DOI: http://dx.doi.org/10.14334/Proc.Intsem.LPVT-2018-p.390-397

ááStrategy for Forage Improvement in Plantation

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ABSTRACT

Improvement of forage production on plantation area is needed to ensure sufficient forage supply for ruminants integrated with plantations. The strategy of developing and increasing forage production on plantation land is primarily establishing a good pasture, starting with the selection of feed crops that are in accordance with the conditions of plantation ecosystem. Furthermore, the development of selected feed crops need to be supported by the most appropriate agronomic techniques. Furthermore, the recommended pasture utilization technique is the rotational grazing system by applying the appropriate stocking rate and rotational period.

Key Words: Forage, Plantation, Productivity

INTRODUCTION

Increasing population and productivity of ruminants need to be done primarily in achieving beef self-sufficiency in Indonesia. However, this effort faces constraints in the form of limited land ownership, increasingly limited grazing land, and limited access for farmers to abandoned lands or forests. This obstacle leads to increasingly limited feed resources for livestock to be developed.

Meanwhile, land for oil palm, rubber and coconut plantations is available very widely. This plantation land provides the availability of biomass as abundant animal feed that have not been optimally utilized for livestock. However, the feed biomass from plantation land can be used on condition that the main commodity of the plantation must not be disturbed. This is the main prerequisite for realizing the integration of livestock plantations that are mutually beneficial for both sub-sectors (Diwyanto et al. 2013).

The cheapest feed resources for ruminants are expected to come from vegetation under plantations which at one time is dominated by natural vegetation. Natural vegetation on plantations is usually characterized by low productivity and quality feed for ruminants. This problem is exacerbated by the reduced light transmission due to the higher shade of canopy of plantation crops in line with age. Given the high benefits of integrating plantation and ruminants and the challenges faced primarily in providing sufficient forage for the livestock, a strategy for improving forage in the plantation is needed.

CHARACTERISTICS OF PLANTATION ECOSYSTEM

An ecosystem is a system in which there is a relationship of interdependence between the components in it, both in the form of living and non-living things. The

relationship of interdependence between ecosystem components is highly organized. Each component has special meaning for other components. The relationship takes place dynamically so that there is a balance of the environment, and raises energy to a particular biotic structure and will cause a cycle of material between organisms and inorganisms.

Plantations are artificial ecosystems created by humans to meet their needs. Artificial ecosystems get energy subsidies from outside, plants or pets are dominated by human influence, and have low diversity. Examples of plantation ecosystems including oil palm, rubber, and coconut plantations. The plantation crop is a large-scale land crop, devoted to commercial crops. Protectionist policies and natural comparative advantages sometimes contribute to determine the location of plantations. This is related to the big difference between wealth and income, foreign ownership and political influence, and an exploitative social system such as contract labor.

The plantation ecosystem has a multifunction that benefits the world community, not only functions as an economy, but also has ecological functions in the ecosystem. Multifunctional plantations are intended to consist of: First, plantations absorb carbon dioxide from the earth's atmosphere and produce oxygen for earthly life (Henson 1999). Second, plantations produce a variety of useful products for humans including energy (biodiesel, bioethanol, biogas, bioavtur, and biolistrics) (Fairhurst et al. 2004).

Third, as soil and water conservation (Harahap 1999), from midribs, leaves and twigs obtained to form humus, resist soil erosion, and store water in the soil. Fourth, plantations are also part of the chain of ecosystem hydrological functions, evapotranspiration functions attached to plant physiology are an important part of maintaining micro air humidity and evaporation of water. Storage of ground water through rooting biopores, storage of water from metabolites bound in plant biomass is part of the hydrological cycle of the ecosystem. Fifth, plantations produce a variety of products with economic value for the world community, both food and non-food products. The process of production, processing, trading of products originating from plantations creates income starting from pre-production, production processes, local trade between regions, and export-import (GAPKI 2016). Sixth, in terms of the socioeconomic conditions of the cultural openness of employment opportunities, plantations are more promising because they can produce many workers in each process both from maintenance, harvest and post-harvest.

The plantation ecosystem also has a negative impact. The initial negative caused by the conversion of land to plantations can damage the ecosystem. Damage to small rivers, loss of habitat for various species of birds. Land conversion also causes habitat loss for animals such as wild pig (*Sus scrofa*), tigers (*Panthera tigris*), bears (*Ursus* sp), patridge (*Gallus varius*), and several types of primates.

Land management strategies based on ecosystem stability can be done in several ways, namely:

1. Increase the capability of farmers to produce and increase production in terms of quality and quantity by managing plantations wisely in accordance with standard operating procedures (SOP).
2. Improving the farmers to comply with the legislation on the environment so that the transition of plantation land into minimized settlements and the realization of conservation forests (Danang 2015)
3. The application of integration of plantation crops with livestock, where natural vegetation in oil palm plantations can be used as animal feed. Manure obtained from

livestock can be used as a cheap organic fertilizer to increase palm oil production, and reduce costs for fertilization and weeding (Prayudi et al. 2005).

FORAGE AVAILABILITY IN PLANTATION ECOSYSTEM

Natural vegetation which is often referred to as weed by the plantation is a plant whose presence is not desirable because it decreases the production that can be achieved by the main crop. Although the types of plants that grow under oil palm trees are generally weeds, these plants are very popular and can be used as a source of forage for livestock (Taufan et al. 2014). The composition of grass that grows generally is very much influenced by several factors, including plant age, rainfall and geographical location (Liang 2007). Based on the characteristics possessed by forage plantations can be divided into three groups, namely grasses, sedges, and broad leaf (Syahputra et al. 2011; Latifa et al. 2015).

Hutasoit et al. (2017) reported that the natural forage that grows on six years old oil palm plantations at an altitude of 50 m with rainfall of 270 mm/year in Aceh Jaya District, Aceh Province varies greatly (Table 1).

Table 1. Variety of availability of forage under six years old oil palm plantation in Setia Bakti, Aceh Jaya District

Forage species	Type*	Botanical composition (%)
Paspalum conjugatum	N	45.2
Ottochloa nodosa	N	35.0
Asistasia intrusa	B	5.7
Cyphrus rotundis	N	3.5
Axonopus conpressus	N	2.1
Clemerotides sperma	B	2.0
Boraria latifolia	B	1.3
Cyrtucocum oxyphlum	B	1.6
Agratum conyzoides	N	1.3
Phyllanthus niruri	N	1.2
Stracytarphita indica	N	1.1

*N: Narrow; B: Broad

Table 1 shows there are 11 species of narrow leafy grasses and broadleaf. dominated by *Paspalum conjugatum* (45.2%), *Ottochloa nodosa* (35.2%), followed by *Asistasia intrusa* (5.7%). The high proportion of *P. conjugatum* and *O. nodusa* shows that this species is more tolerant of shade compared to the other nine species. This composition is relatively small compared to what was reported by Adriadi et al. (2012) where forage composition on oil palm plantations observed consisted of 20 families, 47 genera, and 56 species. While Rosli et al. (2010) reported there were 32 species in the experimental area that used broad spectrum herbicides to eradicate weeds, 25 species including broadleaf and seven narrow leafy species. Furthermore there are 17 species

reported by Taufan et al. (2014) in Kutai Kartanegara Regency, East Kalimantan and dominated by the *O. nodusa* type (7.89%).

Wong & Chen (1998) reported natural vegetation as a source of forage found in oil palm plantations of different ages (Table 2), sufficient to meet the nutritional (protein and metabolic energy) needs of livestock during grazing.

The data above shows the increasing age of oil palm plants, the dominance of grass decreases. It is thought that the older the plant age the less light it receives, so that the energy produced for the formation of dry matter of grass is reduced. At the age of young plants (3-5 years) the highest botanical composition is found in grasses, dicots and legumes. A high proportion of ferns are found in old oil palm plantation (>10 years). The higher energy and protein content found in young plants (3-5 years), while the highest Ca and P content is obtained at the age of plants that are old (>10 years). Although the grass component is dominated the vegetation under any age of oil palm plantation, the protein value is very low (6-8%). However, the existence of legumes component may increase the total forages protein content up to 11-12% (Rosli et al. 2010).

Table 2. Nutrient content of native vegetation in different ages of oil palm plantation

Ages of oil palm (years)	Botanical composition (%)				Nutrient content			
	Grasses	Dicot	Legumes	Ferns	ME (MJ/kg)	Protein (%)	Ca (%)	P (%)
3-5	65	23	19	2	7.42	12.8	0.25	0.30
6-10	64	18	3	15	7.31	11.8	0.59	0.27
>10	50	13	2	35	6.87	12.2	0.63	0.23

Source: Wong & Chen (1998)

CONSTRAINTS AND OPPORTUNITIES FOR IMPROVING THE FORAGES IN THE PLANTATION ECOSYSTEM

Improvement of forage for ruminant's production in the plantation ecosystem has problems, especially at the beginning of the main crop establishment (oil palm, rubber, and coconut). The plantation management has their own concept for planting cover crops on plantation land.

The integration of feed crops on plantations is very possible to improve the quality of the forage. Limitations of sunlight intensity that are available in between of the main commodity of the plantation cause the selection of the types of feed plants that will be introduced are crucial.

The increase in forage production from the introduction of feed crops under plantation crops, especially for plants that have produced can be achieved if the density of the main crop is reduced without decreasing production. The strategy to reduce the spacing of the main commodity is likely to be controversial, because the plantation management already has a standard planting distance for each plantation commodity.

The limited experience of smallholders in the management of pastures and livestock is a major obstacle in improving forage production in plantation ecosystems, in addition to the limited availability of seeds and plant material for the improvement of pastures. Furthermore, Moog & Faylon (1991) stated that there were a number of socio-

economic factors that became obstacles in the integration of livestock in coconut plantations in the Philippines. Coconut plantation owners may only visit their plantation during harvest time and very rarely take the opportunity to maximize land use through the introduction of forages and livestock in the plantation. The low level of education of farmers has made it difficult and slowing extension programs, also increasing the cost of counseling because they have to use an individual approach.

Forage improvement in plantations can be done through the integration of ruminant production into the plantations ecosystem. By implementing a strategy that integrates ruminants and plantations, improvements will be made in terms of quantity and quality of feed availability for livestock.

The availability of forage under plantation generally decreases with increasing age of the main crop associated with the decrease in the amount of light caused by the canopy covered by the plant. In this condition it is necessary to make the right decision in determining the type of forage that best integrated into the plantation, especially choosing and establishing shade tolerant forage species.

The opportunity to improve forage production in the plantation ecosystem is very possible to be done by utilizing available land under plantation stands. Forage crops that are shade tolerant with high production capability, both grasses and legumes, are very suitable to be integrated in plantations.

There are oil palm, coconut and rubber plantations in several countries in Southeast Asia such as Indonesia, Malaysia, Philippines and Thailand. In Indonesia, the area of oil palm plantations in 2017 reached 14.03 million hectares as stated by the Directorate General of Plantations, Ministry of Agriculture (Ditjenbun 2018). This oil palm plantation is very potential for the development and improvement of forage production in meeting the needs of ruminant feed. There are also supports for ruminant production from rubber and coconut plantations covering 3.64 and 3.8 million ha, respectively.

Shelton (1991) reported opportunities for integration of cattle under coconut plantations in several countries on improved and natural pastures, with live weight gain ranging from 44 to 693 kg/ha using stocking rates ranging from 1 to 3.5 AU/ha as is presented in Table 3. In Samoa, it was shown that pasture improvement increase the cattle live weight gain from 148 kg/ha to 225-306 kg/ha under 50% light transmission. This shows that there is a very high chance of repairing pastures under the plantation.

Table 3. Live weight gain of cattle raised on pastures under coconut in several countries

Country	Pasture	Light transmission (%)	Live weight gain (kg/ha)	Stocking rate (AU/ha)
Solomon Island	Natural	60	235-345	1.5-3.5
(2,900 mm/year)	Improved	60	227-348	1.5-3.5
	Natural	62	219-332	1.5-3.5
	Improved	62	206-309	1.5-3.5
Samoa Barat	Natural	50	148	1.8
(2,929 mm/year)	Improved	50	225-306	1.8-2.2
	Natural	70-84	127	2.5
	Improved	70-84	273-396	2.5

Country	Pasture	Light transmission (%)	Live weight gain (kg/ha)	Stocking rate (AU/ha)
	Natural	70-84	401-466	4.0
	Improved	70-84	421-693	4.0
Indonesia	Improved	79	288-505	2.7-6.3
(1,709 mm/year)				
Thailand	Natural	n.a	44	1.0
(1,600 mm/year)	Improved	n.a	94-142	1.0-2.5
Vanuatu	Improved	n.a	175	1.5
(1,709 mm/year)				

***** n.a = not available

Source: Shelton (1991)

STRATEGY FOR IMPROVING THE FORAGES AVAILABILITY IN PLANTATION ECOSYSTEM

To support the successful improvement of forage availability in plantation ecosystems, special strategies that not causing any harm to the main crops and livestock are needed. One of them is a strategy in controlled grazing or rotational grazing that will minimize the impact of grazing on the environment as well as on plantations.

The rotational grazing is the right way to be applied in the plantation ecosystem. Currently, there are facilities that support the implementation of rotational grazing using an electric fence. Weeds found under plantation can be used by ruminants as a source of feed. Indirectly this can reduce the cost of weeding because animal have acted as biological weeder while reducing the cost of purchasing organic fertilizer with the presence of livestock feces that are grazed on plantations.

Adriadi et al. (2012) reported that the composition of weeds in oil palm plantations as many as 20 families, 47 genera and 56 species with the dominant weed structure was *P. conjugatum*. Furthermore, Purwantari et al. (2015) mentioned that *A. compressus*, *O. nodosa* and *P. conjugatum* are some of the grasses found in the oil palm plantation ecosystem in Pangkalan Bun, Central Kalimantan and potential for ruminant feed.

In addition to the rotational grazing strategy, there are actually a number of factors that must be considered for the successful improvement of forage improvement, i.e. planting site selection, soil pH adjustment, weeding management, fertilization, and selection of species and varieties of feed crops to be planted.

The selection of the right species is a very decisive factor. According to Crowder & Chheda (1992), the following types of feed crops are tolerant for palm oil shade over five years of age. These are *A. compressus, Brachiaria miliformis, Ischaemum aristatum, Ischaemum timorense, O. nodosa, Stenotaphrum secundatum, Calopogonium caeruleum, Desmodium heterophyllum, Desmodium intortum, Desmodium ovalifolium* and *Flemingia congesta*.

In addition to those species, Sutedi et al. (2014) reported that *Lablab purpureus* and *Paspalum atratum* grow well under the stands of 5-years-old oil palm trees. Meanwhile, Sondakh & Kaligis (1991) mentioned that the planting of setaria grass

(*Setaria spachelata*) under coconut plantations in North Sulawesi, Indonesia, can improve pasture and weight gain of grazing cattle.

CONCLUSION

Integration of ruminants with plantations will anticipate the main problems of livestock development in the form of narrower land availability. For this reason, a strategy to increase forage production on plantations is needed in order to be able to support optimal levels of livestock production. The characteristics of plantations show the special conditions of the micro climate in the form of limited light transmissions available due to plantation canopy. The strategy of developing and increasing forage production on plantation land is primarily by establishing a good pasture starting with the selection of feed crops that are in accordance with the conditions of the plantation ecosystem. Furthermore, the development of selected feed crops needs to be supported by the most appropriate agronomic techniques. Furthermore, the recommended pasture utilization technique is the rotational grazing system by applying the appropriate stocking rate.

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