil, the tractor is causing compression and thus damaging soil structure. This detrimental effect will be more pronounced when the soil is cultivated in an unsuitable moisture state such as in heavy and poorly drained soil (Briggs and Courtney, 1989).

Soil Structure is very important in influencing the effectiveness and efficiency of farming through on soil fertility and water retention influencing crop yields as well as nutrient loss due to erosion and leaching (Kay, 1992) Intensive soil cultivation, however, are though to cause deteriorations of soil structures (Mastur *et al*., 1996).

In the sloped area, the destruction of soil structure can lead to soil erosion. Kurnia (1996) pointed out that the highest soil loss occurs in agricultural fields. This may be due to agricultural practice conducted in sloped land with continues cropping system of annual crops.

2.2 Negative impacts on water

An intensive agricultural practices influence water particularly its quality. An intensive application of inorganic fertilizers and pesticides can create water pollution. Greater eurotrophication of water (Briggs and Courtney, 1989). Intensive drainage may increase the rate of water movement through soil which may facilitate leaching of some fertilizers and pesticides to streams and lakes contributing to eurotrophication which is excessive biological productivity such a degree that they deoxygenate the water (Barrow, 1987). This effect is more pronounced during wet season particularly in crop plantation in sloped area.

A major factor controlling solute losses is the solubility of the compounds. Nitrates, for example tend to be more soluble than phosphates or potassium compound and therefore they are lost more readily from soil and consequently pose the main threat to water quality. Similarly, pesticides which are neither strongly adsorbed nor rapidly volatilized are likely to be available for leaching and to contribute to pollution more readily than highly volatile pesticides (i.e. parathion, carbaryl) or pesticides which are actively held by clay or organic colloids (i.e. triazine, simazine, and propazine) (Briggs and Courtney, 1989).

2.3 Other negative impacts of pesticides on environment

Widespread use of pesticides have influenced the structure and function of ecosystem, altered the stability of natural communities and reduced species population numbers. Wide Spectrum pesticides can kill non target organisms including the beneficial ones. Destruction of beneficial predators and parasitoid of rice feeding insect, for example, allowed resurgence of noxious pests. In 1985/1986 brown plant hopper (*Nilaparvata lugens*) out break was reported in central java damaging 75,000 ha rice fields. A number of insecticides, especially organophosphates, caused brown plant

hopper resurgence and induced resistance of other insect pest (Ruchiyat and Sukmaraganda, 1991).

Resistance of pests, pathogen, and weeds to pesticides has been documented Brown plant hopper was reported to be resistant to organophosphate and carbamate insecticides. Diamond back mouth resistant to synthetic phyretroid, *Phytophthora infestans* resistant to mancozeb (Ruchiyat and Sukmaraganda, 1991).

Pesticide residue contaminating the water stream can also kill some acceptable aquatic organisms or contaminated them. Pesticide residues in agriculture product have been another concern relating to human health (Briggs and Courtney, 1989; Ruchiyat and Sukmaraganda, 1991).

3. Improvement of agricultural practice in order to manage natural Resources

Considering those negative impacts which may occur, the agricultural system have been directed to sustainable agricultural system with better protection to environment and more healthful production through appropriate management of resource and pests control.

3.1.Soil conservation

3.1.1 Organic amendment

Organic amendment with plant residues provides a major input of nutrients to the soil as their decomposition exert a major control on the availability of nutrients to the plant (Briggs and Courtney, 1989). However the management of the plant residues influences the loss of organic content. Bullen (1974) reported that the reduction of the organic matter content due to ploughing in of straw is lesser than that of burning and removing straw. When straw is harvested, up to 90 % to the total nutrient uptake of the crop may be removed, whereas when it was burned the losses are less as a large promotion of potassium and calcium are returned to the soil as ash, although significant quantities of nitrogen and phosphorus may be removed in smoke. However, ashes nutrients may be lost through leaching (Biederbeck *et al.,* 1980).

In addition, organic amendment is a method in controlling soil-borne disease. Substances released during decomposition of the materials have been reported to reduce the initial inoculums of soil-borne pathogen (Cook and Baker, 1983).

In using organic amendment, however, there are some factors should be considered. The decomposition of the such materials occurs largely through microbial activity and is accompanied by market increase in microbial populations. These process raise the demand for nitrogen and may lead to temporary N deficiencies. Timing of organic amendment, therefore, is critical as crop growing during the stage may be hindered by lack of nitrogen.

3.1.2 Mulching

To reduce the risk of soil destruction due to an intensive tillage, reduced tillage or minimum tillage combined with mulching can be applied. The frequency of soil tillage in annual crops can be reduced by soil mulching.

Mulching in tea plantation using fresh straw of *Imperata cylindrical* (2 kg/m^2) conducted 4 times/year controller weed. It was showed by the reduction of weed biomass by 47% in the first and 54 % in the second year. This mulching practice also increased the tea yield by 16% in the first and 28% in the second year. In respect to soil conservation, mulching reduced the soil erosion to almost zero t/ha in the first and second year observation.

Table 2 Effects of Weed Control on the Biomass and Yield of Tea, Weed Biomass and Erosion 1986/1987

Weed control	Biomass of tea (100 kg/ha)	Yields (100kg/ha)	Weed Biomass (100kg/ha)	Erosion Water (m^3/ha)	Erosion Soil (ton/ha)
Hoeing (as standard)	659.6 (100 %)	39.23 (100%)	85.7 (100%)	545.5 (100%)	8.81 (100 %)
Slashing	652.0 (-5)	32.13(-13)	122.3(+43)	533.9 (-57)	0.00 (-100)
Mulching	775.0 (+18)	50.15(+28)	39.2 (-54)	233.8 (-57)	0.00 (-100)
Glyposate	545.0 (+12)	41.01 (+5)	70.3 (-18)	816.3(+50)	21.76(-147)
Oxyflourfen	791.6 (+17)	45.77(+17)	98.0 (-15)	484.3 (+11)	5.47.0 (-35)

Source : Santosa, 1996

Polyethylene sheets and legume cover crops can also be used as mulches (Purwowidodo, 1983). White-gray polyethylene sheet is also useful as repellent for controlling aphids. It was reported that *Centroma pubescens* improved soil physical properties in eroded land (up to 10 cm topsoil loss) within 6 mount (Ai Dairah *et al.,* 1987). Suwardjo *et al* (1987) also found that land rehabilitation using *Mucuna* sp increased soybean and maize production within 6 mount. In this case, the biomass production is an important factor determining the effectiveness of cover crop in improving soil physical properties.

3.2. Water conservation

In Indonesia, intensive irrigation systems are concentrated for rice field or certain crops such as onion. Most horticulture and estate crops production are partly rain fed and partly irrigated cultivation. In this system, crops are partly dependent upon precipitation but irrigation is also conducted by farmer, particularly during dry season. To obtain good growth, panting is coincided with optimal weather conditions i.e. during wet season. In such system, intake of moisture into the soil have to be maximized and conservation of soil moisture is necessary to attempt.

Mulching is a strategy to conserve water and improve soil moisture. Mulches retain the water and prevent water losses through evaporation and rain splashing. In slope area, particularly when the slope is more than 15% the combination of crop residue mulch and contour grass strip or the use of ridge are used in soil and water conservation. The appropriate ridges can control soil erosion and water loss. Ridge can hold the water from percolation so that allow surface detention and water infiltration. Soil water retention was found to be greater in the furrow than ridge slope. Soil water retention was greatest in the furrow of the tied ridge plots (Mastur *et al*., 1996).

3.3. Integrated Pest Management

With increasing awareness of the negative impacts of an intensive use of pesticides and the importance of sustainable agriculture, pest control have been directed to an integrated pest management (IPM). The increase of public awareness to environmental pollution and food safety has encouraged the agro industries to use the raw materials which are free from pesticide residues. Therefore, an integrated pest management which combine all compatible control measure leading to reduction of pesticide application is an important point to consider in the contract farming.

IPM is the complementary use of available methods of plant protection to control pathogens and pests (Lehmann-Danzinger, 1993). Three elements considered in IPM are 1) multiple tactics to control a pest or disease (sanitation, the use of natural enemies and antagonistic organisms, cultural practice such as appropriate spacing, soil treatments, fertilization etc.); 2) pest population in which pest level maintained below thresholds levels and 3) conservation of environmental quality.

However, generally farmers still view that the use of chemicals as the most effective and convenient method to control pests (weeds, pests, and diseases). They often use pesticides at the wrong time and for the wrong type of problem. In IPM method, the pesticides can be applied when the pest population and disease levels reach an economics threshold. To implement the IPM, therefore, farmers must learn about diagnosis, damage assessment, decision making for pesticides used, choice of crop varieties etc. The agroindusry in cooperative with farmer group leader can assist the farmers in implementing the IPM program.

4. Government support in management of natural resources

Natural resources that make agriculture so location specific create the need for Assessment Institutes for Agricultural Technology (AIATs) to provide leadership in their adaptation to optimize local resources to enhance productivity and farmer income.

The management of natural resources in agricultural system is also guided and supervised by government through ministry of agriculture in-cooperation with Ministry of Environment. Each of them has representative in province and regency levels.

Conclusion

To support agro industries, agricultural systems with high yields are required. An intensive agricultural practices without considering the sustainability of natural resources and appropriate conservation practices, however, can bring negative impacts on the natural resources themselves and environment. Therefore, improvement in agricultural practices through appropriate management of natural resources supported by the government institution should be implemented.

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