Palm oil plantation oriented agrosilvopastoral system development for enhancing the economy

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Abstract. Oil palm plantation is one of the potential economic sources for Indonesia. However, the plantation area is always claimed to bring a damage to the environment. One alternative in managing the landscape of oil palm plantation is through an agrosilvopastoral system. The pattern used is the improvement of plant biodiversity and water and nutrient conservation. These agroecosystems are production and conservation based on silvicultural practices complementary to pre-existing agriculture activities. By promoting these practices, the opportunities of production and conservation function can be gained. Community welfare can be achieved through the planning and revitalizing of eco-palm oil plantation concept. Such systems contain significant ecological and economic interaction. Agrosilvopastoral system can improve the productivity of oil palm plantation, contribute to the environmental maintenance, increase cattle productivity, and harmonize the relationship of the industry and the community, and the sustainability of oil palm plantations.

1. Introduction

Modern monocultural crops simplify the agricultural landscape and reduce the amount of non-crop habitats. It has been suggested that these changes in landscape configuration contribute to an increase of pest damage in crops. A conventional view is that an increase in field size will increase pest density. Accordingly, decreasing field size or diversifying the cropping system is expected to reduce pest damage [1]. Agrosilvopastoral system is an alternative that can improve cow’s population and productivity. This integration can also improve business efficiency in oil palm plantations. A positive synergy that can be achieved by integrating cow with the oil palm is a guarantee of food supply for the cows, saving the use of inorganic fertilizers for palm oil plants and labor savings. Agrosilvopastoral system can improve soil productivity to produce organic fertilizer. Organic fertilizer can increase the added-value of palm oil products and makes the plantation environmentally friendly.

Agrosilvopastoral essentially consists of three main components, namely trees, agriculture, and livestock. Merging the three components in an agroforestry consists of (i) Agrosilviculture is a combination of components or forestry activities (trees, shrubs, palms, bamboo, and others) to the agricultural component. (ii) Silvopasture is a combination of components or forestry activities with livestock. (iii) Agrosilvopastoral is a combination of components or agricultural activities with trees and livestock/animal [2]. The purpose of this system is to integrate the sectors in agriculture that mutually utilize the remainder of the management of a sector, which is then used again in other sectors to produce other useful benefits.
Agrosivopastoral system must strongly be considered to support its continuance according to the market situation, climate, soil type, and species selection. Selecting the intended high-value type including the fast-growing species, rooting in, can provide reliable products and environment conservation [3].

The practical objective of agrosilvopastoral systems (ASPS) in areas is fundamentally devoted to cattle production, wood, fertilizer, and others. These goods are used to solve immediate domestic needs, to provide for local needs. By definition, ASPS is a collective name for land-use system implying the combination or deliberate association of a woody component (trees or shrubs) with cattle in a similar site. Essentially, this system is a model of production and conservation which is based on silvicultural practices complementary to pre-existing agricultural activities. From this point of view, these practices may be applied to a wide range of ecological and productive conditions.

The objective of this research was to study the effect of the agrosilvopastoral system in improving people's welfare. This article elucidates the role of cattle in a sustainable agrosilvopastoral system in oil palm plantation, juxtaposing the assessment of the controversial role of large ruminants by government officials with local perceptions of its largely positive agro-ecological and socio-economic functions.

The specific objectives are (i) to explain the different concepts of animal husbandry promotion and policies towards local agrosilvopastoral systems; (ii) to describe the basis of historical conditions where animal husbandry has played an essential role for the sustainability of the existing farming concepts, particularly in mixed crop-animal husbandry systems; (iii) to draw conclusions regarding the possibility of integrating local knowledge and research findings into an alternative oil palm plantation -livestock policy and practice.

2. Research Methodology
Data are collected through a non-probability sampling approach as follows: for the purpose of formulating policy and program strategies and integrated system engineering expert opinion collection is carried out, consisting of plantation actors, developers, government agencies related to agriculture, spatial planning, trade, small industries, financial institutions, cooperative. Data on internal and external strategy factors are obtained from a field research.

3. Results and Discussion
Traditional farming techniques today are greatly reduced because the cattle population decreased dramatically, pastures and forests narrowed, discharge water sources are being depleted, as a result of increasing population pressures on natural resources so that they could not be controlled. However, traditional farming techniques are constantly being developed and adapted to the changing conditions of natural resources as a buffer system that is believed to be the food security community and a source of cash income for farmers. Based on this belief, since 2012 palm oil plantation has started developing the Agrosilvopastoral intensive program.

Plantation starts developing the Agrosilvopastoral as already practiced by the farmer, in accordance with the conditions of the local culture. Economically, Agrosilvopastoral is as a source of potential income and food sources which are diverse. It also reduces the pressure on soil because it combines food crops and tree planting or plants longevity and livestock. Agrosilvopastoral is developed as one component that has been known in general. At the village level, farmers are very familiar with the Agrosilvopastoral called "garden sustainable" which is a form of soil management and water conservation. Under oil palm productive trees, the farmer can develop various types of plants, example: food crops, plant longevity, vegetables, and livestock intensively. This method will increase the production and productivity of the land in a sustainable manner.

This concept is actually not different from traditional farming techniques that resemble Agrosilvopastoral system because they want to defend the principle of integrating various types of crops and/or livestock of mutual benefit between the components and other components.
Carrying capacity by-product of oil palm plantations and cattle factory calculation based on the needs of dry matter cattle in North Sumatra is in an average weight of 250 kg. Dry material requirements of cattle about 2.5-3% of the metabolic body weight.

A cow weighing at 250 kg in one year requires feed as many as 250 x 3% x 365 days = 2,737.5 kg. Carrying capacity by-product of 5,000 Ha oil palm area in the Kebun Bangun for livestock industry shown in Table 1.

Table 1. Potency of dry waste product of oil palm plantation.

| Waste palm oil type | Amount of waste palm oil (Ton Dry Weight) |
|---------------------|------------------------------------------|
| Pinnate fronds      | 24 blade x 140 x 6 kg x 30% DW = 30.240 |
| Palm coconut oil    | 25 ton fresh fruit bunches x 2.3% x 93% DW = 2.673 |
| Sludge              | 25 ton x 5% x 15% DW = 1.875             |
| Total               | 34.788                                   |

Table 1 shows that potential of the dry weight of waste palm oil of Kebun Bangun North Sumatra is at 34.788 tons/year. This is a very large number; the waste can support as many as 12,365 cattle/year.

3.1. Stage of agrosilvopastoral system development

Agrosilvopastoral development is carried out in several stages. At the first stage, Agrosilvopastoral is only developed on a plantation scale as an example for the farmers in the surrounding areas. With the success achieved from the plantation, Agrosilvopastoral is later expanded in the form of an overlay to enhance a practice from the technical aspects, social, cultural, economic, and policy.

3.2. Oil palm plantation potential as cattle feed

Feeding ingredients derived from oil palm byproducts and their plants have a protein content, digestibility, and low palatability and high crude fiber content. Although these byproducts have low quality, this does not mean that high cow production cannot be produced along the touch of technology to correct unbalanced nutrition.

By products from oil palm industry can be used as animal feed. This waste can be a mainstay and can be developed into raw materials for ruminant animal feed agro-industry, especially cattle. Palm oil plants produce 3 main types of byproducts, namely palm leaf midrib, mud/palm solid, and palm kernel. Nutrient composition of palm fronds, sludge, and palm kernel are listed in Table 2.

Table 2. Nutrient composition of palm fronds, sludge, and palm kernel

| Nutrient     | Palm fronds | Sludge | Palm kernel |
|--------------|-------------|--------|-------------|
| Dry ingredient (%) | 30.00      | 10.00  | 93.00       |
| Crude protein (%)  | 6.50       | 13.25<sup>a</sup> | 15.40<sup>a</sup> |
| Crude fat (%)       | 4.47<sup>a</sup> | 13.00<sup>a</sup> | 7.71<sup>a</sup> |
| Fiber (%)           | 32.55<sup>a</sup> | 16.00<sup>a</sup> | 10.50<sup>a</sup> |
| Ash (%)             | 14.43<sup>b</sup> | 13.90<sup>b</sup> | 5.18<sup>b</sup> |
| TDN (%)             | 56.00      | 79.00  | 81.00       |
3.3. Strengthening technical capacity

Technically, Agrosilvopastoral development in the form of combining several components that interact positively. These components include strengthening plants porch in the form of plant Leguminosae (Arachis glabrate), plant trees (plantation crops), and cattle. Creating biopori and rorak with mulch vertical and planting plants porch amplifier always be the first step to soil managing.

3.4. Strengthening the capacity of social and cultural

From the socio-cultural aspects, Agrosilvopastoral development should be able to suppress the social practices that are less efficient and strengthen the local knowledge possessed by farmers.

Communities that are initially only passive are enhanced in their ability to be active through training and empowerment. Livestock maintenance is carried out by the community with the take and give system between oil palm plantations as a source of animal feed and cow manure as soil fertilizers. This will increase the value of interaction between crop-community-livestock.

3.5. Strengthening economic capacity

Strengthening the economic capacity so farmers have the ability to analyse and calculate the profit or loss from Agrosilvopastoral models that will be developed. Economic analysis of Agrosilvopastoral system is more difficult than the analysis of monoculture farming which have to calculate some types of farming in the field. The result of this study shows that changing from monoculture to agrosilvopastoral can bring a revenue per year from only Rp 9,000,000, after using agrosilvopastoral to increase about Rp 18,000,000.

Integration system between cattle and oil palm three has several advantages namely, (i) an increase in labour productivity; (ii) improvement of soil quality, through urine and dropping; and (iii). improvement of land productivity [4]. Farmers can maintain about 15-20 breeding cattle on dry land [5]. Furthermore [6] suggests from their research result that the development of an integrated cow per year will give a greater benefit.

4. Conclusions

Ecologically, the development of agrosilvopastoral can expand the area of land cover to reduce the rate of soil erosion; the creation of agro-climatic environment (microclimate) is more likely to introduce new crops of high economic value in addition to the enrichment of biodiversity. The ecosystem can create a balance that avoids the explosion of pests like locusts and supply organic matter to ensure the natural fertility of the soil.

The diversity of Indonesian bio-physics and socio-culture are potential resources for community-based agricultural economic development. Triple bottom line benefits should be improved to have environmental conservation, community welfare, and amenity service in order to harmonize the relationship between rural and urban landscape development.

Community welfare can be achieved through the planning and revitalizing of the eco-village concept. Ecologically, Agrosilvopastoral can be developed as an agro-tourism object. It is promoted to gain the creative economy for the rural community. Besides, farming activities, householders or farmers can provide a home-stay service, small traditional food restaurant, souvenir shops, and guidance service for visitors and tourists. It will be an additional income source for smallholder farmers.

Palm oil plantation-livestock integration is a program to make dry farming become potential in increasing the breeder farming earnings, and this program can also correct and increase soil and palm plantation productivity, diversification of crops, and improving household income.

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