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# LEUCAENA LEUCOCEPHALA FARMING SYSTEMS FOR AGROFORESTRY AND THE CONTROL OF SWIDDEN AGRICULTURE

BY

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( The views expressed in this paper are those of the author and not necessarily those of USAID-Indonesia )

## ABSTRACT

Swidden agriculture is a major ecological problem of the tropics. This paper will focus on the Eastern Indonesian provices of East Nusa Tenggara (NTT), West Nusa Tenggara (NTB), and Timor Timur because of their climatic characteristic of a short intense rainy season and a long dry season, two successful indigenous Leucaena Farming System, and the role of the Provincial Area Development Program (PDP) in NTT and NTB. Agroforestry is an integral component of Leucaena Farming Systems to change from swidden to permanent agriculture.

Provincial and district planning boards and technical services have a key role to plan, manage and evaluate projects which are developed to respond to local situations. The transition from swidden to permanent agriculture need local projects and approaches. The PDP in N.T.T. and N.T.B. is providing this approach of local project development in selected local areas of selected districts.

Leucaena leucocephala has been known as a common shrub for over 100 years in Indonesia, but recently selected varieties or Giant Leucaena are being used which have benefits as a multi-purpose tropical leguminous tree and is adaptable to many of the conditions of Indonesia. It is especially appropriate and beneficial for the three above mentioned provinces because of its ability to grow and produce foliage during the long dry season. Leucaena has many uses, but for this seminar it is specifically mentioned for soil conservation when planted in hedgerows while still being used as a source of animal feed and fertilizer because it can be periodically coppiced and will vigorously recover. The Districts of Sikka for eight years and Amarasi for over 40 years of N.T.T. have successfully used the common Leucaena before Giant Leucaena became available. Giant Leucaena has been successful for three years in Indonesia and for over 10 years in the Philippines.

Leucaena Farming Systems have varied purposes which are chosen to meet the needs of the farmer and the government. The experiences from the Districts of Sikka and Amarasi, N.T.T. show the important role which Leucaena has in the change from swidden to permanent agriculture. However, Leucaena is only one important aspect of a multi-number of changes which must be made to respond to the peculiarities of the socio-economic cultural needs of swidden agriculture. The total system of swidden agriculture must be analyzed and modified if there is to be a complete transition to permanent agriculture.

PDP is developing implementation approaches in N.T.B. and N.T.T. with Leucaena Farming Systems as assistance to selected villages within local constraints and conditions of government services. At the same time applied agricultural research trials are being conducted by PDP in N.T.T. to obtain needed local technical information. In addition modified government service support systems are being tried in order to better serve the society while changing from swidden to permanent agriculture.

Recommendations for hastening the process of transition from swidden to permanent agriculture are:

1. Leucaena Farming Systems indigenous to N.T.T. should be studied, analyzed and the information disseminated for use of other areas.

2. National research institutes should include Leucaena Farming Systems research in their programs.

3. Areas should be selected for provincial and district planning boards and technical services to plan, manage, and evaluate projects using the PDP approach to effect the change from swidden to permanent agriculture.

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## I. INTRODUCTION

The practice of swidden agriculture is common throughout the tropics and is a valid practice as long as a fallow rotation of 9 to 11 years is maintained. Major research works have documented the results of shifting cultivation practices which can be generally summarized as being considered ecologically sound before land and population (human and animal) pressures upset this balance. Subsequently swidden agriculture, especially as practised on the steeper slopes, is blamed for being a major ecological factor of soil erosion and water imbalances (excesses and shortages).

Much technical research has demonstrated the ability to reduce the negative effects of swidden system by maintaining the fallow rotation or, alternatively, by the right mix of inputs:financial, technical, and managerial. The greatest drawback to the successful employment of permanent agricultural practices by swidden farmers on steep slopes is the lack of farming systems which meet the goals of both the government's endeavours in development and the people's needs. These goals are:

1. Improving soil and water conservation and
2. Increasing food availability and incomes.

The phrase, Leucaena* Farming Systems, includes agroforestry as an integral component. Agroforestry is the interplanting of trees with other crops in a cropping system or, also, the farming of trees on a permanent agriculture basis. A Leucaena Farming System incorporates the use of one or more of the varieties of Leucaena which is further explained in Section II, Leucaena leucocephala. Leucaena Farming Systems are further elaborated in Section III, Farming Systems.

Leucaena Farming Systems are applicable for many dryland areas of Indonesia for both permanent as well as swidden agriculture. However, in this paper Leucaena Farming Systems are described for the many areas of critical concern in the Eastern Indonesian provinces of East Nusa Tenggara (NTT), West Nusa Tenggara (NTB), and Timor Timur (Tim Tim). Most areas of these provinces can be characterized as having a short intensive rainy season (e.g. more than 300 mm in one month) of two or three months duration with a long, hot dry season (e.g. no recorded

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* Leucaena is a shorter use of the scientific name, Leucaena leucocephala. In Indonesia the most commonly used local name is Lamtoro. There are two types of Lamtoro. Fast growing tree types which are usually called Lamtoro Cung is the Giant Leucaena while Lamtoro biasa or common Leucaena is the short shrubby weed type. Please see Section II, Leucaena leucocephala Part B, Types, for a more detailed description.

percipitation in one or more months) of from six to nine months on some of the poorest, thinnest soils (e.g.the Island of Timor) which have poor water holding capacities and erode easily.

This paper briefly presents the concept of the Provincial Area Development Program (PDP) and the approach using the Leucaena Farming Systems for agroforestry and to overcome swidden agriculture. The PDP is described because it has demonstrated the positive role of local government agencies to identify, plan and manage appropriate projects based on local needs and capabilities.

PDP is being implemented in specific areas of selected districts in the eight provinces of East Nusa Tenggara (NTT), West Nusa Tenggara (NTB), East Java, Central Java, West Java, South Kalimantan, Bengkulu and the Special Province of Aceh. PDP is a joint project of the Ministry of Home Affairs and the U.S.Agency for International Development which, in brief: (1) improves the project planning, management, monitoring, and evaluation capabilities of provincial and other local government agencies while, (2) providing assistance to projects to directly and immediately improve the incomes of the rural poor in selected villages. PDP is administered nationally by the Directorate General of Regional Development of the Ministry of Home Affairs and at the provincial level through the Governor's office by the provincial and district planning boards. Specific projects are administered by the appropriate provincial and district technical services.

Leucaena Farming Systems in this paper are based on both past successful project results in NTT and present project implementation in PDP and elsewhere. PDP projects and activities based on Leucaena, especially as an animal feed, are being implemented in all eight PDP provinces, Leucaena as a major emphasis, because of short rainy seasons and long dry seasons, is in the four provinces of NTT, NTB (Southern Lombok), East Java (Madura) and Central Java (Northern five districts).

In summary, this paper will focus on NTT because swidden agriculture is still widely practised there. Furthermore, Leucaena Farming Systems in Flores and Amarasi Districts have made noticeable contribution and PDP is implementing Leucaena Farming Systems Projects in villages as well as conducting applied research trials.

## II. (LEUCAENA LEUCOCEPHALA)

Common Leucaena has been in Indonesia for more than 100 years and has been usually considered as a weed; but now the selected, fast growing Salvadorian and Peruvian varieties, known as Giant Leucaena, hold promise of becoming valuable crops for tropical countries. Of special importance in this paper is that both the tall tree and leafy shrub types can continue to survive and grow in areas with short rainy seasons and long dry seasons. Each of the varieties described below can provide some or all of the following: soil conservation, forage and animal feed, fertilizer, firewood, shading for sun-sensitive crops, wind breaks and firebreaks, timber, fiberboard, landscaping, paper, dyes, mucilage, jewelery and human food.

A. Location and Climate: Leucaena grows successfully from the saline soils of the seashore to 1,000 meters above sea level, although growth is reduced at either of the two extremes. It grows on almost any type of soil (although it does best on fertile soils) even with annual rainfall as little as 400 mm, but it does not tolerate acidic soils below a pH of 5. However, there has been a reported experimental success of using a Rhizobium innoculant called CB 81 which can help to overcome acid conditions.

Climatic conditions under which Leucaena is able to produce a better return than many other plants for uses of animal feed, fertilizer and soil conservation are those of a few months of rain and many dry months. This has been classified by IRRI (the International Rice Research Institute) as Climate Zone III.2. which is described as areas receiving 100 mm or more of rain for only two to five months.

A short story may better illustrate the characteristic of Leucaena to withstand a long dry season. In East Java, not too many years ago, there was a Turinisasi campaign especially for livestock raising areas. Turi (Sesbania grandiflora) is an excellent, fast growing leguminous tree (as is Leucaena). However, Turi can not withstand as long a dry season as Leucaena. In the story there were two men in a field on Madura, at noon on a typical hot, sunny and cloudless October day where Leucaena and Turi trees were planted. They were discussing the relative merits of Turi versus Leucaena to produce animal feed for cattle during the Madura dry season. The debate drew on and the men grew hotter under the sun, but they did not move under the only tree with leaves -- Leucaena. Why? Because the man who supported Leucaena wanted to prove his point about Leucaena and insisted they stand under the leafless branches of the Turi tree which the other man boasted of as being so leafy and productive for animal feed during the Madura dry season. After they withdrew to the shade of the Leucaena tree, the debate ended.

B. Types: There are three general types of Leucaena leucocephala of the more than 100 species. The three types are:

1) "Hawaiian": short, bushy varieties which have very low yields of wood and foliage, and now considered as an agressive weed. There are known as Common Leucaena or Lamtoro Biasa in Indonesia.

2) "Salvadorian": tall, tree-like, with large leaves, pods and seeds and thick branchless trunks and sometimes known as aboreal, Guatemalan or Hawaiian Giant types or by the designation K-8, K-28 or K-67. They flower once a year and produce about 17,800 seeds per kilo. In Indonesia it is called, among other names, Lamtoro Gung.

3) "Peruvian": tree types like the Salvadorian type but with extensive branching low down on the trunk. The trunks are small but with high quality foliage on the branches.

In brief, Leucaena is a legume which benefits from Rhizobium, a nitrogen fixing bacteria; has a vigorous tap root which is commonly 2/3 as deep as the tree is tall and few lateral root branches; and can obtain water and nutrients from soil strata which can not be reached by most other plants. It has few serious enemies other than man. Reports have varied about the ease or lack of problems in establishing Leucaena to three months of age, but it clearly is a slow grower during the first three months. However, once established it is very productive and can be coppiced repeatedly at periodic intervals. Benefits or uses have been listed above and selected ones are further described below.

C.Soil Conservation/Reclamation: Two different but successful systems have been used in N.T.T. Each is briefly described below.

In Sikka District, Flores, a system called lamtoronization has been successfully implemented on over 20,000 hectares of highly erodeable, steep soils since 1973. Lamtoronization began after determining that constructing bench terraces was neither fast enough nor met the needs of the farmers. The program only planted the common Leucaena variety as (until Giant Leucaena became available in 1978) as hedgerows on the contour to control erosion and provide animal feed, fertilizer and fuel wood.

The results of eight years of implementation include: swidden farmers have become permanent farmers. Estate crops of cloves, cacao and coffee have been established on previously unused slopes over 30%.
Batik Weir River flows all year around since 1979, after being "dead" in the dry season for more than fifty years. Floods since 1977, have been eliminated in Maumere, the District Capital. And crop production between hedgerows has increased because of conservation and the use of coppiced herbage for green manure fertilizer (e.g. cassava production increased from 7 kw. to 2.5 tons per hectare).

Using a different approach the swidden farmers of the District of Amarasi, Timur, have achieved increased prosperiety while controlling erosion by planting common Leucaena (no Giant Leucaena was available at that time) since the 1930's on the land to be left for fallow. This practice has helped to overcome the widespread weed, Lantana (Lantana camara). During the past decade of 1970's more and more land has become permanently used in one of the dryest districts of Timur. Farmers have learned that a permanent agriculture system is possible where Leucaena herbage is coppiced to be applied as fertilizer. An indicator of success is the voluntary arrival of farmers from neighboring districts. Although the Leucaena Farming System was important, the program was one of a group of mandatory laws which traditional leaders have used to guide their followers in the achievement of a higher standard of living primarily based on feeding cattle with Leucaena.

D.Forage and Animal Feed: Leucaena has been known to yield as much as 20 MT of dry matter per hectare per year under good growing conditions and can continue to produce under adverse, dry season conditions. Leucaena provides a source of highly nutritious protein animal feed for the small holder, such as in Amarasi, to feed his animals which is critical when there is a shortage of other feeds during the dry season. Dry Leucaena contains almost four times as much protein as dry Napier grass (Pennisetum purpurem). Leucaena is equivalent or superior to

alfalfa, or lucerne, Medicago sativa, an internationally recognized common leguminous protein animal feed, in nutritive value, digestibility, percentage of protein, total digestible nutrients, and contains almost twice as much carotene (which provides Vitamin A). The pelletized dried leaves are in high demand in the non-tropical countries of Japan and Europe. In Indonesia, also, the dry leaves are in great demand by feed millers.

Recent research in Indonesia has demonstrated Leucaena's effectiveness and safety when mixed with other feeds or when fed as the sole feed for six continuous months as is done in Amarasi during the dry season. The research results were very significant as it was internationally thought that there were negative side effects based on research conducted in another country.

E.Fertilizer: In one of the sub-projects of the National Integrated Leucaena Research Project for the Philippines entitled, "Economics of Leucaena Production and Its Integration Into Appropriate Farming Systems" researchers have found that Leucaena is a good substitute for inorganic fertilizer for corn and lowland and upland rice. Corn, fertilized with herbage from the intercropped Leucaena, produced as much grain (3.0 tons/ha) as the pure stand of corn (without Leucaena as an intercrop) fertilized with 60-30-30 NPK inorganic fertilizer.

On the island of Cebu, Philippines, where much of the corn is traditionally grown on steep slopes and yields are very low (300-350 kg/ha) it was demonstrated that yields can be increased nearly four hundred percent using some inorganic fertilizer with Leucaena herbage, or two to three hundred percent during the first two years after switching to Leucaena with only the herbage from soil erosion control hedgerows. Upland plantings of IR-36 rice produced 4.34 ton/ha with Leucaena herbage, which compared to 4.47 ton/ha with the application of 80-30-30 inorganic NPK fertilizer.

## III. LEUCAENA FARMING SYSTEMS

There are many types of planting patterns in the varied Leucaena Farming Systems depending on the purposes of the farmer and the government. (See Attachment A as a guideline for plant spacing of Leucaena depending on the planned use.). Because this seminar concerns agroforestry and the control of swidden agriculture, the examples using Leucaena in farming systems for the purposes as described in II-C above on Soil Conservation/Reclamation and plant spacings numbers 2 and 3 in Attachment A need to be considered further by this Seminar.

The results using Leucaena in N.T.T. as described above described that a swidden farmer will change to permanent agriculture. Because the farmer was usually at a subsistence level, he needed a farming system for permanent agriculture which would meet his family's food needs as well as to earn some income. The transition from swidden to permanent agriculture demanded a type of farming system which had to be successful without depending on continuous external inputs which the farmer could not afford and probably did not understand. Furthermore, the approach took into account that the swidden farmer had very little contact with assistance from technical services and had little experience of working with his neighbors. In Sikka District one of the first activities was

to develop a cooperative group relationship among farmers which benefitted the project implementation and the contact with technical service agents. Field implementation activities used the approach of providing quick visible result within the existing socio-cultural structure.

The permanent agriculture Leucaena Farming systems accomplished the purposes of the local district administration in Sikka and Amarasi of reducing erosion while increasing water availability. Furthermore, increased properity of the farmers became a major contribution to economic development of the respective areas.

Even though the Sikka and Amarasi Districts experiences had not become national projects, PDP-N.T.T. began establishing Leucaena Farming Systems in late 1979. The past two years of implementation have been accomplished with only limited resources. The scarcity of resources included: a strong Leucaena Farming Systems concept, but a minimum development of an implementation plan; few technical extension agents and hardly any of them with appropriate training for developing permanent agriculture from swidden conditions; no availability of seed of varieties of Giant Leucaena; and a willing, but weak technical services' support system. The PDP's experiences are briefly presented as an approach that has been implemented with a scarcity of resources.

Recruitment and general basic training for untrained field agriculturalists and motivators occurred before field implementation which began January, 1980 after PDP received one kilogram each of the Giant Leucaena varieties of K-28 and K-67. Even though there were no project funds, seedlings were raised at the Belu District Forestry Office and distributed in March, 1981 at the end of the rainy season, by giving only four seedlings to each of 100 farmers in seven villages. Of the approximately 2,800 seedlings distributed an average of 75% of them servived the dry season even though many of the recipient farm families had insufficient water for themeselves. This is a remarkable achievement as compared to the dismal rate of survival of some regreening projects. One village, Kabuna, Taifeto Barat, Belu has collected 500 kg. of seeds as of September 1981 from that original planting of 700 trees.

The successful result mentioned above of farmers' management of the seedlings encouraged PDP to distribute from August - October 1980, 42 kg. of K-8 seeds and the needed plastic bags for seedling establishment to 4700 farmers in 47 PDP assisted villages in Belu, Timor Tengah Utara (TTU), and Alor Districts. The purpose was to provide each village with enough seeds to establish its own village seed supply on farmers' land. Monitoring visits reported that all villages successfully reached the goal of sowed the seeds in plastic bags and established the seedlings.. An analysis of the approach is being conducted to determine the first year's results of field establishment, percentage of seedlings surviving the dry season and amount of seeds collected.

Because of an insufficient supply of Giant Leucaena seeds and the need for a Leucaena Based Farming System to prevent soil erosion due to swidden methods, two village, Kabuna and Biloe, Biboki Utara, Timor

Tengah Utara, each established a pilot ten hectare project. Guidance for the project was given in the two weeks Lamtoronization training to the two village heads and two PDP motivators during October, 1980 which was provided in the District of Sikka at the Social Development and Research Institute of Nita. Additional support to the projects was provided by the PDP advisor who worked with the agricultural to provide on the job training. Both pilot projects were established during the rainy season in December 1980 with a monitoring report of good results. Also, improved varieties of food crops were planted between the hedgerows, but the yield data from the kabupaten is not available in Jakarta. However, Kabuna sold more than two tons of the short season mungbeans.

The pilot projects encouraged 12 more village heads from the three PDP districts of Belu, TTU, and Alor to request the pilot project for their villages. In preparation for the project implementation, the 12 village heads and the 12 motivators received the Lamtoronization training in Sikka. Implementation is planned for December, 1981 by using the seeds produced by the giant varieties planted last year.

It must be mentioned that food crops varietal trials have been conducted in 1980 and 81 on farmers' fields and at the station. The plan is to introduce improved varieties of corn (diet staple), mung beans, upland rice, and soybeans to be intercropped between the Leucaena hedgerows.

Next year at this time a more complete report will be available, but initial impressions have been very favorable. The impressions are:

Firstly, fasrmers have readily acknowledged that the Leucaena has increased availability of animal feed in the dry season. (In fact in Belu District's capitol, Atam Bua, the green, succulent branches of Giant Leucaena during the dry season is the most commonly stolen thing). In addition the cattle loan project of PDP has a stipulation that recepients must have Giant Leucaena trees as a feed source.

Secondly, the initial results from the two pilot villages demonstrate that the hedgerows of Leucaena are less likely to be burned because farmers are interplanting food crops which reduces the amount of dry flamable materials. The PDP advisor believes that the regreening projects should use the hedgerow system where applicable and allow farmer to intercrop with annual food crops.

Thirdly, the PDP agricultural advisor recently visited the site of the three year old Leucaena Farming System for hillsides on the Island of Cebu, Philippines. He commented that the setting was very similar to that of the Island of Timor and that the Filipino farmers recognized the soil conservation benefits of the Giant Leucaena hedgerows. In fact the terracing effect is already visible.

Fourthly, the applied agriculture research station at Sukabitetek, Belu has established trial plots of five Leucaena varieties, K-8, K-28, K-67, Peru and common in order to interplant corn, upland rice, mung beans and soybeans. Data will be collected on the herbage production of

each of the Leucaena varieties, but in one year we can see that the Giant Leucaena is twice as tall at 2-3 meters than the common Leucaena. Production trials of the four food crops will be tested by fertilizing with the measured Leucaena herbage and comparing with the use of recommended NPK fertilizers.

Fifthly, it is clear from the initial two pilot villages that Leucaena Farming Systems are only part of a necessary total package in order to effect change from swidden to permanent agriculture. For example the PDP assistance has been important to get farmers to begin to work cooperately together. It has also been the beginning of the involvement of technical services with farmers and vice versa. Furthermore, permanent agriculture necessitates that supporting institutions such as marketing and transportation need to develop. Already in some PDP assisted villages, the production of only the improved variety of mung bean has exceeded the traditional marketing system. Also, many of the villages are inaccessible in the rainy season except for long, difficult walks. Farmers have demonstrated that they can produce more food crops if the systems provide support.

## IV. CONCLUSIONS/RECOMMENDATIONS

### A. Conclusions

1. Swidden agriculture is a major ecological problem throughout the tropics. In determining approaches to assist farmers to shift from swidden to permanent agriculture in the Eastern Indonesia provinces of East Nusa Tenggara (N.T.T.), West Nusa Tenggara (N.T.B.) and Timor Timur (Tim Tim), the short rainy and long dry season is a major factor which must be strongly considered along with the socio-economic-cultural setting.

The provincial Area Development Program (PDP) implementation experiences have shown the important role of the provincial and district planning boards and technical services or project development.

2. Leucaena leucocephala as a shrub has been proven useful to help change from swidden to permanent agriculture in the District of Sikka and Amarasi, N.T.T. The new varieties or Giant Leucaena is a multi-purpose tropical leguminous tree which is proving to be valuable for agro-forestry specifically for Eastern Indonesia because of its climatic conditions, as well as for other parts of Indonesia.

3. Leucaena Farming Systems are of many types which are chosen based on the purposes of the farmer and the government. It has proven to be an effective soil conservation farming system in the District of Sikka, N.T.T. while also increasing food crop production. In the District of Amarasi, N.T.T. it has helped to bring about a permanent agriculture system because Leucaena is an excellent livestock feed. The PDP is implementing village level projects and conducting applied agricultural research to develop appropriate approaches using Leucaena Farming Systems.

## B. Recommendations

1. Leucaena Farming Systems which are effective in N.T.T. must be studied and analyzed. Studies are needed to document two main bodies of information. One body of information is technical knowledge and skills being successfully used. A second main body of knowledge is the approaches being used based on socio-economic-cultural considerations. Documented information should be widely disseminated.

2. National research institutes for forestry, food crops, livestock, and economics should conduct research on the benefits of Leucaena Farming Systems based on their institutes mandates because there are many farming systems, not just one system. Leucaena is a multi-purpose tree and can be included in research by all institutes and is urgently needed by the farmer with small land holdings.

3. The role of provincial and district planning boards and technical services for planning, managing, and evaluating projects is a key for developing projects which fit the local conditions and effect the change from swidden to permanent agriculture. Areas should be selected for development of pilot projects through these agencies and the Provincial Area Development Program has a successful approach.

GIANT LEUCAENA PLANTING GUIDELINES*

ATTACHMENT A

(Based on the Purpose/Use, Quantity of Seeds/Seedlings, and Plant Spacing)

| No. | Purpose/Use | Plant Spacing | | Ratio Seedlings Kg/Ha | Total Seeds/Seedlings Based on 17,000/Kg | Total Seedlings Based on 70% Germination | |
|---|---|---|---|---|---|---|---|
| 1. | Trees for seed | 2mx5m | | 0.10 | 1,700 | 1,190 | d) |
| 2. | Erosion control and fertilizer | 10cmx5m | a) | 2.50 | 42,500 | 29,750 | |
| 3. | Erosion control and fertilizer | 5cmx2m | b) | 10.00 | 170,000 | 119,000 | |
| | | 2cmx2m | | 25.00 | 425,000 | 297,500 | |
| 4. | Livestock feed | 5cmx75cm | | 13.30 | 226,100 | 158,270 | |
| | | 10cmx75cm | | 6.70 | 113,900 | 79,730 | |
| 5. | Lumber/Building materials | 10mx2m | c) | 0.05 | ,850 | ,595 | e) |
| 6. | Firewood | 1mx2m | | 0.50 | 8,500 | 5,959 | f) |
| 7. | Lumber for buildings and firewood | 1mx2m | c) | 0.50 | 8,500 | 5,959 | f) |

Notes:

a) For topography with slopes of 0-20%: Seedlings/seeds are planted following the contour (lay of the hill) in pairs of rows which are spaced 50 cm. between the two rows and 10 cm. between the seeds/seedlings in the row. The distance between one pair of rows and the next pair of rows is 5 meters.

b) For topography with slopes above 20%: Seedlings/seeds are planted following the contour (lay of the hill) in pairs of rows which are spaced 40 cm. between the two rows and 5 cm. between the seeds/seedlings in the row. The distance between one pair of rows and the next pair of rows is 2 meters.

c) After the plant spacing of 10 cm. x 2 m is well established, the plant spacing should be thinned to 10 m x 4 m. Selection will be those trees which have grown the best and straightest.

d) There must be 1000 seedlings/ha. based on one seedling per hole. The remaining seedlings are for replanting those seedlings which die.

e) There must be 500 seedlings/ha. based on one seedling per hole. The remaining seedlings are for replanting those seedlings which die.

f) There must be 5000 seedlings/ha. based on one seedling per hole. The remaining seedlings are for replanting those seedlings which die.

* Roberto A. Monserrat, Agriculture Advisor, PDP II-NTT
Joseph Manek, Head of the Branch of the Provincial Forestry Service in the District of Belu, Province of East Nusa Tenggara.

Attachment B

## SOURCE OF INFORMATION

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