The use of *Leucaena leucocephala* in farming systems in Nusa Tenggara, eastern Indonesia

Jacob Nulik[1]

Nusa Tenggara consists of three provinces -- East Timor, East Nusa Tenggara, and West Nusa Tenggara which are a group of islands in eastern Indonesia known as Kawasan Timur Indonesia (KTI).

The province of East Timor lies in the western part of Timor island, stretching between 125^{o} and 127^{o} 19' S. The northern part is bordered by the Wetar Strait, the eastern part by the Maluku Sea, the southern part by the Timor Sea, and the western part by East Nusa Tenggara. It has a total area of 14,609 km^2 and is administratively divided into 13 *Kabupaten* (districts), 62 *Kecamatan* (subdistricts), and 442 villages. East Timor is in the tropics. The southern part is influenced by climate conditions in Australia, where the lowest temperature can reach 18^{o}C in June-August, the maximum temperatures 32-34 ^{o}C, and annual rainfall is 800 to 1500 mm. In the southern coastal areas, average annual rainfall is in the 1500-2000 mm range, while it could reach 2500 to 3000 mm in the mountain region. Potential areas for animal grazing can be found in Kabupaten Kovalima, Manufahi, Viqueque, Lautem, and Baucau dan Bobonaro (IPPTP Comoro, 1997).

The East Nusa Tenggara Province lies between 12-18 ^{o}S and 118-125 ^{o}E. It is an archipelago with 156 islands; 4 are large islands (Timor, Flores, Sumba, and Alor) and the remainder are small islands which may or may not have inhabitants.

Administratively, this province consists of 12 Kabupaten and 1 Kotamadya, with a total area of 47,350 km^2 and a population of about 3.3 million people in 1993. The climate is influenced by its geographic position, which is between the Flores Sea and the Indian Ocean. The southern parts are drier than the northern parts. The dry condition is significantly influenced by the dry wind blowing from the Australia continent. The island of Flores, which lies quite far from Australia, generally, has better rainfall than Timor and Sumba islands. Based on the analysis of Pramudia et. al. (1997) East Nusa Tenggara in general has single rainfall pattern (91%). This indicates a clear difference between total rainfall in the rainy season and that in the dry season. Double rainfall patterns were only found in some places (6%) such as at Bajawa and Weluli (Kabupaten Belu), Lewa (Kabupaten Sumba Timur) and at Palla and Medakalada (Kabupaten Sumba Barat) (Basuki et al. 1997). The double pattern indicates no clear differences between rainy and dry season, although rainfall is not evenly distributed in all years.

The province of West Nusa Tenggara consists of two large islands, Lombok and Sumbawa. Total area is around 20,153 km^2, with Lombok having around 4,738 km^2 (23% of province size) and Sumbawa, 15,414 km^2 (77%). The province has a tropical climate. Maximum temperature is 33.2 ^{o}C and minimum temperature is 19.0 ^{o}C, with maximum relative humidity of 93-98% and a minimum of 48-65%. The average rainfall ranges from 1000 to 2000 mm/yr with 36-86 rainy days/year; 4-5 months are wet months and 7-8 are dry months. The dominant soil types are Complex Regosol, Lithosol, Mediterranean, and Rendzina which cover 67% of West Nusa Tenggara. The rest (23%) of the soils consists of complex brown forest and nonalcic brown; the remaining 10% consist of alluvial, Grumosol, and Andosol types. The soils are grouped into Alfisols, Entisols, Inceptisols, and Vertisols. The agroecology characterized is by dry land with

[1] BPTP, Jl. Tim Tim K. 32, Naibonat, Kupang NTT, Indonesia.

dry climate, especially in Sumbawa Island and in the north and south parts of Lombok (IPPTP Mataram, 1997).

The development and use of *Leucaena leucocephala* in the farming system are much more pronounced in East Nusa Tenggara, especially in Amarasi on Timor island and Sikka on Flores Island. There are some small areas in West Nusa Tenggara and East Timor through where *L. leucocephala* can be seen. This paper focuses on the two locations mentioned.

Farming systems in Nusa Tenggara

Except for those in Lombok island in West Nusa Tenggara and Flores Island in East Nusa Timor, which have better rainfall and where the agricultural sector has been intensively managed, Nusa Tenggara farmers are subsistence farmers. They work to obtain enough food to support their family and only a small amount of production is sold to earn extra income for their daily needs.

Livestock industry

Nusa Tenggara plays an important role in the supply of beef as well as breeding animals to other areas of Indonesia. Bali cattle are one of the leading ruminant livestock exported from Nusa Tenggara. In Lombok Island, West Nusa Tenggara, the cattle industry is currently engaged in cross breeding with larger size cattle such as Aberdeen Angus and Simmenthal Sumbawa, on the other hand, is the source of pure Bali cattle.

East Nusa Tenggara is concentrating on Bali cattle in Timor and Flores islands, while Ongole cattle are produced on Sumba island. In Timor, extensive cattle raising is mainly practiced in the eastern part where more land is available for grazing and only 1 or 2 animals are tethered per farm household for fattening. Animals are sold whenever the farmer needs cash. This region provides breeding cattle for other parts of the island. Meanwhile, at Amarasi, cattle are mainly tethered for fattening. In Sumba Island, cattle are extensively raised and allowed to graze in native grasslands.

East Nusa Tenggara exported up to 50,000-70,000 cattle per year for beef and breeding animal. These cattle come mainly from Timor. However, with the increasing occurrence of *Brucellosis,* fewer breeding cattle are exported now from Timor. East Timor's Bali cattle industry is just developing. It has good potential for raising the breed.

The use of *Leucaena leucocephala* in farming systems

Development of *Leucaena leucocephala*

Leucaena leucocephala is well known by farmers in Timor, East Nusa Tenggara. This legume/tree shrub was introduced in the 1930s. At that time, under the strong rule of the Amarasi King (Raja Koroh), farmers in Amarasi were obligated to plant *L. leucocephala* in rows in an effort to get rid of *Lantana camara* weeds in the region. Farmers practicing shifting cultivation were not allowed to move to another land until they establish *Leucaena* in the former land. The short variety of common *Leucaena* (also called shrubby Leucaena) used in this activity had been widely distributed in the west part of Timor by the 1960s, especially around Kupang (the provincial city of East Nusa Tenggara) and was an important source of firewood. Planting was still encouraged through primary school students in Kupang who facilitated seed collection.

This practice of *Leucaena* planting was well undertaken and became a specific system of farming in the Amarasi region. It became known as the Amarasi model. By the 1970s, large areas in Amarasi were covered by *L. leucocephala* and the Dinas Peternakan (Government Livestock Services) started promoting cattle fattening through

the introduction of the PUTP system Panca Usaha Ternak Potong or Five Efforts in Beef Cattle Fattening). By this time, the 'K-number' varieties of *L. leucocephala* from the University of Hawaii, were starting to be widely used. Planting of the K varieties started in early of 1960s at Flores Island. The district of Sikka used the local variety, while the K varieties were grown at about the same time in Amarasi, Timor. The system of planting is currently known as the Sikka model.

A detailed history of *Leucaena* development in East Nusa Tenggara was described by Piggin and Parera (1984). Planting of *Leucaena* in West Nusa Tenggara was done mainly through seed production programs started by IFAD at the sub-district of Sekotong in Lombok where *L. leucocephala* cv. Cunningham from Australia was used. However, in as much as many areas in Lombok, especially the rice fields are intensively cultivated, farmers are more interested in planting *Sesbania grandiflora* along the rice bunds. This legume provides less shade so beans such as *Dolichos lablab* may be planted under the trees. On the other hand, a *Leucaena* stand makes heavy shade, thus preventing any other plant to grown under it.

With the arrival of *Heteropsylla cubana* (psyllid insect) in 1986-87 many *L. leucocephala* areas have been greatly reduced and alternative legume trees have been planted to support animal production in the region. Recently, however, *Leucaena* in Nusa Tenggara seems to have made a good recovery and is again being considered an important fodder plant in the region besides *Sesbania grandiflora, G. sepium*, and *Acacia angustissima* and lesser species in use such as *Calliandra calothyrsus*, *C. tetragona* as well as other fodder sources from non-legume trees such as *Macaranga tanarius, Hibiscus tileaceus*, and *Ficus* spp.

Practical use of *Leucaena* in farming systems

Initially, planting of *L. leucocephala* was done by establishing thick rows of *Leucaena* 2-3 m apart in poor degraded lands (mainly hilly) with contour arrangement. After 3-4 yeas of planting of *L. leucocephala,* a good cover is achieved, and the land was then used for planting food crops such as maize, peas, and other preferred crops. In the model, the rows of *L. leucocephala* were cut to the ground level. The materials cut (leaves and wood) were used as animal fodder and firewood or left in the field and burned when dry. *Leucaena* transformed this degraded land into fields suitable for food crop cultivation. When the soil condition improved, farmers started to grow banana, coconut, and other useful food crops. This turned degraded *Lantana camara* land to arable land for the Amarasi farmers.

As years went by, the area became thick with *L. leucocephala* but farmers continued to cultivate the land using row plantings of *Leucaena* or land that was already covered by a thicket of *Leucaena* where rows could no longer be identified. Such slash-and-burn systems are still practiced in many areas in Amarasi today.

In the 1970s, as the 'K varieties' of *Leucaena* were being introduced, farmers in Amarasi began to use these taller varieties. In the Sikka model*, Leucaena* was planted in wider rows (5-6 m apart) and the land in the alley was used for planting food crops. No slash-and-burn cultivation was introduced. Livestock was thus of secondary importance to farmers in Sikka, where only a few owned cattle. By the 1980s intensive cattle raising become popular in Sikka, before the arrival of psyllids. The Psyllid forced farmers to use alternative trees such as *G. sepium* and *C. calothyrsus*. In some places of Flores (Manggarai), Timor (TTS), and East Sumba (Lewa), farmers are used *Leucaena* as a shade tree for coffee plantations (Momuat et al. 1990).

With the close distance between rows in the Amarasi system, better control of soil erosion was observed. Also, farmers spent less time in weeding their crops because weeds were effectively controlled.

Animal fodder

In the past, Amarasi farmers used *L. leucocephala* leaves alone. In some places where water was scarce, banana stems were fed to the animals. This practice is still being followed today.

Farmers in Amarasi still practice fallow systems using land grown with local *Leucaena*. A family with 5-7 members can manage to fallow 2-4 ha of *Leucaena* land to grow corn and peas and to establish 1.5-3 ha of forage garden grown 2-3 m apart in rows of mixed legumes such as *L. leucocephala* (K varieties), *G. sepium* (local) and *Sesbania grandiflora*. This forage garden is usually established 2-3 km from the farmers' house and is used as source of fodder from the middle to the peak of the dry season when it is difficult to get enough forage for the tethered animals. During the rainy season, many diverse varieties of fodder can be obtained – native grasses (*Sorghum timorensis* and an annual *Pennisetum* spp.) or introduced grasses (*P. purpureum)* or *Pennisetum* hybrids mixed with *Leucaena* leaves (local or K varieties). The current practice of forage cultivation may still be improved through the introduction of other grasses into the rows of the legume trees which grow better in shade such as *Panicum maximum* and *Andropogon gayanus* (Nulik 1996). At present, only native grasses such as the annual *Pennisetum* spp. and *S. timorensis* occupy the rows; they can only produce fodder during the rainy season.

The daily weight gain of Bali cattle under the fattening system in Amarasi can reach up to 0.4-0.5 kg/day (Field 1988; Ataupah 1983) which compares with 0.1-0.2 kg/day under natural range conditions in Timor (Field 1988).

Future use of *Leucaena*

Although *Leucaena* in Nusa Tenggara has made a good recovery, farmers, have learned that there is a need to plant a larger variety of species of tree legumes. Varieties of psyllid-resistant *Leucaena* also have been tried and evaluated in Timor Island (in Besipae) and some promising species/varieties have already been identified for further development (Piggin et al. 1982). However, because of lack of seeds and the scant information given to farmers, these species/varieties are still not adopted by farmers in the region.

Research on *Leucaena* establishment in various types of soils in Timor and possible forage production has been conducted by Field (1988). Thus, a technology exists for growing the legume under Nusa Tenggara conditions.

Leucaena planting in other areas of Nusa Tenggara is promising – the legume may be grown in the eastern part of Sumba and eastern part of West Timor in East Nusa Tenggara, in East Timor, and in the eastern part of Lombok and Sumbawa in West Nusa Tenggara.

Conclusions

The use of *Leucaena* in the farming system in Nusa Tenggara has long been practiced for a variety of reasons: to prevent invasion of *Lantana camara* weeds, to improve the quality of degraded lands, and to prevent erosion. The arrival of *H. cubana* in 1986-87 has set back *Leucaena* development, but its recent recovery promises a brighter future in areas of Nusa Tenggara where it fits well into the farming practices. Inadequate technology transfer and unavailability of seed are slowing the adoption of the psyllid-resistant *Leucaena* species/varieties. Farmers are interested to grow other *Leucaena* varieties and other tree legume species as well as grasses as sources of fodder. There

thus is an immediate need to provide seed/seedlings to the farmers and to let them select the type of fodder suited to their system of farming.

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