THE DEVELOPMENT OF SLOPING AGRICULTURAL LAND TECHNOLOGY (SALT) IN THE PHILIPPINES

II. SALT for Sustainable Livestock Production

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ABSTRACT

The SALT-2 technology, developed for small-scale low-income farmers on slopelands in tropical Asia, combines crop production with the raising of small livestock, in this case dairy goats. A farm of only half a hectare is divided into two parts, one for forage crops, and the other for food and cash crops. Livestock are fed on the forage crops, mainly leguminous shrubs, which are planted in hedgerows along the contours and around the boundary of the farm. Twelve does raised under this system for dairy provided an annual net farm income of more than US$1000.

INTRODUCTION

In the past, food production was able to outpace the growing human population as more land was brought under cultivation. Various plant varieties, improved irrigation, fertilizer, and improved tools and equipment also allowed farmers to produce more from each hectare of land. As a result, world grain production increased from 620 million mt in 1950 to 1,660 million mt in 1985. The average yield per harvested hectare rose from 1.1 mt to 2.6 mt.

But times have changed. The total world grain output today has dropped to 303 kg/year per person, from 346 kg/year per person in 1984, a 12% drop. If this trend continues, grain in Asia will be in greater demand as human food than at any previous time in history.

Since most meat production is based on grain and grain by-products, new sources of feed which do not compete with human food or with land that produces food for humans need to be found. A sustainable livestock production system is needed for Asia.

There are many definitions of sustainable agriculture, but all describe a dynamically stable and continuous production system that achieves a level of productivity satisfying prevailing needs and is adapted continuously to meet future pressing demands for increasing the carrying capacity of the resource base (Okigbo 1990).

Importance of Livestock

Livestock play an important role in sustainable agriculture, since they can counteract two environmental problems: declining soil fertility and soil erosion. They eat forage and grain, and produce manure which helps sustain and build the soil for future forage and crop production. Research from different African sites has confirmed that manure raises yields and improves soil organic matter content (Mclntire 1989).

Preventing erosion is a vital part of sustainable agriculture. In the Philippines, about 8.25 million ha are severely eroded, while a further 9.3 million ha of hilly land in the country are highly susceptible to erosion. However, if these slopelands were managed properly, they could provide an enormous amount of food for livestock and for human consumption.

Other Asian countries are experiencing the same problem. In China, the annual average soil loss due to erosion is estimated to be five billion tons. In Indonesia, the total area classified as degraded or "critical" is estimated to be 43 million ha, or about 24% of the total land area. In Laos, the total amount of degraded land is around 8.1 million ha, or 35% of the country's total land area.

A study conducted by Roberts (1944) in the United States showed that abandoned cropland suffering from erosion could be converted to grass-

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legume pasture with a carrying capacity of one cow per hectare. Today, it is possible to combine soil-protecting cover crops and row crops with soil-conserving minimum-tillage systems.

Animals can also be used to control weeds through grazing. In some instances, the costs of weed control can be reduced and crop yields increased by letting animals graze weeds and cover crops under trees. In some parts of the Philippines, farmers are raising goats under mango trees, and sheep are being raised in rubber plantations in Malaysia for weed control.

Drought is one of the perennial hazards for all agricultural enterprises that do not use irrigation. Any agricultural system planned should include how to cope with deficiencies of rainfall. Livestock can level out the effects of the seasonality and variability of rainfall, whether they are raised on pasture or in agroforestry or crop-based systems (Raun 1981).

In terms of food, livestock are a good source of protein, particularly meat and milk. In developing countries, it has been observed that the demand for food animals increases as incomes rise with economic growth. Given the cost of grain and the probable future scarcity, there is an urgent need to develop a feeding system for livestock based on forage rather than feed grains, and to find forage crops that produce well on marginal lands. Small ruminants with their lower feed requirements can be expected to play an important role in a no-grain animal raising system.

Constraints in Livestock Production

Nearly every farm in the Philippines has some livestock. The production system ranges from a few goats, chickens, and pigs foraging to support themselves to a confined system where food is brought to the animals. Livestock development programs in the past have given little emphasis to small ruminants and their potential role in increasing the food supply and income of poor, small-farm families. Large ruminants such as cows and water buffalo are so expensive that most farmers cannot afford them, while the small size of most Filipino farms means that animals must either be tethered, or penned and fed by a cut-and-carry system.

Most farmers in the Philippines are in a state of transition from keeping free-ranging livestock to a confined system. Farmers prefer to raise livestock in an area where they can allow the animals to roam around and graze, especially in forested or semi-forested areas. In many parts of the Philippines and elsewhere in Asia, livestock production competes with forest management programs, and animal raisers are seen as enemies of the forest. Livestock producers must be taught a feed production system that does not degrade their forests and lands.

Disease is another problem with which farmers have to deal. There is usually inadequate government support for this. If veterinary medicines are available, farmers cannot afford them, and have to depend on their own skills and knowledge to handle disease among their animals.

Raising Livestock and Forage

The Mindanao Baptist Rural Life Center (MBRLC), developed a hillside farming system called SALT-1 (Sloping Agricultural Land Technology) in 1978. The center has been raising livestock, especially small ruminants, since it came into existence and has been giving them various leguminous shrubs and trees as forage.

In the mid-1980s, the Center realized that there were few if any sustainable livestock systems available to small-scale low-income upland farmers, and began a program to develop one. The result is called SALT-2 (Simple Agro-Livestock Technology).

The Simple Agro-Livestock Technology (SALT-2)

SALT-2 (see Fig. 2) is a combination of agriculture, forestry, and livestock production. In SALT-2, the production of firewood (from hedgerows), fruit trees, agricultural crops (citrus, corn, peanut etc.), and animal feed (from hedgerows and grassy strips), and goat raising are integrated. While the model farm is 0.5 ha, the area can be smaller or larger depending on the available land.

As in SALT-1, an A-frame is used to define the contours, which are planted in double hedgerows of leguminous shrubs and trees such as *Flemingia congesta, Gliricidia sepium, and Desmodium rensonii* (Table 4).

The farm is divided into two parts, one quarter of a hectare for forage crops and the remainder for agricultural crops. The forage crops are planted in hedgerows between the strips. Of the forage crops, 50% is planted in *Desmodium rensonii*, 25% in *Flemingia congesta*, and 25% in *Gliricidia sepium*. *Flemingia* is important in the system because it can withstand drought better than most other forage species. (See Appendix for further details about the forage species). Together with feed concentrates, these forage crops provide the protein

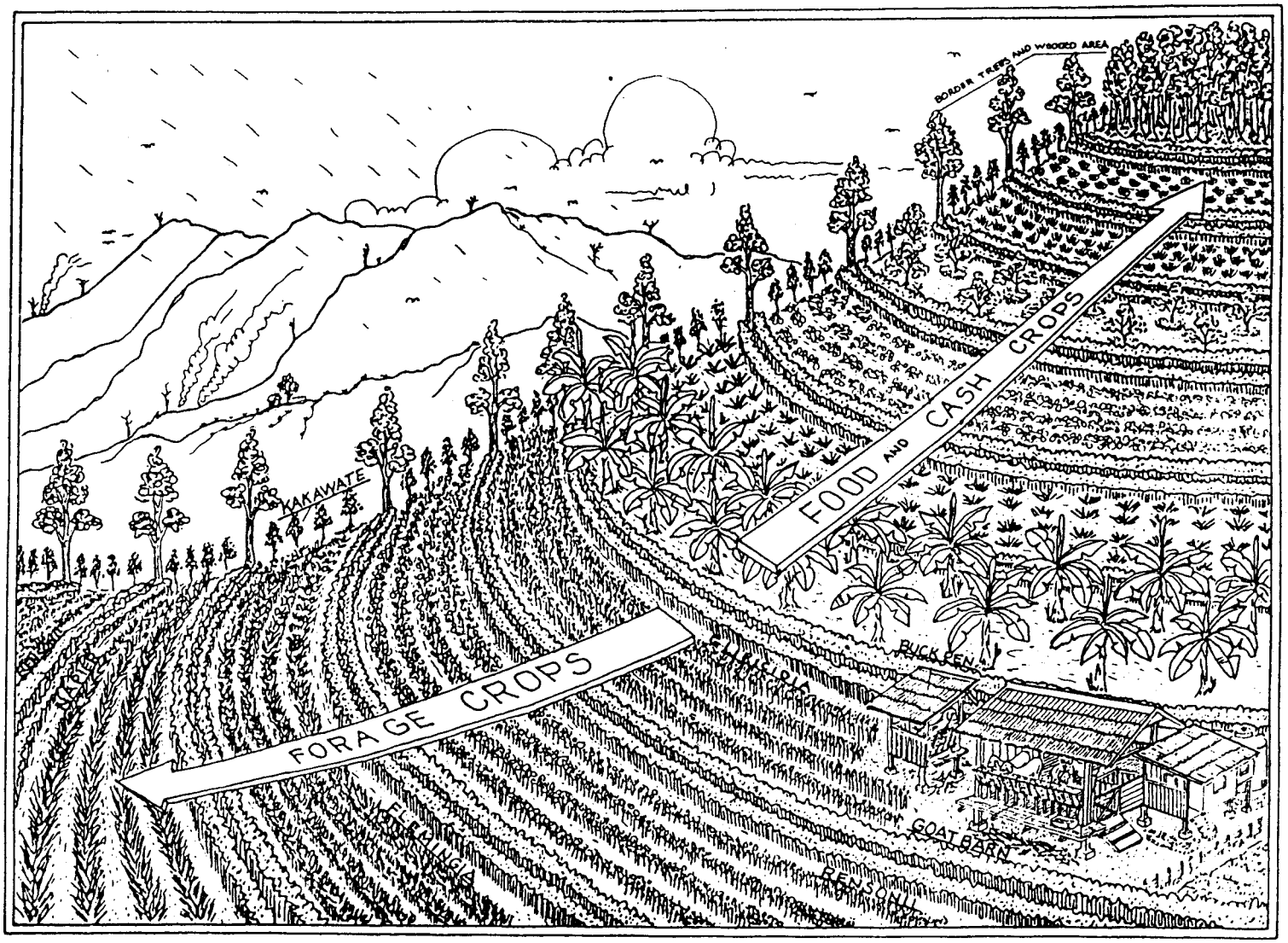

Fig. 2. Simple agro-livestock technology (SALT-2)

Table 4. Outstanding legume forages of Mindanao tested at MBRLC

Name of legume	mt/ha/yr*	CP as % of dry weight	Palata-bility**	Feed intake as % of total forage
Flemingia macrophylla	75 - 90	15 - 18	3	up to 25
Gliricidia sepium	85 - 100	18 - 20	1	up to 75
Leucaena leucocephala	30 - 40	21 - 22	1	up to 75
Desmodium rensonii	65 - 85	20 - 23	1	100

* Depends on soil fertility and planting management (double hedgerows with 3 - 4 meters between hedgerows)
** Palatability scale: 1-very palatable; 2-palatable; 3-low palatability

needed by the livestock.

The 0.25 ha used for crops is planted in a combination of perennial cash crops, and annual crops used for human food. Permanent crops are planted in 85% of the total area of this component, using coffee, citrus, and black pepper (*Gliricidia sepium* is used as a trellis for the pepper). The remaining 15% is allotted to annual crops such as corn, mungbean, peanut, etc. The crops, which are fertilized with goat manure and/or foliage from the hedgerows, serve as the immediate source of food and income for the farmer.

The boundaries of the SALT-2 farm are planted in *Gliricidia sepium*, both for forage and as a boundary fence. Fruit trees such as rambutan can be interspersed with the *Gliricidia* on two sides, but the fruit trees should not shade the crops too much.

The goat shed, occupying a space of about 58 m^2, is located right in the center of the farm, to minimize labor in carrying forage to the animals. The ideal number of goats for a shed of this size is 12 does. The buck house is built separately, and does are brought to the buck house only when they are in heat.

The goats should not be kept on the farm until the forage crops are fully established. Recommended breeds of goats are Anglo-Nubians for milk, and crossbreeds of Nubian and native goats for meat.

Hedgerows are cut regularly and the foliage is spread on the alley strips as green manure, or fed to the goats on a cut-and carry basis. Cutting of hedgerows starts when they reach a height of 1.5-2.0 m, and a stump of 1.0 m high is left to coppice. During the rainy season, a farmer may have more forage than his animals need, but he still needs to continue cutting so that the hedgerous do not shade out the agricultural crops. If there is too much green growth, the leguminous shrubs can be used as a green manure for the agricultural crops.

Feasibility of SALT-2

As in SALT-1, crop rotation is practiced in the SALT-2 system. After every second crop of corn, the strip is planted in legumes such as peanut and mungbean. The corn and legumes are not utilized as feed but are sold in the market. The cash is used to buy feed concentrates for the goats, while any remaining money serves as income for the farmer. (Table 5 shows the economic feasibility of SALT-2 in slopeland areas).

A study conducted by Laquihon (1993) showed that when dairy goats were given a home-made concentrate or one of three different types of fodder tree legume (*Leucaena leucocephala, Desmodium rensonii,* and *Flemingia macrophylla*), there was no significant difference in milk yield, milk composition or milk taste. The study did however show that *Leucaena leucocephala* and *Desmodium rensonii* were more palatable than *Flemingia macrophylla*. Of the three fodders, *Flemingia* had the highest feed cost, while *Leucaena* had the highest return on investment with 134.48%, followed by *Desmodium* (120.02%) and *Flemingia* (109.45%).

Other livestock such as cattle and sheep can also be raised in the SALT-2 system (see Table 6). Goats, however, are preferred in Mindanao. There is a strong market demand for goat meat, especially among the large Moslem population, while goats also have a high fertility rate.

Dairy goats are fed every morning and afternoon. They need concentrates as well as forage to maintain high milk production. A good concentrate mixture consists of 36% *Leucaena* leaf meal, 23% corn grain or broken rice, 21% copra meal, 18% first-class rice bran, 1% salt, and 1% limestone. (Note: Some tests at MBRLC indicate that *Leucaena* leaf meal can be as much as 50% of the total ration without any ill effects.) A good forage mixture is 50% *Desmodium rensonii*, 25% *Flemingia*

Table 5. Cost and return analysis of SALT-2 project, MBRLC, Kinuskusan, Bansalan, Davao del Sur, Philippines

Unit: US$

Particulars	1991	1992	1993
1. Returns			
1. Cash income			
a. Crops			
1. Corn	64.83	16.60	58.12
2. Citrus	26.66		33.82
3. Black pepper		79.20	28.88
4. Misc. crops	63.11	34.18	7.63
b. *Breeding and sale of kids*	534.56	721.84	1,016.00
c. *Goat meat*		44.56	
d. *Milk*	2,816.78	2,738.99	2,161.68
A. TOTAL CASH INCOME	3,505.94	3,635.37	3,360.13
2. Value of non-cash income			
a. *Replacement stock*	100.00	100.00	100.00
b. *Added value to the stock*	760.00	760.00	760.00
c. *Manure*	656.80	656.80	656.80
B. TOTAL NON-CASH INCOME	1,516.80	1,516.80	1,556.80
C. TOTAL GROSS RETURNS	5,022.74	5,152.17	4,862.93
II. COSTS			
1. Cash			
a. *Crop seeds*	8.92	4.20	0.48
b. *Seedlings*	191.20		
c. *Forage expenses*	4.00	2.48	3.00
d. *Feed*	1,166.82	886.23	1,195.51
e. *Veterinary supplies*	80.72	56.09	26.92
f. *Tools and equipment*	47.04	27.26	24.96
g. *Office supplies*	4.55		4.55
h. *Repair of buildings*	444.99	7.39	
i. *Loan interest*	214.40	158.00	97.60
g. *Loan payment*	240.00	240.00	240.00
D. TOTAL CASH COSTS	2,402.64	1,381.65	1,593.02
2. Non-cash costs			
a. *Labor*	1,479.36	1,555.51	1,739.89
b. *Depreciation*	120.96	120.96	120.96
c. *Livestock mortality*	154.00	154.00	154.00
E. TOTAL NON-CASH COSTS	1,754.32	1,830.47	2,014.85
F. TOTAL COSTS	4,156.96	3,212.12	3,607.87
NET PROFIT (C-F)	865.78	1,940.05	1,255.06
NET CASH RETURNS (A-D)	**1,103.30**	**2,253.72**	**1,713.11**
RETURN ON INVESTMENT	20.8%	60.39%	34.78%
BENEFIT-COST RATIO	1.20	1.6	1.35

1US$ = 25 Philippine pesos

Table 6. Profitability, and technical and investment requirements of projects involving small ruminants fed with fodder legumes.

Type of livestock	Feed source	Profit	Use	Technical level required	Investment level required
Barbados sheep	*Rensonii* *Flemingia* Grass *Gliricidia*	Medium	Manure in high demand for crops and fruit trees	Low	Low
Meat goats	*Rensonii* *Gliricidia* Grain by-products if available	Medium	Manure Meat Breeding stock	Low-Medium	Low-Medium
Dairy goats	*Rensonii* *Gliricidia* Feed ration	High	Manure Meat Breeding stock Milk	Medium-high	High
Cattle fattening	*Rensonii* Other legumes Grasses	High	Meat Breeding stock Manure (no demand)	Low-Medium	High

Data from the MBRLC Program, Mindanao, Philippines, 1991-1995.

macrophylla, and 25% *Gliricidia sepium*. The forage given daily should equal at least 10% of the goat's body weight. The goats are also given salt and plenty of water.

Dolores Javier, University of Southern Mindanao, found in a studyof 10 farmers who had adopted SALT-2 for dairy goat production that it gave a significant increase in farm income. Whereas the average annual income of the ten farmers before they adopted SALT-2 was only US$727, their average annual income two years after implementing SALT-2 had increased to US$2022, an increase of 168%.

Cost and return analysis conducted at the MBRLC showed that SALT-2 can generate a monthly net profit of US$113 per half hectare, with a return on investment of 37.17% (Table 5). As well as this financial benefit, it gives self-sufficiency in food production for the family (diverse food crops plus about 4,735 liters of goat milk yearly) and a protected and improved soil (which receives about 16 mt of goat manure each year). Thus, the system enhances the productivity and sustainability of the uplands.

Recommendations for Future Research

More studies should be done on the screening of fodder tree legumes, and more testing is needed of the feasibility of feeding different legume leaf meals. Simple procedures need to be developed which will enable small-scale farmers to make leafmeal for farm use and for sale. Rural veterinarians need to have special training in the low-cost health care of small ruminants, and a search should be made for species of plants, especially legumes, that are suitable for cut-and-carry feed systems.

It should be noted that the forage fed to the MBRLC goat diary herd for the past 6 years has been 100% legumes (no grass), but no ill effects have been observed. A simple milk ration has also been fed, which gave an average milk production of 2.5 liters per day over 250 days of lactation.

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APPENDIX

SOME LEGUMINOUS FODDER TREES USED IN SALT

1. *Flemingia macrophylla* Bulme ex. Miq.

(Local name: Malabalatong)

Description

Flemingia macrophylla is a woody, leguminous, deep-rooted shrub, up to 3 m in height. It has hairy young branches and basal sprouts. The leaves are trifoliate with leaflets that taper to the apex, which are often longer than 10 cm. The flowers are bell-shaped (campanulate) and about 5 mm long. Each flower is arranged on an individual axis and has greenish strands with red stripes. The pods are 11 to 15 mm long and contain bluish black seeds 2-3 mm in diameter.

Ecology

Flemingia can be found growing from sea level up to 2000 meters. The minimum rainfall required is from 1125 mm to 2000 mm. It is a hardy plant that can resist long dry spells, and is capable of surviving on very poorly drained and occasionally water-logged soils.

The plant is tolerant of light shade and is moderately able to survive fires. It can also be grown beside waterways and in shaded locations.

Distribution

Flemingia is native to Asia, particularly India. In Thailand there are three or four types growing in the north of the country. Because of its adaptability as a hedgerow, *Flemingia* can be found in almost all Asian countries.

Culture

Flemingia is propagated mainly by seeds, which are borne as early as six months after planting. There are about 50,000 to 76,000 seeds per kg.

To facilitate germination, seeds can be treated by soaking them in water for 48 hours, or immersing them in boiling water for 3-10 seconds, or immersing them in hot water for one minute. Seeds can also be planted directly in moist soil, but germination will take 5-10 days.

Flemingia is sown along contours in hedges 3-4 m apart, usually by direct seeding. Sown seeds take 3-7 days to germinate when properly pretreated, while untreated seeds take 5-10 days.

Flemingia requires ordinary land preparation. For the first two months after planting, it should be kept weeded. When hedges of *Flemingia* planted on the contours on sloping lands are trimmed, they sprout abundantly from the base, effectively shading out weeds within the contour lines.

Pests

The usual pest attacking *Flemingia* is the pod fly. Seedbeds may also be attacked by other insects. *Flemingia* should not be intercropped with pigeon pea because the latter has been observed to be an alternate host of pests that damage the plant. There are few insects that attack the mature plant.

Uses

Flemingia appears to have some value as a dry season browse, although its digestibility value is less than 40%. The palatability of immature herbage is considerably better than that of old, mature herbage. Reported crude protein values range from 14.5 to 18.3%.

Flemingia is also a good source of fertilizer. Although it has lower leaf nutrient levels (especially K, Ca, and Mg) than *Leucaena leucocephala* and *Gliricidia sepium*, the amounts are still substantial (N = 2.35 to 2.83%; P = 0.19 to 0.25%; K = 0.98 to 1.40%; Ca = 0.65%; Mg = 0.20%).

A test has shown that *Flemingia* can be given as 100% fodder legumes to dairy goats for 120 lactating days without harmful effects (Laquihon 1993), but it is the least preferred fodder legume of those tested. At the MBRLC, *Flemingia* is mixed with other legumes and grasses when fed to goats (MBRLC 1989).

At 10,000 plants per hectare, *Flemingia* produces a yearly average of 12.4 mt of leaf dry matter, with three-month cutting intervals. MBRLC tests show 75-90 mt/ha/year over 12 cuttings with 200,000 plants per hectare.

II. *Gliricidia sepium* (Jacq.) Steud.

(Local name: Kakawate or Madre de Cacao)

Description:

Gliricidia sepium is a small, thornless tree less than 10 m high, with an open crown. Its trunk is often twisted and contorted, and is less than 30 cm in diameter. Leaves are 15-28 cm long, pale green underneath and green and shiny on the upper surface. Flowers are pink, 2 cm long. The pods are about 10-14 cm long, with 6-8 seeds per pod.

Ecology:

Gliricidia grows in places with a wet, warm climate in areas around 1200 m above sea level. An average temperature ranging from 22-30°C, with an average annual rainfall of not less than 1300 mm, is most suitable. The species is drought resistant, although it loses its foliage in prolonged dry seasons. However, growth is fast on sufficiently moist sites.

It can grow on both calcareous and acid soils. Although growth is obviously best on well-manured fertile soils, the tree can thrive on soils with low fertility.

Distribution:

Gliricidia is a native of Mexico. It was introduced into the Philippines by the Spaniards in the early 17th century, and became naturalized in the Ilocos region. Today, it can be found throughout the country.

Culture:

Gliricidia can be propagated by seeds, or its mature branches can be grown as cuttings. If seeds are used, these can be treated by soaking them in hot water in the morning until the water cools, and sowing them the following day. Generally, the seeds are sown in seedbeds, spaced 5-10 cm apart within rows with 10-20 cm between rows, to allow root pruning and easier transplanting. The seeds are then covered with a thin layer of soil. Watering and mulching is done regularly to retain moisture in the seedbeds.

When the seedlings reach a height of about 10 cm, they are transplanted into pots or polyethylene bags containing a mixture of topsoil and humus. They are raised in the nursery, then hardened before they are planted out into hedgerous.

The cutting to be used in propagation should come from mature branches of trees at least two years old. The cuttings should be about one foot long, and the end to be planted should be cut straight across. The cuttings should be planted at 25.4 cm in depth in a slanting position (at an angle of about 60°) for better results.

In Mindanao, *Gliricidia* can be coppiced about 10 times a year once the plant is well established. In drier climates, it can be coppiced only 3-4 times a year.

Uses:

Gliricidia is grown for a variety of uses. It is used as firewood (its calorific value ranges from 4,550 to 4,900 kcal per kg). It is also good for fencing and preventing soil erosion. Other functions include support for tree trunks and branches, and as green manure.

Gliricidia is also a good fodder. The leaves contain over 20% crude protein and are a nutritious feed for cattle. At MBRLC, it is used as feed for goats with the following mixture: *Gliricidia*, 25%; *Desmodium rensonii*, 50%; and *Flemingia macrophylla*, 25%.

III. *Desmodium rensonii*

(Common name: Tick trefoil)

Importance

Desmodium rensonii is a good fodder for all types of livestock. It contains approximately 20-22% crude protein. It is also a good source of biomass. *Desmodium* produces a yearly average fresh biomass of 65-85 mt/ha/year, equivalent to 13-17 mt of dry weight/ha/year.

In agroforestry systems, this tree is used in hedgerows in alley cropping. It has an estimated nutrient content of: 2.35-2.38% N; 0.19-0.25% P; 0.98-1.40% K.

Soil Requirements:

Desmodium can grow in a variety of soils, but it thrives best in well-drained soil.

Culture:

The land where this tree is to be planted must be properly prepared for good germination and establishment. Planting distances depend upon the purpose. For hedgerows, the distance between rows is 50 cm and between hills is 2.5 cm with 2 seeds per hill.

For seed production, the hills should be 50 cm apart with 2-3 seeds per hill. Germination takes place 3-4 days after sowing, and no pretreatment is necessary.

Pests:

Insect defoliators are a common problem of seedlings. The plants should be sprayed with insecticide when necessary. Mature plants are seldom attacked by insects.

Harvesting:

Desmodium may be harvested for the following uses: For forage, once a month or every 45 days to a height of 30-50 cm from the ground. For organic fertilizer, excess cuttings may be piled around crops. They serve as good source of organic fertilizer for both perennial and annual crops.

Animal Feed:

The leaves can be fed to cattle, goats, sheep, rabbits, guinea pigs and pigs. The seeds have been reported to make an excellent chicken feed.

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