AIM AND PROSPECTS OF TEAK BREEDING IN THAILAND

A programme of work for the Thai / Danish Teak Improvement Center at Mae Huad Teak Plantations

by

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INTRODUCTION

On the 25th of January 1965 an agreement was signed between the governments of Thailand and Denmark concerning the technical cooperation on genetics and silviculture of teak. With the arrival of two Danish forest geneticists about a week later work on the first three years of the scheduled cooperation took its beginning.

The decision to join forces on the improvement of teak comes naturally as a development of the extensive botanical cooperation between the two countries during the last 8-10 years, for which the Committee of the Thai/Danish Botanical Studies is largely responisble.

As part of these studies teak has been subject to various observations and experiments in relation to tree breeding. GRAM and SYRACH LARSEN (2) observed the initiation of flowers in young teak at the leading shoot and pointed out its consequences for the quality of the stem. SA-ARD BOONKIRD and KEIDING made investigations on budding of teak and succeeded in establishing a clone collection in 1959 (1,4,6). In the following years Sa-ard founded two more clone collections for the study of wood qualities and "black streak" respectively. Further Sa-ard began work on the first seed orchard in Thailand at Pachtong, at the same time he and his coworkers continued the selection of plus trees and made studies of the flowering habit of teak.

The growing interest for studying teak in more details with the purpose of improving the species also had its background in the heavy exploitation of the natural teak forests. Not only does the extraction of timber surpass the natural regeneration thus reducing the stock of teak rapidly, but it might have a more serious effect by also lowering the quality. The almost systematic felling of the best trees (fig 1.)

leaving the inferior ones behind to produce seed and thereby the next generations might in the long run lead to a loss of valuable characteristics (genes) or a replacement by less valuable ones. To counteract this development various measures have been taken of which the extension of teak plantations probably is the most effective.

The heavy exploitation of the natural teak forests and the planting of teak both call for immediate action in order to preserve the good teak still in exsistence and in order to provide forestry with seed from the best stands only. The preservation of trees and the provision of seed are both important parts of any improvement work and combined with the preliminary studies and experiments made it feasible to take up breeding of teak more systematically. Hence the establishment of the Teak Improvement Center at Mae Huad Teak Plantations.

In the following the various objects of the breeding work are set up in a working programme for the center. It is supplied with some explanations and comments based on experiences obtained since the start of the project but also from other fields of tree breeding in temperate and tropical climates.

OBJECTS

I. **General purpose:** The improvement of teak in respect of vigour, form, wood qualities and resistance to pests and diseases.

II. To outline and bring into operation a programme of selection and breeding, comprising:

1. The provision of a material for breeding and for the study of variation by a) selection of plus trees and subsequent vegetative propagation and b) by setting up provenance and progeny trials.
2. Studies of the variation of different biological characteristics such as growth rate, flowering, branching habit, seed production, fluting and wood qualities, all of which may be of importance for the improvement of teak.

Fig. 1: "Negative selection". Good tree to the right marked and ringed for felling. Tree to the left with crooked stem marked as seed tree.

Fig. 2: Plus tree, V. 27, standing near the road from Lampang to Ngao. 90-100 year old tree of unsual fine appearance.

Fig. 3 : Budgraft on big rootstock. Photographed one and a half month from budding.

Fig. 4 : Clone collection 1965 at Mae Huad, photographed 3 months after budding. Each row represents one clone.

3. Controlled pollination and subsequent execution of crossing series.
4. The setting up of a registration system and advice on experimental procedures.

III. To advise on and support the organization of seed collection, distribution and utilization, by means of :

1. Selection and demarcation of the best stands for seed collection both in the mixed teak forests and in plantations.
2. Establishment of clonal seed orchards.
3. Investigations of storage and treatment of seed.
4. Investigations and improvement of nursery practice.

IV. To encourage co-operation, including exchange of material, with tree breeding stations outside Thailand, with other fields of research, with forestry education and with practical forestry. Further the center might support the breeding of tree species other than teak.

MEANS AND METHODS

It is characteristic for breeding of forest trees that the selected material often is used for production of seed or timber before the testing is completed. Investigations and utilization go hand in hand. Seed orchards as an example are established with clones representing newly selected plus trees currently under test, and seed source areas will provide seed in several years before their inherited potentials have been proved. This trend is particular pronounced in the early stages of a breeding programme but will gradually become less as the breeding and testing advance. It is less "risky" than it might appear and it is justified by the relative slow growth of trees and the slow formation of new generations.

On the other hand the tree breeder may also take advantage of the long time involved in testing his material before it comes into maturity. Many of his experiments may have multiple purposes as explained under the discussion of provenance and progeny trials and seed orchards may be improved long before they have finished the production of seed. Further, once a step forward in the improvement

has been achieved, it can always be maintained by vegetative propagation. These too are typical features of the tree breeding.

II,1 : Provision of material for breeding and for studies of variation.

a. *Selection of plus trees.* A plus tree should distinguish itself in some or all of the following characters: 1) Vigour, 2) straight and persistent axis, 3) clear, cylindrical bole without bumps, epicormics and buttresses, 4) light and spreading branching with knotangles approaching 90°, 5) a reasonable amount of seed production and 6) freedom from disease. These are the main criterions for selection but other characteristics such as quality of wood and early or late initiation of flowering may be of great importance too.

It is obvious that the perfect tree possessing all these qualities is very seldom if ever found and that the selection usually is a compromise between the ideal and the relative merit of the tree judged from the surrounding stand. Further the trees are selected on phenotypic appearance i.e. the result of the interaction between inherited characters (genotype) and the environment. The problem is to assess how much of the good appearance is genetically determined. The difficulty increases the less we know of the history of the tree and its environment and, when, as is the case in the natural teak forest, the latter changes within very short distances. Therefore the selected trees have to be tested under uniform conditions in order to get a proper estimate of their genotype. This is the main purpose of the clone collections in which the selected trees are brought together by means of budgrafting.

The description of plus trees is carried out on printed forms, the socalled Plus Tree Record Forms, with entries for the various characters. Some of these are measured (height, diameter, flutedness, age and branchangle) and the rest is scored. Both for measurements and scoring rules and definitions are worked out and the description thus follows a standard procedure. For more details: See section II,4 or special notes kept at the center. Plus trees are marked with a black and yellow band painted at breast height and their vegetative number (V-nr.). If for some reasons the tree is selected but not yet described or propagated only the yellow band is painted on.

Up to the end of 1965, 25 plus trees were selected and propagated in clone collections and in the multiplication garden. Of these 14 are mature trees from the mixed teak forest in the provinces of Lampang and Prae, while the rest is from the plantations around Mae Huad. Another 12 trees have been selected for special characters, either colour of wood or "black streak". Of course many more trees will have to be selected and budded in order to get a good basis for the breeding and the variation studies. Some of the difficulties in selecting plus trees in the natural stands of teak have already been mentioned but in addition we have the problems of transportation both of equipment and budwood. Further in view of the environmental conditions, in the natural teak forests, we might easily spend too much time cruising after superior trees in proportion to the results, it yields. It is therefore suggested, at least in the beginning, to concentrate selection in relatively pure and evenaged stands and preferably not more than one or two days' travel from either multiplication garden or air transportation. It is still possible to get a fairly widespread representation of different localities that way. Beside the natural teak forests the plantations offer good opportunities for selection, especially in respect of early and late flowering. The possibilities for comparison are often much better, and although very few plantings are more than 25 years old most of the characters, we are interested in, may be scrutinized.

However for a long term policy of selection conditions might be considerably improved by using the provenance and progeny trials as basis. Having assessed the relative merit of the provenances only the best trees from the best provenance (s) may be selected, thus eliminating a large portion of the uncertainties regarding origin and influence of environment. Partly for this reason great emphasis was laid on securing a representative collection of provenances as early as possible.

The plus trees as already stated are preserved and concentrated in the clone collections by budgrafting for the purpose of evaluating their genotypic values. We may decide according to this evaluation which clones to use for the seed orchards, but at the same time it gives a much improved basis for the study of individual variation.

Variation, either between individuals or between groups, is fundamental for selection and breeding and it is therefore essential, that we obtain an impression of its magnitude and of its kind. In the clone collection from 1959 we have already observed a great variation in flowering habit between clones. It seems that this character to a large extent is inheritable. Other characters such as branching habit appear at present less variable and it is probable that this is more influenced by environment. These differences in reaction to environment between various characters, i.e. the differences in genetic control, are of considerable interest to the tree breeder and may be deciding for his policy of selection and breeding. If for instance "knotangle" appears to be under low genetic control (low heritability) selection is not likely to be very effective and the character might better be controlled by good silviculture. For the opposite reasons the selection for late initiation of flowering may be intensified.

The technic of vegetative propagation has been described earlier (KEIDING and SA-ARD 1960, SA-ARD 1964) as well as its necessity for carrying out a breeding programme. The budding method widely used in rubber plantations is very well suited for teak. Although the technic might still be improved the actual budding does not present any bigger problems. With the introduction of multiplication gardens and with careful supervision of the budgrafts during the first two months, we may get percentages of success of between 90 and 100. However budwood i.e. branches with buds from selected trees is rather sensitive to heat and drought. Only by sealing the ends of the budwood in wax and by packing it in moist sawdust may the buds be viable up to 3 days. The best results are obtained when budding takes place the same day the budwood is cut. This, as already mentioned, limits the scope of propagating far-away trees in the natural forest, but it might be helped by setting up temporary multiplication gardens in connection with nurseries in different parts of the country. Thus as an example the multiplication garden near the seed orchard at Tak, to be budded in April 1966, may conveniently be used for plus trees from the Mae Sod area and in the following year moved to the central multiplication garden at Mae Huad.

Vegetative propagation is applied, where it is desired to preserve and multiply selected material. Clone collections and multiplication gardens have already been mentioned. The purpose of the latter is solely the production of budwood in large quantities and of better quality than that from the original plus trees. Further, budding is used for the establishment of seed orchards and breeding gardens. It might even be comtemplated to apply budding on a bigger scale making stands of clones in the plantations, like rubber. In any case the budding operations will take up a considerable part of the field work each year and it is therefore of great importance, that a sufficient number of labourers are trained in this technic as well as in the upkeep the first one or two critical months.

b. Provenance and progeny trials

The natural habitat of teak is spread over a vast area between the 15th and the 25th northern degree of latitude and in East-West direction from Laos to India through Thailand and Burma. The mixed teak forests are interspersed between other types of forest or agricultural land and this may have caused a slowing down or an interruption in the free exchange of genes. Over a long period of time populations in the outskirts of the range or in isolated localities may have adapted themselves to different climatic or edaphic conditions. They may have formed different ecotypes and in extreme cases distinct races as the Teli race from India. Whatever has caused the diversion or specialization the offsprings from the different localities may be of varying value. This has been proved for several tree species in the northern hemisphere and to some extent for teak in the so-called provenance test.

We therefore considered it as one of our first tasks to prove the existence of different ecotypes or more correct, populations of varying genetic value, within the boundaries of Thailand. The investigations should at the same time give informations about which places were the most promising as seed sources. As it is the first time a provenance test has been attempted in Thailand we tried to spread our collections evenly over the teak bearing areas. Due to the limited time at our disposal this could not strictly be adhered to

and more remote and inaccessible areas had to be left for later collections. With the cooperation of the Forest Industry Organization (F.I.O.) about 65 localities are represented. Details regarding localities and amount of seed collected are stated in a progress report to the Forest Department from September 1965. The first batch of seedlings will be planted out in a replicated trial at Mae Huad in May 1966, and we hope to follow it up with a similar trial in 1967 under different conditions in another part of the country. Provenance trials at a later date should include seed samples from other countries and thus be linked up with internationally organized provenance tests.

In progeny trials the seed may derive from single trees after free pollination, from clones in a seed orchard or from controlled pollination. As distinct from provenances, the parentage, at least on the maternal side, is known, and through progeny tests it is possible to estimate the breeding value of individual trees. Single-tree offspring after free pollination may give indication of whether the selected trees have general combining ability i.e. the ability of the mother tree to impress the offspring in a good direction irrespective of the male parents. A better test of general combining ability is performed when seed is harvested from individual clones in a seed orchard and the clonal offsprings are compared in a socalled polycross test. The best and most reliable informations about breeding value, general and specific combining ability will however be obtained, when we are able to carry out controlled pollination on a large scale. Special efforts therefore should be made in working out the technic of controlled pollination. Collection of seed from plus trees may begin in January-March 1966 and provided we can get enough seed the first progeny trials may be laid out in 1967.

II,2: Studies of variation

In the discussion of plus tree selection and the evaluation of genotype, the importance of studying variation in clone collections have already been dealt with. Provenance and progeny trials may serve similar purposes. It was stated that different characters might be under different genetic control and what effects this might have

on a programme of selection and breeding. The significance of variation may be judged by the ratio of the variation "within" to the variation "between". In our example from the 1959-clone collection the character called "late flowering" did vary to some extent within the different clones. A few trees in otherwise flowering clones did not flower this year because of varying exposures to light, but these discrepancies were insignificant compared with the fact, that some clones flowered and others did not at all. Although not measured the "knotangle" appeared to vary only a little both within and between clones—the ratio approaches 1—and the character is probably under less strict, genetic control than "late flowering".

These and similar observations should be continued and extended in the following years.

II,3 : Controlled pollination or generative propagation

The collection of selected material either by vegetative propagation or by the harvest of seed in natural stands of teak is in the principle a preservation and a concentration of phenotypical superior material. This alone might be an improvement merely by avoiding the poorest stands or obvious wolf trees. Real progress however can only be expected by combining the valuable characteristics present in the clones and in the provenance or progeny trials through controlled pollination.

Controlled pollination in teak has only very recently been started and only a few and scanty informations from India are available. We therefore began a more thorough study of the mode of flowering in the clone collection from 1959 and in a 19 year old planting at Mae Huad. In the former a 10 m high bamboo scaffold was raised to facilitate the more detailed studies and the hand-pollination. In the following is given a brief account of those observations, which are related to controlled pollination. A more detailed report will follow at a later date.

The flowers of teak are small, the corolla being 6-8 mm in diameter. They are bisexual having both stamens (6 in number) and stigma in the same flower. The flowers are collected in big inflores-

cences varying in height from 40-60 cm and sometimes even bigger. Unless trees are completely free from shading of neighbouring trees the inflorescences will appear high up in the crown. Hence the 10 m high bamboo scaffold. During most of the flowering period, which lasts for one and a half to two months, the individual flowers open few at the time and usually spread over the inflorescence. The anthers are split open in two halves immediately after the flower has fully opened, exposing a sticky mass of pollen. The flowers are normally open for one day after which time the stamens become brown and withered. The style too seems to crumple after one day of flowering. Thus the receptible period is probably not more than one day. When the flowers are protected by terylene bags it may however last up to two days before withering sets in. The natural pollination is carried out by various insects, which seem to be attracted by the nectar at the base of the corolla. It is very doubtful that wind play any part in the pollination.

Compared with the pollination of unisexual, windpollinated flowers of tree species in the temperate zone teak obviously have many new and perhaps more difficult problems and only a few advantages. They are treated shortly in the following.

1) *Isolation.* Isolationbags have to be dense enough to exclude even small insects. If the bags are to cover the whole inflorescence they must be big, but big isolationbags may become too heavy and cause the whole inflorescence to break. With the sporadic and prolonged flowering an isolationbag covering the whole inflorescence has to be removed and replaced many times for the actual pollination (handpollination). This is unfortunate as many flowerbuds and potential fruits may fall off in the process.

In our initial experiments we found that medium sized terylene bags as those employed in pollination work in Great Britain may be useful provided the inflorescences are pruned and if some kind of opening device could be added, making it possible to operate over different parts of the inflorescence without removing the bag. We have in mind some kind of zip or plastic locker used in bags for cornflakes. As an alternative much smaller bags covering only branchlets of the

inflorescence may prove practical. This was tried with bags made of nylon netting but the material became too brittle and tended to break during the two months of exposure to rain and sun. The method should be tried again with a different material preferably terylene.

2) *Pollination.* In view of the short time the stamens appeared to remain fresh and the lack of facilities to extract and store pollen we decided to use newly cut anthers. Flowers were taken from the male parent trees, emasculated and the anthers collected in a plastic cup with a sticky, watery solution of sugar. The anthers were then transferred one at the time with an insect pin to the stigma of each of the flowers of the female partner. Prior to pollination these were emasculated too. All together a rather delicate and time consuming method. Due to the sticky solution the anthers would adhere to the stigma and it was hoped, that the pollen would germinate and proceed down the style. However we had very little success, obtaining only one fruit out of 90 pollinated flowers (crosspollinated). To some extent it might be ascribed to a general poor seed setting this season, but either a refinement of the method or other methods should be attempted next summer viz. brushing of the stigma with previously extracted pollen.

3) *Selfpollination.* A very important factor for the technic to be employed in controlled pollination is the ability of teak to selfpollinate i.e. to become fertilized by its own pollen. In our opinion the teak flowers do not seem to be well protected against selffertilization, as the anthers are ready to shed their pollen at the same time the stigma appears receptible. Unfortunately our initial investigations did not give a clear cut answer. On one hand forced selfpollination, using the method just described, did not yield any fruits, but in view of the poor results obtained in the crosspollination, this is not conclusive. On the other, one of the isolationbags, in which the flowers were left to themselves, did have a few. As the question of whether teak is capable of selfpollination or not also means a great deal for the establishment of seed orchards, it is essential, that the investigations are continued and intensified. This apply equally well to the problems of isolation and pollination if we shall hope to get sufficient material for the progeny trials.

It would be advisable too as soon as possible to establish a socalled breeding quarter consisting of buddings placed at wide distances with the sole purpose of producing easy accessible flowers.

II,4: Registration system and experimental procedure

Recordings and observations should be kept in good order and they should be easy to look up, when special informations are required. It is desirable too, when different people at different times carry out the same observations, that they follow the same pattern so all the necessary details are recorded as uniform as possible. For routine observations and recordings standard forms and standard procedures have therefore been worked out. The various forms currently in use are outlined in the following:

1. Plus Tree Record Form:	Description and scoring of plus trees. Records of vegetative propagation and progenies from the tree in question. Cross references to Propagation Card and Seed Lot Card.
2. Propagation Card:	Registration of vegetative propagation i.e. amount, time, method, number of successful propagules. The figure of the latter is entered in form 1.
3. Seed Lot Card:	Registration of all seed lots being subject to tests of one kind or another. In case of singletree offsprings or controlled pollination: Cross ref. to form 1.
4. Pollination Card:	Recording of details and method of controlled pollination. Cross reference to form 3.
5. Flower Observation Card:	Registration of time schedule for flowering, especially of selected trees. Is of importance for the composition of seed orchards.

As part of the registration a system of numbering has been introduced. All material which have been propagated *vegetatively* is

marked with a V-number and the year of propagation. The original trees which have supplied budwood or scions are referred to by these V-numbers. Once a clone has been established all subsequent propagations get the same V-number. Only the year of propagation changes.

Similarly all *seed* lots are given a S-number. In difference from the V-numbers a S-number is never used twice. When as an example seed is harvested from the same mother tree in different years, each seed lot is given a new number, irrespective of the type of pollination (free or controlled). The reason for this is that two seed samples from different years will probably never have exactly the same genetic constitution.

Beside the propagation and seed lot cards *registres* of successive V-and S-numbers are maintained. Seed source areas will also be registered and possibly described, but as the mixed teak forest offers special problems, rules for the assessment are still under consideration.

Although field experiments may vary considerably in purpose and lay-outs they all have some common features such as: Statement of purpose, description of experimental areas, facts about experimental material, statement of design, treatment of results, duration of experiment and statement of responsibility for upkeep. A standard procedure on general lines may therefore be worked out, and examples will be given with the first provenance trials to be plantet in May 1966.

Further details and explanatory notes for all the forms and registres will be available at the Teak Improvement Center.

III, 1: Seed source areas

It will probably last about 5 years from the establishment of a seed orchard until it starts to produce seed in small quantities and about 10-15 years before it is in full production. To meet the requirements for the present aim of 2500 ha of teak plantings annually we have to add the time it will take to build up a sufficiently large area of seed orchards. It is obvious that it will take several years before all new plantings can be supplied with seed solely from seed orchards.

In the meantime seed will have to be collected from natural stands and plantations, and as a mean to improvement, collection should be restricted to the better stands only. These should as far as possible be demarcated and treated with thinning and slashing of undergrowth to promote seed production from the best trees and to ease seed collection. In the selection of "seed source areas", beside vigour and quality, the age of the trees, the extent of the stand and the possibilities of control have to be taken into consideration. Very old trees or small stands, although of good quality, will produce seed in too short a period or in too small an amount to make the demarcation and various treatments worth while. As regards the control of the collection and the dispatch of seed it will be an advantage, if the seed source areas are relatively near to villages and forest stations. Some areas of this kind have already been earmarked in the districts of Mae Sarieng, Mae Sod and in the Mae Tar plantations.

III, 2: Clonal seed orchards

Definition according to Matthews (8) is as follows: "A seed orchard is a plantation of genetically superior trees, isolated to reduce pollination from genetically inferior ones and intensively managed to produce frequent, abundant, easily harvested seed crops". Seed orchards are most commonly established with vegetatively propagated material but may also be composed of seedlings from superior progenies or provenances.

So far two areas of about 12 rais each have been cleared and planted with stumps in May/June 1965, and will be ready for the first rounds of budding in April/May 1966. One of the seed orchards is situated at Mae Gahr approximately 50 km north of the Center and near to the mainroad from Lampang to Chiengrai. The other is placed 15 km from Tak beside the road from Tak to Mae Sod. In both areas, which are well isolated from other teak trees, 10-15 clones from the selection at Mae Huad will be used as parent trees in a balanced mixture, so as to obtain the best possible pollination between all clones. Planting distance in both areas is 3×3 m, which might seem a little close, but in the lay-out a removal of every alternate tree is taken

into account. One or more clones might also be discarded as the testing advances.

The two seed orchards will, beside the production of seed, serve as important fields for observations and experiments. Most of the informations about establishment, upkeep and development are new and therefore of importance for the building up of seed orchards on a larger scale. Various treatments of the ground (cultivation) or the trees (manuring, pruning) in order to improve seed production and harvest may also be tested.

In the coming years new sites for seed orchards will have to be found, and it is possible, that we should look as far south as the peninsula to find suitable places. Growth of the trees here might not be as fast as in the north, but seed production will probably be as good or better and isolation will be easy to obtain.

III, 3: Storage and treatment of seed

So far storage of seed seems to have been no problem. There is apparently an abundance of seed for each year's requirements and surplus seed is just left outdoors in a big basket container, as those used for storage of rice. The situation may change however when a certain discrimination in seed collection is enforced, at the same time the areas to be planted increase. Further seed will gradually become more valuable and need more attention and control when the seed orchards come into production. We visualize a development in which all seed ultimately is collected from recognized seed source areas or seed orchards accompanied by the introduction of a seed certification system and the establishment of a distribution center. The latter may conveniently be placed at Mae Huad Teak Plantations. Naturally we have to be prepared for such a development and investigations of storage have or will be started. They comprise the effects of temperature, humidity, storage media, containers and various treatments of the seed viz. cleaning, sorting and application of insecticides and fungicides.

III, 4: Nursery practice

Seed is usually sown in elevated beds of one meter in width as shown in fig. 5. The nurseries are most often temporary and are left,

when stumps have been pulled twice. The density of sowing is about 20 liter per 7 m of bed (7 m^2) and the seed is broadcasted. On an average the seed will germinate with a percentage of 20-30. Apart from the loosening of the soil, when the beds are raised, no other preparations are made. The dense sowing of seed causes usually a dense growth of seedlings of varying heights. This in fact is intended as the faster growing seedlings should not become too big for pulling out the first year and the smaller should become big enough for the following year.

In our opinion this practice has certain disadvantages and it seems a somewhat wasteful use of seed. The second batch of seedlings after two years of growth might have been affected by the suppression of the more vigorous ones and therefore get off to a slower start. It is probable too, that a certain amount of selection takes place by planting out in two rounds. The seedlings from the latter may be less vigorous not only because of differences in time of germination, but also because of inherited tendencies for weaker growth. For experimental plantings in particular this is unfortunate.

Therefore some investigations have been started concerning pretreatment and grading of seed, sowing distance and early transplanting with the purpose of getting better and more uniform germination and thereby giving the seedlings an even chance to develop. An interesting observation regarding pretreatment of seed has already been made. It is the influence of ants on germination. They can, by eating the exocarp of the fruits, improve germination significantly. K. Bryndum has decribed these experiments in a special paper: "The Germination of Teak".

For further improvements of germination and growth various chemicals should be tried against weeds, pests and diseases. Application of fertilizer might also prove beneficial. Finally the possibilities of establishing permanent nurseries should be investigated as they may become of increasing importance for the control and distribution of improved plant material.

IV: Co-operation

It will be appreciated from the preceding sections that forest tree improvement is concerned with many aspects of forestry.

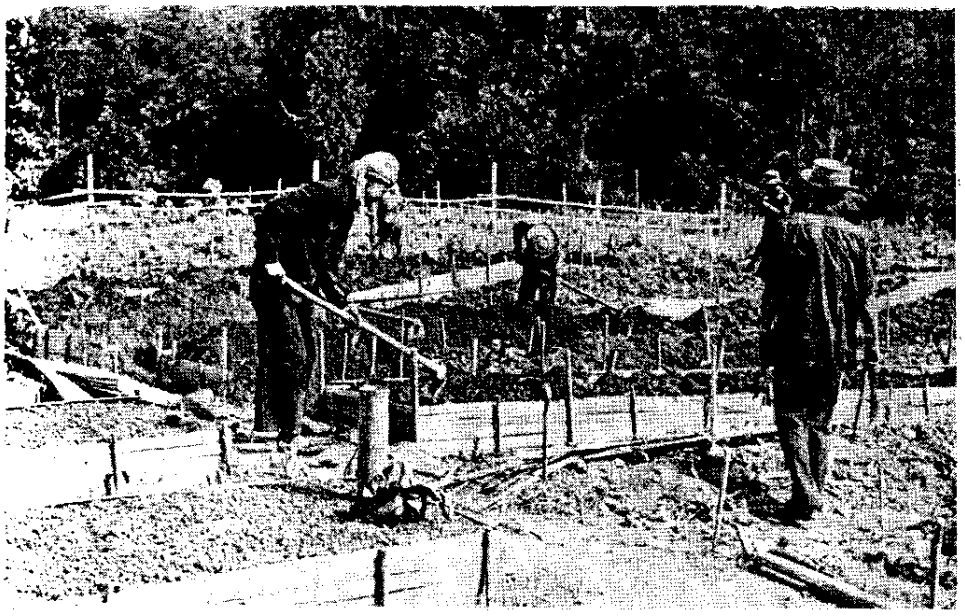

Fig. 5 : Preparation of seedbeds. In foreground to the left completed beds with seed broadcasted on top. Note the density of sowing.

Fig. 6 : Close-up of single teak flower approx. 4 times nat. size.

Fig. 7: Handpollination in teak. A pollensack is transferred with an insect pin to the stigma. The altered shape of the inflorescence is caused by tieing up branchlets to the axis and by the limited space inside the isolation bag.

Although actual breeding may claim most of our activities, we invariably overlap other fields of research viz. silviculture, pathology, zoology, wood technology, plant physiology etc. We will often need the advice from specialists in these different fields, but on the other hand will our material of clones and provenances/progenies offer them new opportunities for investigations and experiments. Similarly forest officers in charge of planting operations and the upkeep of plantations will have many practical experiences, which might be of help in the breeding work, but naturally they should also be interested in the progress we make, as they are the first to benefit from the improvements.

The same principle of exchange both of knowledge and material will of course apply to tree breeding stations outside Thailand. Also here the benefit might be mutual. From breeding stations of long establishment in the temperate climates many experiences have been accumulated, from which the Teak Improvement Center may pick and choose and thus get off to a better and quicker start. On the other hand the relative fast growth and short period to maturity of tropical tree species may soon yield results of interest to the same breeding stations.

Further the center might be open for cooperation in the improvement of other species than teak. We are thinking particularly of the development taking place in the planting of the two pine species, Pinus khasya and P. merkussii. If, as proposed from various sides, pines are to be cultivated on a large scale, the organization of seed collection, establishment of seed orchards, etc. will have to be on the same lines as for teak. The existence of a breeding center with experiences and facilities in these fields might be of very great interest.

It all points to the fact that cooperation in different directions and at different levels is beneficial. The Teak Improvement Center should therefore consider it as part of its obligation to make its work comprehensible both for scientist and lay-men by means of articles, instructive notes and demonstrations.

Finally I should like to draw the attention to the article 7 of the agreement, which says: "The common project will be managed

in a spirit of cooperation between the Danish experts and their Thai counterparts": I am glad to state, that in the first year of establishment we have experienced this kind of spirit. Without the support, interest and hospitality received from all ranks of the Forest Department we would not have been able to start the provenance trials and vegetative propagation in the way it has been done. We wish at this place to express our thanks to the representatives of the Forest Department, the director general Mr. Dusit and the deputy director Mr. Krit and our Thai counterpart Mr. Som Pherm Kittinanda.

Further we are greatly indebted to Mr. Sa-ard Boonkird for his unfailing interest and support and for having carried the flag since the early investigations in 1958-59.

We cannot conclude this article without mentioning the name of Dr. C. Syrach Larsen. His inspiration, enthusiasm and special interest in the breeding of teak in Thailand has been of very great importance for the launching of the project.

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