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A FARMER'S PRACTICAL GUIDE

FOR

LAMTORO GUNG

BY

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(The views expressed in this paper are those of the
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A b s t r a c t

A FARMER'S PRACTICAL GUIDE FOR LAMTORO GUNG

Lamtoro gung's (Leucaena leucocephala) adaptability and multiple uses give it a comparative advantage in large areas of Indonesia where the dry season lasts longer than 3 months. The Provincial Development Programme assistance is designing and testing cropping systems based on lamtoro gung. Two August 1982 meetings - Lamtoro Gung Workshop and the National Lamtoro Seminar I - not only presented valuable research and field information but also emphasized the farmers' need for practical technical information to guide the field implementation of projects including lamtoro gung. For this reason, a table of management recommendations was drawn up. This table, accompanied by explanations of it, provides extension workers and lead farmers with basic technical information which should be adapted to local conditions. The recommendations are based on six main purposes so that farmers can choose the main purpose that meets their needs. The choice subsequently guides the farmers to a set of recommended planting and cultural practices designed to maximize production of the primary product while still allowing for the possibility of secondary products.

Lamtoro gung (*Leucaena leucocephala*) has generated wide ranging interest in Indonesia. The fact that many government and nongovernment institutions are implementing research and field activities prompted the convening of two important national meetings in 1982:

The Lamtoro Gung Workshop, 19-21 August, sponsored by the Ministry of Home Affairs and jointly opened by the three ministers of Home Affairs, Environment, and Agriculture, presented the implementation experiences of five provinces: East Nusa Tenggara, West Nusa Tenggara, East Java, Central Java, and the Special Province of Jogjakarta. Lamtoro gung was included in projects in those areas because the farming practices were similar, based on rainfed agriculture on small parcels of poor, hilly soils in climates with a dry season that lasts longer than 3 months. Lamtoro gung provided farmers the opportunity to generate income while reducing erosion and improving soil fertility. The results of the workshop were sent to all national, provincial, and district administrators and heads of technical agencies.

The National Lamtoro Seminar I, 23-25 August, hosted by the Agency for Research and Application of Technology (BPPT), received 52 abstracts from researchers and field implementers of which 41 were selected for presentation. This national seminar offered individuals with research and field experiences with lamtoro gung from all over Indonesia, the opportunity to share their work. The information presented

is not only of general importance for Indonesia but is also of international interest. It covers leucaena's uses as fodder for ruminant livestock, hedgerows for reducing erosion, and fermented seed cake (tempe in Indonesia) for food, and features leucaena varieties suitable at various altitudes from sea level to 1500 m and on acid soils (pH < 5.5.)

Both national meetings demonstrated that many people and institutions in diverse locations of Indonesia are researching and implementing projects that include lamtoro gung for the purpose of direct use by farmers. Specific efforts are the development of lamtoro gung in cropping systems by the Provincial Development Program (PDP); the promotion of hedgerows to reduce erosion in Sikka District; energy research and leaf production field trials assisted by BPPT; and varietal trials at various altitudes and on very acid soils by the Ministry of Agriculture in North Sumatra Province.

Special mention is made of PDP's efforts to develop cropping systems for small farmers in East Nusa Tenggara (NTT) Province and especially the work of Roberto Monserrat, PDP agricultural adviser in the province East Nusa Tenggara, in cooperation with the Central Research and Development Institute of Food Crops of the Agency for Agricultural Research and Development of the Department of Agriculture, and various NTT provincial and local administrative and technical services. During the past 3 years, the effort has focused on developing cropping systems and cropping patterns using field station plots and farmers' fields. During 1982-83 demonstration plots will be established in 65 villages.

The management recommendations (Table 1) and explanations of management recommendations, that were prepared as an attachment to the final report of the Lamtoro Gung Workshop, were an initial effort to respond to the lack of readily available technical and managerial information sought by the various and rapidly increasing number of farmers planting lamtoro gung. The six management recommendations were organized according to a planned main purpose, which was to be decided on by the farmer from a list of several main purposes. The list was designed to meet the needs of farmers who depend on rainfed agriculture on small holdings of poor soils where the dry season lasts longer than 3 months. In this, usually difficult, environment the farmers need to increase production and their land needs attention if it is to generate more income, and at the same time, reduce erosion and improve soil fertility.

The two national meetings emphasized that lamtoro gung attracts farmers because of its ability to generate income and reduce erosion while allowing them to produce food crops. Although this sounds relatively straightforward, the farmers do need to learn new cultural practices for lamtoro gung. For example, in one area, a local extension worker was promoting the use of lamtoro gung and one of the farmers, who planted it, eventually ripped out the 4 m tall trees from his fence row because his food crop yielded comparatively less near the trees than in the middle of the field. He believed that the roots of the lamtoro gung were the problem. Neither the farmer nor the extension worker realized that the shade, not the roots of the trees, was the problem. Instead of destroying the trees, the farmer needed to understand that by coppicing the tree for leaf production at the beginning of the food-crop planting season, he could produce benefits

from the tree; produce the food crop; and once again coppice the tree for its leaf production during the dry season. This example motivated me to prepare this guide.

Table 1. Management Recommendations for Smallholders Growing Leucaena in Indonesia.

Main Purpose	Planting		Cultural Practices			Example of Primary Product		Example of Secondary Products	
	Spacing	Method and Population	Seed Required	0-12 months	More than 12 Months	0-12 Months	More than 12 Months	0-12 Months	More than 12 Months
1	2	3	4	5	6	7	8	9	10
1. Trees for seed	a) Slope 0-5% 3m x 3m b) Slope 5-50% 2m x 5m	Seeds or seedling a) 1,111/ha b) 1,000/ha	a) 0.25 kg/ha b) 0.22 kg/ha	-Weed control -Protect from fire -Protect from animals	Continue to harvest seed until tree becomes too tall	Seeds 0.25-0.5 kg/tree/year	Seeds 0.75-1.0 kg/tree/year	None	Firewood plus leaves for animal feed at the time trees are cut for firewood
2. Conservation/reducing erosion	a) Slope 0-15% double rows 25cm x 5m	Seeds 16,000/ha	3.6 kg/ha	-idem- a food crop which does not excessively shade the lamto-ro gung is planted between the double rows	-Replace plants which have died -coppice for secondary product	Not Applicable	Reducing erosion	Leaves but do not coppice before trunk diameter is 3cm.	Leaves 5-10 metric tons/ha by fresh weight for green manure (growing season) or animal feed (dry season)
	b) Slope more than 15% double rows 1) 25cm x 2m 2) 10cm x 2m	Seeds 1) 40,000/ha 2) 100,000/ha	1) 8/9 kg/ha 2) 22.25 kg/ha	-idem-	-idem-	-idem-	-idem-	-idem-	Leaves 10-20 metric tons/ha by fresh weight
	c) Terrace 1) Raised bed 0.5m x 10m 2) Bench 1m x 2m	Seeds, seedling or stump 1) 2,000/ha 2) 5,000/ha	1) 0.4 kg/ha 2) 1.0 kg/ha	-Weed control -Protect from fire -Protect from animals -Interplanted food crop	1) -idem- 2) -idem- "Shedding" of leaves for green manure	1. -idem- 2. -idem-	1. Not yet studied 2. -idem-	1. -idem- 2. -idem-	1. Leaves (no measurement of production has been made) 2. -idem- -"Shedding" after second year
d) Homegarden 1) 25cm in the row 2) Individual 2m x 3m	Seed, seedling or stump 1) 400/100m 2) 17/100m ²	1) Row: every 100m 90gr 2) Individual: 3.6gr 100m ²	-idem-	1) -Replace plants which have died -Coppice for a secondary product 2) -idem- -"shedding" of leaves for green manure	-idem-	Reducing erosion and for leaves, but do not coppice or "shedding" unless trunk diameter is 3cm	-Leaves for animal feed -Mulch -Firewood -Food (leaf, fruit and young seeds)		

1	2	3	4	5	6	7	8	9	10
3. Leaves for animal feed	a) Fence 75cm - 1m in the row	Seed, seedling or stump 100-133/100m	Every 100m 22 - 30 gr	-Weed control -Protect from fire -Protect from animals -Coppice when trunk is 3cm in diameter 70cm to 1m above the ground	Coppice every 3 mons. during the rainy season and 4 mons. during the dry season	Leaves for animal feed depending on growth rate of plants	Leaves from two coppiced trees/day for each head of cattle being fattened	-idem-	-Firewood -Green manure
	b) Field 1m x 1m	-idem- 10,000/ha	2.2 kg/ha	-idem-	-idem-	-idem-	One hectare for 2-3 head of cattle being fattened	-idem-	-idem-
4. Firewood	a) Field 1m x 2m	Seed, seedling or stump 5,000/ha	1.1 kg/ha	-Weed Control -Protect from fire -Protect from animals -Do not cut	Cut the tree 30cm above the soil when trunk diameter is 7cm. Leave only three branches of regrowth	-idem-	In Indonesia 20m3/ha after 2 years (according to research)	-idem-	Leaves for animal feed or green manure at the time the tree is cut
	b) Fence 1m-1.5m	-idem- 67-100/100m	Every 100m 15-22 gms.	-idem-	-idem-	-idem-	-idem-	-idem-	-idem-
	c) Community forest 2m x 3m	-idem- 1,666/ha	0.37 kg/ha	-idem-	-idem-	-idem-	-idem-	-idem-	-idem-
5. Trees for shade	Double rows 25cm x 2.5m - 6m	Seed 13,333/ha to 32,000/ha	3.0-7.1 kg/ha	-idem-	Depending on the shade required, coppice first time when the trunk is 3cm in diameter	-idem-	Shade for other tree cash crops such as coffee, cacao	-idem-	-Reducing erosion -Green manure -Animal feed
6. Green Manure	Slope 0-15% Double rows 25cm x 5m	Seed 16,000/ha	3.6 kg/ha	-idem-	Coppice first time when trunk is 3cm in diameter 70cm-1m above ground	-idem-	5-10 metric tons/ha (fresh weight)	-idem-	Leaves for animal feed one time during the dry season

EXPLANATIONS OF MANAGEMENT RECOMMENDATIONS

The Lamtoro Gung Workshop was based on reports of field experiences with lamtoro gung for:

- . Increasing farmers' incomes on small areas of land, while
- . Improving the environment through reducing erosion and improving soil fertility.

Therefore, the management recommendations have been organized according to main purposes for which farmers may wish to use leucaena on their land. Additional possible large scale applications of lamtoro gung, (energy plantations, silvipasture systems, and monoculture reforestation), have not been addressed. The technical information has been synthesized from research trials and field implementation reports from Indonesia as well as other countries. Nevertheless, the recommendations must be adapted, according to local conditions.

Before continuing with more detailed explanations, I think some general comments are needed. The term, lamtoro gung, is used for varieties having the K designators such as K6 (Peru), K8, K28, K67, etc. Also included is one variety, Cunningham, released by the Commonwealth Scientific and Industrial Research Organization Townsville, Australia.

Uses for the varieties most common in Indonesia are:

K-8, K-28 and K67: firewood and poles because of fewer and higher branches (except when coppiced) than other varieties. Coppicing causes a substantial increase in branching and leaf production so that K8 and K28 forage yield is similar to Peru and Cunningham.

K6, Peru and Cunningham: leaf production for animal feed and green manure because the tree, without coppicing, has more and lower branches than the other K varieties.

Some general points need to be emphasized in the use of the management recommendations (Table 1):

- one main purpose for each location must be planned before planting is done;
- cultural practices directly relate to the main purpose;
- the planting system depends also on the main purpose and on the cultural practices;
- leaves and young stems can constitute 100% of the diet of ruminant animals to be fattened for slaughter. Most efficient weight gain is obtained, however, with 40% lamtoro gung leaves and 60% roughage such as grass, straw, or crop wastes;
- leaves and young stems can make up to 30% of the diet of ruminant breeding stock with no ill effects;
- leaves and young stems can be up to 5-10% of the diet of chickens, pigs, and rabbits with no ill effects;
- plant growth is less vigorous at elevations above 500 m, in soils below pH 6, in water-logged soils, and in saline soils.
- germination rates can be improved by scarification of the seeds.
- plant growth is enhanced by atmospheric nitrogen fixation which is assisted by inoculation of seeds with soil taken from beneath vigorously growing lamtoro trees or with commercial inoculum, when available, immediately before planting so that the sun does not kill the live bacteria;
- Plants can be frequently coppiced but will have a longer, more productive life if stems are 3 cm (the width of a thumb) in diameter before the first cutting; cut at the height of 30 cm - 1 m, and allowed to regrow for 3 months in the rainy season and 4 months in the dry season.

Definitions of categories in the management recommendations:

Main Purpose

Lamtoro gung may be used as a permanent or temporary component of cropping systems. It may be interplanted in hedgerows, alley cropped, planted as a border or grown as an individual plant with other crops. It assists to stabilize and improve soil fertility. It has potential to produce a variety of products, but it can serve only one main purpose at a time. For example, the most leaves are

produced because of frequent coppicing when the tree does not continuously produce seeds . If both seeds and leaves are wanted from the same plant, either type of production will be lower than when only one type (i.e., seeds or leaves) is regularly harvested.

Planting

Each main purpose has a recommended spacing for the more effective production of the desired product, be it seeds, leaves, firewood, or erosion control. Variations in soil and climate conditions will require slight adjustments to adapt the recommendations to maximize productivity at any particular site. Choice of planting method is dependent on factors such as seasonal availability of labour and comparative germination percentage plus the cost of seeds, establishment of nursery, transportation, and supervision of implementation. The three methods (direct seeding, seedling, and stump planting) have differing requirements.

The choice of method to establishing demonstration plots must be consistent with local farmer capabilities. For example, the selection of the main purpose, conservation/reducing erosion, means that tens of thousands of plants per hectare will be planted. Because of the large number of plants, the farmer will probably choose direct seeding, especially if he or she already has seeds, based on the cost considerations and ease of implementation despite the lower germination rates to be expected with direct seeding. Farmers may consult local extension workers for assistance.

The density of plants per hectare is calculated from the planting distance and the assumption that 100% of the seeds will grow.

The required amount of seeds (± 15.000 seeds/kg) is based on the recommended plant density for each main purpose and the estimated survival rate from germination to 6 months. The percentage used for calculation for each planting method is: seed (direct) 30%; stump 50% and seedling 60%.

Cultural Practices:

Lamtoro gung appears to grow very slowly the first 3 months after germination, as most of the plant's energy is spent in putting down a strong tap root. During the 1st year's growth, including the dry season, lamtoro gung must be protected primarily from the shade of faster growing plants (weeds), fire, and grazing livestock. After the 1st year, cultural practices and expected products relate to the chosen main purpose. For example, if the main purpose is for animal feed the plants should be coppiced every 3 months in the rainy season and 4 months in the dry season. Another example: if the main purpose is green manure, the lamtoro gung 3 cm in diameter should be coppiced one week before the food crop is planted, and the cuttings immediately incorporated into the soil for maximum nutrient benefit.

Although application of phosphate fertilizer will enhance establishment, it is not recommended based on the principle that output is to be maximized with minimum inputs and risks to farmers living in a subsistence or limited cash economy.

Primary and Secondary Products

The primary product is the one that fulfills the main purpose and for which the planting system and cultural practices have been designed. The secondary products are those that are possible with the planting system and cultural practices required for the yield of the primary products.

Achieving the Main Purpose

Trees for Seed

Seed trees should be allowed to grow until the seed pods become too high to harvest easily and then cut back to 1 1/2 m high before or at the beginning of the third rainy season, whichever occurs first. Only three of the sprouts spaced evenly around the trunk should be allowed to grow back. Cutting of the tree should occur at the beginning of the rainy season; seeds should not be harvested in the rainy season because of increased prevalence of pathogens and insects and because regrowth will be quicker and seeds will be ready to be harvested at the beginning of the succeeding dry season.

The fruiting season is usually long and continuous. Pods should be harvested when mature (yellow) and not overly mature (dark brown) because, with age, the seed coats harden and insect-disease damage increases. Harvesting of seeds should be done in the dry season and should be discontinued just before the first rain. Mornings and evenings are preferred times of the day for harvesting so that the seeds lost through pods shattering are minimized.

Seeds for storage should be immediately separated from the pods, cleaned, and sun dried for 3 days. Dry seeds and the use of airtight containers provide the best conditions for storage. Farmers commonly dust stored seeds with wood ash (one part sifted ash to 2-4 parts seeds) to deter insects and pathogens.

Conservation/Reducing Erosion

To reduce erosion and increase soil fertility one must save the topsoil. Planting leucaena is an effective way of doing this, and it has advantages for secondary products. For example, coppicing the plants and applying the leaves to the soil can provide nutrients for interplanted food crops. The four recommended systems are: for slopes 0-15% not terraced; for slopes above 15% not terraced; for improving existing terraces and for planting in home gardens. In all these systems, the cultural practices are similar. That is, during the first year of establishment the lamtoro gung should be:

- . Planted on raised ridges or beds, especially in the first three systems;
- . Planted just before the rainy season; and
- . Protected from too much shade, weeds, fire and animals.

After establishment, the timing, frequency, and height of coppicing depend on the types and ages of the crops to be interplanted with lamtoro gung. For example, if there are food crops, the important general principle is that lamtoro gung must not excessively shade the interplanted food crops.

The primary product is erosion control, but the secondary products deserve special attention. The timing of cultural practices is important. If food crops are to be interplanted with leucaena, the steps would be:

Coppicing:

- . 1 week before planting the food crop, coppice the lamtoro gung 30 cm - 1 m above ground so that lamtoro gung does not over shade the crop interplanted;

- . Incorporate the leaves immediately into the soil because the nutrient contribution of the cuttings as green manure is greater than when incorporated later;
- . 1 month after the food crop is planted, coppice the lamtoro gung again and apply on the soil surface as green manure;
- . Each time lamtoro gung is coppiced cut a little higher on the plant so that more branching takes place and, therefore, more production of leaves; and
- . During the dry season, when crops are not interplanted, coppice only one time for use as animal feed.

Green manure can be obtained by the shedding method, which saves labour used for coppicing. In this method, one girdles or removes a 20-cm wide strip of bark on the trunk 1.5 above ground. Within 1 month, the leaves dry and fall. Shoots grow back from the portion of the trunk below the girdled area. Only three shoots should be allowed to grow.

These are some general principles and cultural practices for the four conservation/reducing erosion systems. Some of the differences among the systems are:

- . For slopes of 0-15% not terraced: Seeds and seedlings are planted along the contour of the hill in double rows, with 40 cm between two rows and 10 cm between plants in the row. The distance between two double rows is 5 m.
- . For slopes above 15% not terraced: Seeds/seedlings are planted along the contour of the hill in double rows, with 40 cm between the two rows and 5cm between plants in the row. The distance between two double rows is 2 m.
- . For existing terraces: When landholdings are very small lamtoro gung is planted on the terrace to provide not only green manure for interplanted crops and animal feed in the dry season but also for the tap roots to loosen the soil, improve water infiltration, and reduce runoff.
- . For home gardens in humid areas: leucaena may be an individual plant, intercropped or used as a fence.

- For home gardens drought prone areas: *Leucaena* may serve as a fence of two or three rows around the home garden, as an individual plant or intercropped. The long tap roots will penetrate the soil to find water and bring plant nutrients closer to the surface of the soil where other plants can use the nutrients. One can obtain green manure by coppicing or inducing the shedding of leaves. The leaves are incorporated in the soil or used as a mulch.

Leaves for Animal Feed

There are two suggested planting systems to be used with the cut and carry harvesting system for penned animals. These are:

- Fence: *Lamtoro gung* is planted as a living fence. The principle is to make the land more productive, but it does not restrict access of animals;
- Field: *Lamtoro gung* is planted in a field to produce animal feed as the primary product.

For fattening ruminant animals, the leaves are most effective if they constitute about 40% of the total ration. Research results obtained by the Government of Indonesia, at the Livestock Research Center, Ciawi, West Java, and field experiences from East Nusa Tenggara show that leaves have no toxic effect when fed as 100% of the ration for fattening ruminant animals. This is most useful when other feeds are unavailable during the dry season.

Firewood

There are three suggested planting systems for a primary product of firewood:

- Field: *Lamtoro* is planted in a field to produce firewood as the primary product.
- Fence: *Lamtoro* is planted as a fence around the home garden, along the road, etc.
- Community forest: *Lamtoro gung* should be planted on selected community lands reserved for the planting of firewood as the primary product.

All three of the above systems will produce firewood as the primary product as well as produce leaves for animal feed or green manure as a secondary product at the time the trees are cut.

Trees for Shade:

When the main purpose is to provide shade on slopes from 0-50% or steeper, seeds or seedlings are planted along the contour of the hill in double rows, 40 cm between the rows and 25 cm between the plants in the row. The trees will be thinned to suit the shade requirements of the interplanted tree crop. The distance between two double rows is from 2.5 m to 6 m, depending on the planting distance for the crops to be shaded and the steepness of the slope. Only tree crops should be grown on the steeper slopes.

Green Manure

The recommended method to produce green manure as the primary product is to plant lamtoro gung in double rows, with the distance between the rows 40 cm and 25 cm between plants in the rows, or to plant it as a fence, with 25 cm between plants in the row. There are two green manuring methods; coppicing and applying the leaves and the induction of shedding.

Results from research in the Philippines demonstrated that:

The effect of lamtoro gung as green manure for corn was the same as using chemical fertilizer applied at the rate of 90-40-40 NPK/hectare.

For rainfed upland rice, the production of the IR36 variety when lamtoro gung was used as green manure was the same as using chemical fertilizer applied at at the rate of 80-30-30 kg NPK/ha.

CONCLUSIONS

The management recommendations evolved because of field implementation needs and the unavailability of existing practical materials for field use. The scope and the organization of the recommendations, according to main purpose more accurately reflected the farmers' situation in the areas of the five provinces where lantoro gung was being actively promoted. Thousands of hectares of land supporting tens of thousands of people were planted to lantoro gung even without technical guide materials. It is hoped that each main purpose of the management recommendations will be further developed for farmers' use.

I recognize that this guide is only a first attempt to organize lantoro gung in a format for field use, and I solicit specific constructive suggestions.