SOME ASPECTS OF ARTIFICIAL REGENERATION IN BURMA WITH PARTICULAR REFERENCE TO TEAK (*Tectona grandis* Linn f.) AND *Eucalyptus* spp.

U Mya AUNG*

Summary

The economy of Burma is greatly dependent upon its natural resources, particularly timber, and the Forests of Burma have for over a century, been managed under the Burma Selection System. The system, however was considered inadequate and as such extensive establishment of man-made forests was suggested.

Plantation techniques for the major species namely teak (*Tectona grandis* Linn f.) and *Eucalyptus* species are outlined. Their major problems, ie. economic and labour, are emphasized and a solution is suggested.

Introduction

Burma depends mainly upon the export of rice, other agricultural products, mineral products and timber. The trade section is heavily dependent on these commodities as they are the only products presently able to compete in foreign markets and capable of earning substantial quantities of foreign exchange.

Rice constitutes the main export of the country and has done so for many years. From 1955 to 1957, Burma's rice export accounted for approximately 30% of the world's total, with the country being the world's largest rice exporter. However, export of rice has steadily declined since 1962. The export of other agricultural products has also declined. Thus, in the absence of any indication of mining development and with the steady decline in rice export Burma may need to depend more heavily on timber export in future.

Like many tropical countries, Burma is faced with the problem of the management of extensive mixed natural forests. A management system known as the Burma Selection System was adopted since the introduction of scientific management of the forests over a century ago. This management system being a system of exploiting just one tree species (ie. teak) from multi-species forest, is neither enriching these forests nor fulfilling silvicultural requirements (Aung Din, 1956; Kermode, 1964). There are also theoretical and practical arguments which indicate a reduction in teak stocking following the use of the Burma Selection System. Thus in order to compensate for the decreasing teak stock and the shortcoming of this system, artificial regeneration work has to be carried out. Although artificial regeneration work has been done since the prewar days, planting was stopped and again resumed from 1941-42 to 1946-47 and only in 1947-48.

Teak (*Tectona grandis* Linn f.) and Pyinkado (*Xylia dolabriformis,* Benth) were the major species planted up till 1970. Starting from 1971 Eucalyptus, particularly *Eucalyptus camaldulensis* was also planted extensively. However it was not meant for quality timber. The object was mainly to supply posts, poles and fuel for the local inhabitants, and it was thus planted only in the local supply working circle. Other *Eucalyptus* species, namely *E. grandis, E. citridora, E. robusta, E. teriticornis,* etc. were also planted. However, these are being planted only on an experimental scale and their suitability for extensive planting still needs to be assessed.

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* Deputy Director, Forest Department, Rangoon, Burma.

Teak

The use of man-made forests for production of teak has many advantages compared to the present use of natural forests. There will be substantial improvement in management control, in access, in production levels and in extraction procedures.

Since work in plantation is concentrated, management and the control of operations would be simplified. Plantation sites can be selected so that the topography is not too steep for mechanized operations, and the construction of a network of roads within the plantation would be justifiable. This would facilitate a more convenient and intensive degree of forest management.

Production levels would be much higher in a plantation than in natural teak forests. Natural teak forests in Burma are estimated to have a stock of one yield tree in 3.2 hectares (Ko Ko Gyi 1972), whereas in plantations of Site Quality III approximately 130 trees per hectare would be left after the final thinning. Thus, the final yield alone from plantation could be much higher than that from natural forests.

With the possibility of construction of a network of roads, and the application of mechanized units, extraction work in plantation could be more efficient. Plantations also permit the immediate application of the results of tree breeding research. Improvement could thus be anticipated both in production levels and in quality control of the timber produced.

The extent of teak plantations established in the country beginning from the early times can be seen below.

Table 1 Teak plantations

Period	Area planted in hectares	Average per year
1895-96 to 1926-27	27,658	864
1927-28 to 1940-41	9,272	662
1941-42 to 1946-47	–	War years
1947-48 to 1954-55	20	2
1955-56 to 1976-77	14,300	650
1977-78	1,338	1,338
1978-79 (Target)	1,862	1,862
1979-80 (Target)	2,469	2,469
1980-81 (Target)	3,096	3,096
1981 (Target)	3,683	3,683
Total	63,698	

1 Plantation work

Success depends on organization and straight adherence to plantation timetable for all items of works. A typical working schedule in Burma, is shown below.

1) Area allotment to the 'ya' cutters 15th December
2) 'Ya' cutting and fire protection 17th Dec.—25th February
3) Burning 3rd April
4) Kyunkwe 6th April
5) Staking 12th April
6) Direct sowing 7th May
7) Stump planting 1st June
8) 3-weedings 1st, 2nd Year
9) 2-weedings 3rd Year
10) 1-weeding 4th Year

Weeding in the 2nd, 3rd and 4th years is carried out by the forest department with hired labourers.

2 Nursery technique

Both temporary and permanent nurseries are used in the regeneration of teak. Each and every forest division has its own temporary nursery. Permanent nurseries in Burma are meant mainly to supplement the stock produced by temporary nurseries in case of any shortage or failure.

3 Seed

Although Southern Burma seeds give better germination (Ko Ko Gyi 1972), seeds or sowings are usually collected from the locality where they are to be planted.

Generally, germination of teak seed is very poor, being 35—59% for lower and central Burma origin and 7—20% for upper Burma origin (Kermode 1937, Mg Gale (2) and Nyunt Naing 1967). Various pretreatment methods have been tried and so far, the method of alternate soaking and drying was found to be the most practicable (Ko Ko Gyi, 1973).

Experiments by Bryndum (1966) in Thailand showed that the removal of the leathery exocarp by exposure to attack by ants improved germination considerably. This probably improves permeability and gaseous exchange (Ko Ko Gyi, 1973). A machine for removal of the exocarp of teak seed has been constructed by Thai Danish Teak Improvement Centre in Bangkok and the results obtained were encouraging (Hedegart 1971).

4 Seed showing

Teak seedlings are very hardy and fairly easy to raise in nurseries. In Burma sowing usually commences at the beginning of the rains in April. The seeds are either broadcast or sown in lines 15 cm. apart. After sowing, it is preferable to roll the beds lightly so as to press the seed slightly into the bed before covering up. Generally approximately 1.0 cm. soil cover is used in most teak nurseries.

Sowing density depends upon the germination % of the seed lot used. In Burma, generally a density of 190 seeds per square meter is used, aiming at a density of 43—86 seedlings in that area (Mg Gale (2) and Nyunt Naing, 1957).

5 Lifting and stump preparation

Generally, over one year old seedlings are lifted for planting at the beginning of the rains in June. The stumps for planting are prepared by cutting off and discarding the stem at about 2.5 cm above the collar. The tap roots are cut approximately 10—20 cm. below the collar, using a sharp knife to get a clean cut. The lateral roots are also removed. Stumps one to two centimetres in diameter at the collar are considered to be the best (Venkataramaung, 1956; Kermode, 1964).

In Burma, stumps are normally planted out within two or three days after preparation. However if necessary, stumps can be stored for a much longer period. Mg Gale (2) and Soe Tint (1969) found that stumps bundled in hessian cloth and kept in the shade can stand storage for 14 days with no watering, without affecting survival % significantly.

6 Field establishment

The *taungya* method was commonly used for the establishment of teak plantation in Burma. However, due to the difficulty in recruiting the "ya" cutters, the method was abolished in 1974 and all plantation work is now being done departmentally.

7 Site preparation

The area to be planted is clear felled in January or early February. Burning is carried out before the first light shower in April. Any unburnt debris are collected, piled up and burnt again, and this is called "kyunkwe" in Burma.

8 Initial spacing

The initial spacing adopted for teak used to be 1.8 m × 1.8 m and this is marked by bamboo stakes. Although 1.8 m × 1.8 m was found to be the best silviculturally as well as from the point of view of timber quality, (Anderson, 1958; Laurie and Griffith, 1942), it has now been replaced by a spacing of 2.74 m × 2.74 m since 1974-75 due to both financial and labour problems. Teak stumps are then planted at each stake.

9 Direct sowing

Direct sowing of seed is also being done in parts of Burma where the distribution of rainfall is not regular. In this case three seeds are sown at each stake.

10 Time of planting or sowing

Time of planting varies with the area. In the major part of the country, the best time for planting is generally about the last week of May or early June. Direct sowing is usually carried out in April during which both the temperature and rainfall are the most suitable for germination.

11 Weeding

Weed has been a problem in most tropical countries and so far, weeding is still being done manually in Burma. With the initial spacing of 1.8 m × 1.8 m three weedings were prescribed in the first year, three in the second year, two in the third year, and one in the fourth year. However, due to financial and labour problems, it became necessary to reduce the intensity and cost of weeding. This was done by adopting a much wider spacing of 2.74 m × 2.74 m and prescribing spot weeding at a frequency of two weedings in the first year, and two weedings in the second year as the final weeding. These are in the trial stage and the results are not known yet.

12 Thinning

For the initial spacing of 1.8 m × 1.8 m a thinning regime of 5-year interval for the first 15 years, and 10-year interval later up to the age of 40 is prescribed. The plantations beyond this age limit were treated as part of the natural forests for felling and utilization along with those from the natural forests on attaining the fixed exploitable girth sizes. Under this system/practice of plantation establishment, the average results of growth and yield on average sites tend to be in the region of 1.549 metre g.b.h., 34.146 metre height and 26.62 m^3 per hectare at age 60 or a M.A.I. of about 0.44 m^3 per hectare. The standard "D" grade thinning was practised for the selection thinnings.

For the initial spacing of 2.74 m × 2.74 m mechanical thinning is being applied now, consisting of a first one at the age of 5-7 years, reducing the stock by 50% and a second/final selection thinning at the age of 15 years reducing the final stock to around 124—173 stems per hectare (approximately 7.62 m × 7.62 m spacing). The plantation after this age will be regarded as firmly established and henceforth treated as part of the natural forest.

It is of interest to note that in recent years, the trial system of elite thinning carried out in India (Madras—1955/56) consisting of an initial espacement of 2.59 m × 2.59 m (Quality I/II), with the remaining elites being about 7.32 m apart, showed exceptional growth over trees thinned under the conventional system (0.356 m d.b.h. against 0.254 m d.b.h.). The average difference in diameter development was found to be as large as 40% at 20 years of age. One can almost say that this serves to illustrate that the thinning regimes of the past for teak may have been too cautious, and conservative, and that substantial yield increases may perhaps be obtained by suitable changes in thinning schedule.

Eucalyptus

Eucalyptus have greatly been used as exotics. This is mainly due to their being easily adaptable to environmental conditions different from those of their natural range (Metro, 1955). Moreover,

their rapid rate of growth can meet most of the requirements of modern forestry.

In Burma, the species is used mainly to regenerate artificially in the local supply working circle for supplying the local inhabitants with posts, poles and fuelwood. It is also being used with success in the afforestation of the central dry zone of Burma.

1 Nursery technique

In Burma, either seed beds or seed boxes are being used for sowing Eucalyptus seeds. The size of seed boxes used is 0.61m × 0.61m × 0.15m. Although it is cheaper to use seed beds, there are many advantages in the use of seed boxes.

1) Seed boxes can be put on a rock and this facilitates control of insects, preventing them from destroying or carrying away the seeds.
2) The seed boxes can be moved to any convenient places for pricking out operation or for shading purposes.

2 Soil mixture

Sand or soil mixture such as sand, cow dung and soil are used in seed boxes or seed beds for sowing Eucalyptus. In order to have a thorough mixture, cow dung, sand and soil are first sieved through a 5mm × 5mm sieve and then mixed in the proportion of 1:2:3. (Sein Mg Wint, et al 1970).

Seed boxes are then filled with the mixture up to 10—15 cm. Thirteen to 31mm deep of pure fine sand is added on top of this. The method gives good germination and strong and healthy seedlings.

3 Sowing

The soil mixture is sprayed with endrine one day before sowing.

Lines not deeper than 13mm to 52mm apart are drawn on the sand in the seed box. Mixture of Eucalyptus seed and sand in the proportion of 1:4 is then sprinkled on these lines. The lines are then filled with just enough light sand so as to make the surface even.

4 Watering

Great care is taken in watering as minute Eucalyptus seeds can be easily washed away. Moreover, both over-or under-watering can affect germination. Normally fine spray gives the best results.

5 Shading

Generally, the seed boxes or the seed beds are placed under 50% shade. Shading is done mainly to protect the seedlings from excessive heat or from frost in hilly areas.

6 Pricking out

Seedlings are pricked out and planted in pots or plastic bags when they are 25—75mm tall and have 2—3 pairs of leaves. Time required to reach this size ranges between 1-1/2 to 2 months. The soil used in the pots or plastic bags is sand, cow dung and soil mixed in the proportion of 1:2:3. The mixture is well watered one day before pricking out.

The pricked out seedlings are placed under 50% shade and watered twice a day. Care should, however, be taken that there is no water logging in the plastic bag.

The seedlings after pricking out usually grow up into different sizes. In order to avoid suppression of the small seedlings by the big ones, the pots or the plastic bags are usually sorted into lots of approximately equal sizes. Sorting out and moving the bags also help in preventing the roots from penetrating into the soil.

7 Hardening off

The seedlings are ready for planting out in the field when about 5—6 months old. In order to

avoid or minimize the shock when planting out in the field, they are first "hardened off" for about two weeks. During this period, the seedlings are gradually exposed to full sunlight and watering is also reduced gradually. However, they should be well watered twice before being planted out.

8 Field establishment

Site Preparation. For plantation in Local Supply nursery. This is carried out in the same manner as in preparing site for teak plantation. In dry zone, uprooting, harrowing, plowing, trenching etc., have to be done.

9 Time of planting

Time of planting varies with the area. It depends greatly upon the rain and soil moisture. In areas with high rainfall, planting operation is usually carried out by about the end of May or in early June. In dry areas deficient in soil moisture, a break in rain after planting can cause high rate of mortality. However, it is safe to plant if there is soil moisture up to a depth of 0.46 m.

10 Planting

In Burma, the method of planting Eucalyptus varies with the area (1) Normal planting method (2) Planting method in the dry zone.

(1) Normal planting method: This method is applied in the areas of the country with sufficient rainfall for the growth of the spp. Initial spacing adopted is 4,9m × 4.9m. The plastic bags containing the seedlings are first removed and then the seedlings are planted in previously dug pits.

(2) Planting method in the dry zone: In the dry zone areas, seedlings are planted either in pits or in ploughed up areas. An initial spacing of 4.9m × 4.9m is adopted. Ploughing gives very good results, but cost of establishment incurred is a bit too high. At present, planting in the dry zone area is being done in 1.2m × 1.2m × 0.3m pits.

11 Weeding

Intensity of weeding in Eucalyptus plantation is less than that in teak due to the rapid height growth of the species. Presently two weedings are done in the first year and only one in the second year.

Conclusion

It is clear that timber is one of the most important export items in Burma and that the economy of the country is greatly dependent upon it.

Consequently, a silvicultural system to get a maximum production in perpetuity is greatly needed.

The present Burma Selection System can not be fully considered as a satisfactory system to induce natural regeneration of teak. Thus, extensive establishment of high production man-made forests to supplement the Burma Selection System or, a gradual conversion to clear cutting system where site factors are favourable is needed.

Although, the present plantation technique is quite successful from the point of view of survival, it is evident that emphasis could not be placed on timber quality due to economic and labour problems. These problems can be solved only by investing more on the forestry sector and by mechanization of, at least, the major part of the plantation work.

Discussion

Fujimori, T. (Japan): What are the advantages of adopting the clear cutting system and planting method over natural regeneration of teak?

Answer: The advantages are as follows: 1) Faster results are obtained; 2) Species composition can be easily regulated; 3) Early growth is more rapid; 4) Stocks are fuller and more even;

5) Species which is planted is more valuable than natural regeneration; 6) All phases of management can be concentrated.

Prasert B. (Thailand): Sometimes due to a drought spell, stumps at the dormant stage cannot be prepared with hardy stumps. Then there may be still enough moisture for teak seedlings to grow with spring cells which are succulent and tend to become susceptible to fungus disease such as *Pithium* spp. or *Rhizotectonia* spp. What procedure do you follow in such case?

Answer: We can raise teak plantation either by stump planting or by direct sowing which is even preferable. Since teak seeds are abundant and cheap we normally sow seed directly. If this fails, we do patching by using stumps or small seedlings from the nearby temporary nursery.

Yunus K. (Indonesia): 1) What is the limit of site quality in which you are still justified to plant teak? 2) Is it not preferable to use closer spacing instead of wider spacing which may interfere with the stem quality? 3) Why are taungya cutters less and less interested in the taungya system?

Answer: 1) Sites suitable for establishing successful teak plantations are those which are capable of bearing a pure crop of teak of a quality not worse than III. 2) Closer spacing was found to be best both from the angle of silviculture and from the point of view of timber quality. Wider spacing was adopted to reduce the frequency of weeding and thinning owing to financial and labour problems. 3) The salaries of taungya cutters are very low.

Choob K. (Thailand): Do you have any problem with teak stem borer?
If you do, at what age is it more serious and how much damage does it cause?

Answer: At present we do not have any problem with teak stem borer.

Glori, A. (The Philippines): Why do you apply hardening process to Eucalyptus although planting is done in the rainy season?

Answer: Hardening process is applied because sometimes after planting there is a dry spell which may adversely affect the growth of the seedlings. With the hardening process the period of watering can be reduced.