FORAGE AND PASTURE PRODUCTION IN INDONESIA

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ABSTRACT

Most of the livestock in Indonesia are raised by small holders, rather than in large, commercial herds. The use of sown and native pastures and forage trees and their potential for livestock development are reviewed.

The sources of forage for small holder farmers in intensive cropping areas are mainly grasses from waste areas, leaves from shrubs and trees, communal grazing lands and crop residues.Experiments with introduced forages have shown that total dry matter and crude protein content is comparable with levels obtained in other tropical countries. Promising grasses and legumes have been made available for use by small holders at a number of Government centers throughout Indonesia. A few grasses and legumes have shown promise as a source of feed and for soil and water conservation when planted on the face of terraces in upland cropping systems. Introduced grasses and legumes have also been sown with plantation crops to provide soil cover, improve soil fertility and provide feed for integrated cattle enterprises. A wide range of leguminous and non-leguminous trees is used as forage for ruminants in Indonesia, but there are few data available on agronomic aspects of forage production and their impact on animal production.

There are more than 20 million hectares of savanna and savanna woodland in Indonesia. This represents an important resource for extensive livestock production. This extent and type of grasslands are reviewed. Animal production from these grasslands has been increased by oversowing with legumes and from supplementation with local agricultural by-products.

There are three main factors which restrict the cultivation of improved forages: (1) high priority of land utilization for food crops, (2) the very small size of farms, and (3) socio-economic conditions.

The Central Research Institure for Animal Science is the national center for forage and agrostology research which will be reviewed.

Introduction

Geographically Indonesia extends from 6° North latitude to 11° South latitude and from 95° to 141° East longitude, the greater part being in the southern hemisphere. The country covers a little more than one-eight of the earth's circumference at the equator, a distance of 5,510 km from East to West, and extends over 2,035 km from North to South. It is estimated that the present population of Indonesia is about 145 million.

The Republic of Indonesia consists of some 13,667 islands ranging in size from tiny atolls up to large land masses, such as Kalimantan with an area of 533,248 km^2. Less than 1,000 of these islands are inhabited. Because of climate and soil factors a large percentage of the Indonesian population is concentrated on the island of Java and Madura (Table 1).

Java and Madura together represent only 7% of the total land area of the country but are inhabited by 95 million people, about 65% of the total population. Thus a great variation in population density/pressure exists between different parts of the archipelago. Since over 75% of the population depends on agriculture, it can be realized how population density has a direct effect on the availability of land and the size of farm holdings. There is also a marked variation in climate and soils, which with variation in population density causes a great diversity in agricultural systems.

There are 14.4 million agricultural holdings in Indonesia, which are concerned primarily with crop production, but livestock play an important economic and social role.

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Table 1 Indonesia's major islands and population distribution

Island	Area in km²	% of total land area	% of total population
Kalimantan	533,248	28.33	4.23
Sumatra and adjacent islands	468,147	24.87	16.22
Irian Jaya	392,576	22.16	0.78
Sulawesi	186,880	9.93	7.30
Java and Madura	130,660	6.94	64.93
Other islands	170,775	7.77	6.54

Hardjono, 1970.

The enormous differences in population of the islands and the marked regional variations in the social and institutional infrastructure, in addition to the environments, result in a broad spectrum of types of farming, agricultural patterns and efficiencies. For example, on Java and Madura millions of small holders, most of whom farm less than one hectare, practice intensive cropping systems as their forebears did for centuries before them. Multiple cropping, which has been highlighted in recent years in the press in various parts of the world, is not a new phenomenon in these areas.

The ruminant livestock population of Indonesia in 1982 was estimated at 6.59 million beef cattle, 0.14 million dairy cattle, 2.51 million buffalo, 7.89 million goats and 4.23 million sheep (Table 2). The largest increase in ruminant population during 1977-1982 was for dairy cattle (10.7%).

Table 2 Ruminant animal population (thousand head) in Indonesia from 1977-1982

	1977	1978	1979	1980	1981	1982*	% average increase 1977-1982
Beef cattle	6,217	6,330	6,362	6,440	6,516	6,594	1.21
Dairy cattle	91	93	94	103	113	140	10.77
Buffalo	2,292	2,312	2,432	2,457	2,488	2,513	1.93
Goats	7,232	8,051	7,659	7,691	7,790	7,891	1.82
Sheep	3,304	3,611	4,071	4,124	7,177	4,231	5.61

* Estimate.

Sources of forages for Indonesia's traditional small holder farmers are natural fodder, mainly grass, cut from waste land areas, roadsides, rice bunds, hedges and browse species of shrubs and trees, communal grazing land and food crop residues.

There are a few commercial dairy farmers, near big cities, and small farmers in watershed projects in various river basins who make use of high producing cultivated grasses and legumes. They rely mainly on *Pennisetum purpureum, Panicum maximum, Brachiaria brizantha, Setaria splendida, Leucaena leucocephala* and *Calliandra callothyrsus*. These forages were introduced many years ago, but only a few of them are receiving adequate level of fertilizers and stable manure for optimum production.

In the extensive livestock farming systems outside Java, sources of forage are mainly from natural grassland.

Sown pastures

Farming systems which incorporate sown pasture species, especially legumes, can

enhance soil fertility and soil structure. This property can be utilized in the multiple cropping patterns which use pasture to restore the soil fertility after cropping or by systems of interplanting of pasture species and crops (i. e. legumes can be planted between rows of maize). The use of legumes can improve the quality of available roughage for livestock and reduce weeds in crop systems (Siregar and Armiadi, 1982).

The production and quality of feed supplies can also be increased by planting small pockets of land, such as roadsides, rice bunds, fence lines, and lips and risers of bench terraces, to improved forage species for use in cut-and-carry systems.

Forage production has also been increased by planting pastures under tree crops such as coconuts, rubber, oil palm and timber. High levels of animal production have been obtained in experiments in Bali (Rika *et al.*,1981).

Use of upland areas in various parts of Indonesia for agriculture has caused a number of major problems. Deforestation has resulted in soil erosion, loss of soil fertility, and increased danger of floods. Traditional terraces are usually poorly constructed and maintained and thus fail to check erosion, and do not significantly raise the yield of crops. Population growth has forced the cultivation of ever-steeper slopes without proper conservation measures, and together with unsuitable cropping patterns has aggravated erosion problems. There are 24 watersheds in Indonesia which have been identified as requiring conservation measures.

If the traditional terraces are reconstructed with good bench terraces, which have suitable waterways and drop structures, and the bare terrace risers (vertical face of terrace) and lips planted with legumes and for grasses, erosion can be considerably reduced.

All the watershed development areas have a livestock component. Because bench terracing reduces the usable cropland by 30 to 50%, farmers must grow twice as much on the available area and plant the 30 to 50% area of terrace risers and lips with grasses and legumes to increase forage production, and therefore make bench terraces profitable and reduce water and soil erosion. In order to achieve these goals it is vital to provide farmers with high-yielding species/cultivars of grasses and legumes, technical input, training and credit.

The grasses and legumes which can be used for planting on risers or lips in the upland areas of Java include *Brachiaria brizantha, B. ruziziensis, Setaria splendida, S. anceps* cv. Kazungula, *Digitaria decumbens, Pennisetum purpureum, Leucaena leucocephala* and *Centrosema pubescens* (Table 3).These can be cut and fed to ruminants, and thus increase the farmer's income. The forage crops that have been mentioned above have good sodding ability, good forage value, and tolerance to low soil fertility and drought.

There is scope for farmers in the more extensive grassland areas to also intensify their production through sowing small areas of land to higher yielding and better quality forages.

Native pastures

The main native pasture resources occur in the drier areas of the country, mostly outside Java and Madura (Table 4).

The grazing land ecosystems are scattered throughout Indonesia (Fig. 1) and are woodland or grassland savannas resulting from the degradation of climax forest. Their distribution is partly linked to local climate. Savannas cover large areas of abandoned or unused land and are undergrazed, although overgrazing occurs in the neighbourhood of human settlements.

In the eastern half of the archipelago (Nusa Tenggara) grass or open tree savannas, which are maintained by regular dry-season fires, cover large areas; 35% of Lombok/ Sumbawa and up to 65% of Sumba and Timor. The best grazing lands are dominated by shorter growing grasses such as *Paspalum* sp., *Axonopus compressus, Chloris barbata* and *Eleusine indica.* Legumes are few in number and include *Desmodium* sp., *Rhynchosia* sp., and *Indigofera* sp. The tall savanna grasslands are dominated by *Themeda, Heteropogon* sp.,

Table 3 Dry matter yield (DMY) and crude protein of some promising grasses and legumes at Bogor, Indonesia

Species	Cutting interval (days)	DMY (t/ha/yr)	Crude protein (%)	Reference
A *Grasses*				
Brachiaria brizantha	45	36.08	6.24	Siregar and Djajanegara (1972)
Setaria sphacelata	45	24.33	9.25	Siregar and Djajanegara (1972)
Digitaria decumbens	45	34.19	9.28	Siregar and Djajanegara (1972)
Andropogon nodosis	45	27.80	9.11	Siregar and Djajanegara (1972)
Panicum muticum	45	30.39	9.00	Siregar and Djajanegara (1972)
Euchlaena mexicana	40	17.71	11.75	Siregar *et al.* (1981)
Pennisetum purpureum cv. Hawaii	40	35.91	11.85	Siregar *et al.* (1981)
Pennisetum purpureum cv. Africa	40	36.19	9.67	Siregar *et al.* (1981)
Panicum maximum cv. Hawaii	40	31.40	9.91	Siregar *et al.* (1981)
Panicum maximum cv. Guinea	40	36.78	10.47	Siregar *et al.* (1981)
Setaria splendida	42	37.82	—	Siregar and Herawati (1981)
B *Legumes*				
Calopogonium caeruleum	40	22.41	13.00	Siregar and Yuhaeni (1982)
Stylosanthes guianensis cv. Endeavour	60	3.12	16.33	Siregar and Nurhayati (1982)
S. hamata cv. Verano	60	1.88	13.75	Siregar and Nurhayati (1982)
S. guianensis cv. Cook	60	1.94	16.63	Siregar and Nurhayati (1982)
S. guianensis cv. Schofield	60	0.97	15.63	Siregar and Nurhayati (1982)
S. scabra	60	0.94	17.04	Siregar and Nurhayati (1982)
Gliricidia sepium	42	23.21	25.32	Siregar *et al.* (1981)
Leucaena leucocephala cv. Peru	42	20.00	22.00	Siregar (1983)

Table 4 Estimated area of grassland in various regions of Indonesia

Region	Area of grassland (m ha) as estimated by Schwaar (1973)	Soepraptohardjo (1972)
Java and Madura	0.40	0.44
Sumatra	7.20	7.25
Kalimantan	5.53	5.29
Sulawesi	3.96	4.67
Bali	0.24	0.21
Nusa Tenggara	2.52	3.78
Maluku	0.81	0.18
Irian Jaya	0.44	0.04
Indonesia	21.09	23.51

Sorghum sp. and *Chrysopogon* sp., which alternate with dense formations of *Imperata cylindrica* and the spiny *Mimosa pudica,* both of which have spread due to repeated burning.

In southern Sumatra, Sulawesi and Kalimantan, *Imperata cylindrica* formations are very widespread and constitute the major proportion of the estimated pasture area.

In Java and Madura, with a very high population density, grazing lands occupy less than 5% of the land but support 65% of the livestock of Indonesia. In these islands, grazing is mainly provided from crop fallows and uncultivated land dominated by various *Paspalum*

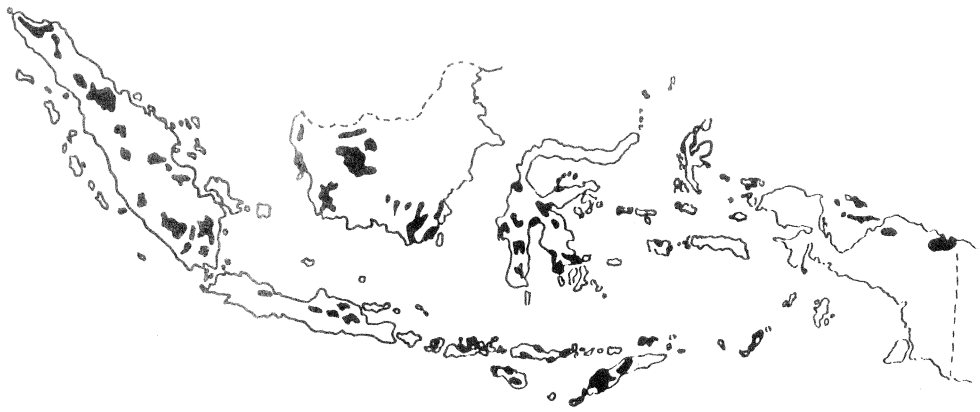

Fig. 1 Distribution of savanna and savanna woodlands in Indonesia.
Adapted from Soepraptohardjo (1972) land use map of Indonesia, by Ivory and Siregar (1983).

species.

Till and Blair (1980) reported that cattle on native pastures lost or barely maintained liveweight at 0.5 AU/ha but on pastures with significant amounts of introduced legumes they gained about 250 g/ha/day at stocking rates of up to 3/ha. This represents a six-fold increase in carrying capacity together with significant increases in animal production. Stocking rates ranging from 0.5/ha to 2/ha on native pastures showed no effect on animal production which suggests that such pastures are limited by the quality and not by the quantity of the pasture available.

Pasture in plantation crops

There was an estimated total of 6.69 million hectares of various plantation crops in Indonesia in 1975 (Table 5). Integration of ruminants and pasture crops is possible mainly in rubber, oil palm, coconut, tobacco, clove and kapok plantations.

The use of forages by ruminants in the plantation crops has already occurred in various parts of Indonesia. With plantation crops, such as oil palm and rubber, the potential for combining pasture and crop production only exists in the early years of establishment of the

Table 5 Distribution of plantations under various crops in Indonesia (1975)

Commodity	Total area (ha)	Percentage (%)
Rubber	2,327,238	39.2
Coconut	2,217,950	37.3
Oil palm	185,303	3.1
Coffee	398,941	6.7
Kapok	319,480	5.4
Cloves	225,238	5.8
Tobacco	169,768	2.8
Tea	101,117	1.7
Total	5,945,035	100

After Harimurti Martojo, 1979.

plantation crop due to severe light competition in pastures under mature stands of trees.

The concept of integrated cattle/coconut farming is not new. This production system has been practiced in Indonesia since the turn of the century. Traditionally, however, cattle have been raised under the coconut as "sweepers" or "brushers" to keep native grasses, legumes and weeds under control. Today the cattle-coconut production system is becoming a popular practice since it offers several advantages. For example Rika *et al.* (1981) have shown that cattle grazing under coconuts in Bali with sown pastures of *Brachiaria decumbens, Centrosema pubescens* and *Stylosanthes guianensis* grazed at 5 yearling/ha (initially 800 kg biomass/ha) would provide a long-term production of about 550 kg livestock gain per ha per year.

Soedhardi *et al.* (1970) from their report on fattening of cattle at one state-owned rubber plantation in Java indicated that the most productive lands for pasture production were areas of rubber which had less than five years further production where the tree density had decreased significantly. The ground cover in this situation was mostly native grasses which produced an average of 15 ton per hectare per year in six harvests with a cut-and-carry system.

Tree forages

There are very few data available on agronomic aspects of forage production from trees, and the impact of feeding tree forages to ruminants in Indonesia. However, a wide range of leguminous and non-leguminous trees are used as forage in Indonesia, especially in Java. These tree species are multipurpose plants which produce a good quality fodder in addition to other products such as fuelwood or building material and also provide erosion control. *Leucaena leucocephala, Albizia falcataria, Sesbania grandiflora, Calliandra callothyrsus, Gliricidia sepium, Hibiscus, Ficus* and *Lainnea* species are considered promising plants to be developed not only on forest and other public lands, but on private land as well.

Some of the above species have high dry matter yield and crude protein (Table 3). In various parts of the country farmers grow tree forages along the boundary of fields and in land not suited for food and cash crop production. Such trees are grown either as fruit trees, as wind-breaks, as supports for certain climbing crops and as hedges or as posts for fencing the farm.

The farmers cut the tree forages for feeding to ruminants. Cutting is usually carried out irregularly (sometimes every 1-3 months), according to the availability of other sources of forage. The feeding system used by the farmers is dominated by grass species during the wet season but as the dry season approaches, the grass proportion of the ruminant diet decreases, but the tree leaf proportion increases. Nitis *et al.* (1980) reported that in Bali during the wet season the roughage fed to goats consisted of 63% tree leaves, 34% grass and 3% other broad leaf species. During the dry season, however, when the growth of grasses became stunted, but the growth of tree crops was still good, the roughage proportion was 94% tree leaves and 6% grass.

The data on Bali cattle in Bali showed that, steers fed grass only gained 0.12 kg/day, but if fed grass supplemented with 11-28% tree leaves they gained 0.19 kg/day (Nitis, 1981).

Major constraints

There are two methods of large ruminant production which are practiced in Indonesia.

In densely populated areas, especially in Java and Madura, large ruminants are kept mainly for use as work animals and for production of manure. Despite the extreme population density in these intensively cultivated areas and the fact that little land is available for livestock raising, almost two-thirds of the large ruminants are concentrated in

these areas.

On the other hand, in savanna areas with lower population densities, an extensive method of production predominates. In these areas cattle are raised mainly for meat production and the possession of large numbers of cattle is a symbol of social status.

These two distinct situations have led to differences in the pattern of feeding the animals. In Java, for example two-thirds of the feeds available are agricultural by-products, whereas in the other areas natural grasslands are the main feed source.

There are at least three factors that hamper the cultivation of improved pastures:

1 There is a high priority of land utilization for food crops and fiber or industrial crop production.
2 The average size of farms is very small (0.5-1.0 ha), particularly in Java and Madura.
3 The existing socio-economic conditions within Indonesia do not stimulate pasture cultivation on a significant scale and consequently feed supply will have to depend on natural sources for some time.

Research activities

There are five main areas of research in forages which are being conducted at the Central Research Institute for Animal Sciences (CRIAS):

1 Plant collection and genetic resource evaluation

Most activities are focussed initially on forage plant evaluation. The species evaluation programs are located at key sites which are representative of Indonesia as a whole. A collection of local plant species with forage potential has been undertaken in Sulawesi and Sumatra with the possibility of subsequent collections in other areas. The indigenous species are being compared with a wide range of introductions of grasses, herbaceous legumes and tree legumes from other major species collections in Australia and other countries.

2 Plant nutrition, plant ecology and forage agronomy

Many soils on land available for forage production have considerable physical and chemical constraints to their utilization for forage production. The nutrient limitations to forage production and means of ameliorating these problem soils are being studied under greenhouse and field conditions.

Considerable emphasis is being placed on tree legumes for use in intensive animal/cropping systems. Besides the evaluation of a wide range of tree legumes in regional nurseries, a multisite evaluation of forage production of the more promising tree species has been undertaken.

While most activities are concentrated in the lowland areas of Indonesia, two programs are examining the productivity of herbaceous legumes, tree legumes and grasses at higher altitudes. One program is concerned with the use of mixtures of forage grasses and legumes to provide high quality feed for ruminants and control erosion in upland cropping systems.

3 Forage nutritive value and animal production

The nutritive value and chemical composition of the various forages in plant introduction and evaluation programs are being determined by *in vitro* and *in vivo* methods in selected experiments.

Grazing experiments are being conducted in South Sulawesi and Sumba. In both locations experiments are analysing animal productivity on native grasslands and improvements in animal production from over sowing of new legume species and fertilizer application. In addition one experiment is analysing the benefit of using various supplements to increase liveweight gain and reproductive performance of young female cattle.

4 Rhizobiology

An effective *Rhizobium*/legume symbiosis is very important for forage production by legumes and soil fertility improvement. Early activities of this program have concentrated on the development of laboratory facilities, technical training, importation of *Rhizobium* strains from overseas, collection of local strains and culturing, multiplication and preparation of *Rhizobium* strains for inoculum production.

Other programs are examining the effectiveness of local strains of *Rhizobium* and competitive effects of introduced and local strains on various soils.

5 Socio-economic studies of forage and animal production systems

Research has been undertaken to identify the biological, social and economic constraints to forage and animal production in Java and South Sulawesi. This will enable forage research programs to be problem-orientated. Data from existing reports on agroclimatology, soil surveys, land use and animal and human population densities have been used in pattern analysis programs to subdivide Java and South Sulawesi into "homogenous" sub-regions where the natural resources within these sub-regions are likely to produce similar animal and forage production systems. It is hoped that subsequent surveys of these sub-regions will establish their particular biological, social and economic constraints to forage and animal production.

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Discussion

Manidool, C. (Thailand): Are you implementing any program for seed production of pasture crops?

Answer: Yes, we have set up such programs in 9 government stations.

Toutain, B. (GERDAT): Could you explain how you introduce legumes in speargrass savannas?

Answer: In strip cultivation, by disking.

Kawanabe, S. (Japan): 1. Are savannas and savanna woodlands a climax vegetation? 2. Who owns the savannas?

Answer: 1. The savanna is an artificial vegetation derived from forest as a result of shifting cultivation. 2. These lands are owned by the government. They are communal grazing lands.

Mendoza, R. C.: (The Phillippines) 1. I am interested in *Calopogonium coeruleum*. Where does that species set seed? 2. Cattle and goats seem to account for most of the ruminant population in Indonesia. Where are they concentrated?

Answer: 1. This species sets seed at high altitude (700m). 2. These animals are concentrated in West Java, primarily for the poor farmers.

Kitamura, Y. (Japan): The yield of legumes you indicated seems to be very low. Are there any limiting factors with regard to soil nutrients, such as P.?

Answer: There are a large number of limiting factors related to soil (Red Yellow Podzolic Soils), including deficiencies in N, P and micro-nutrients. We also encounter the problem of Mn toxicity.