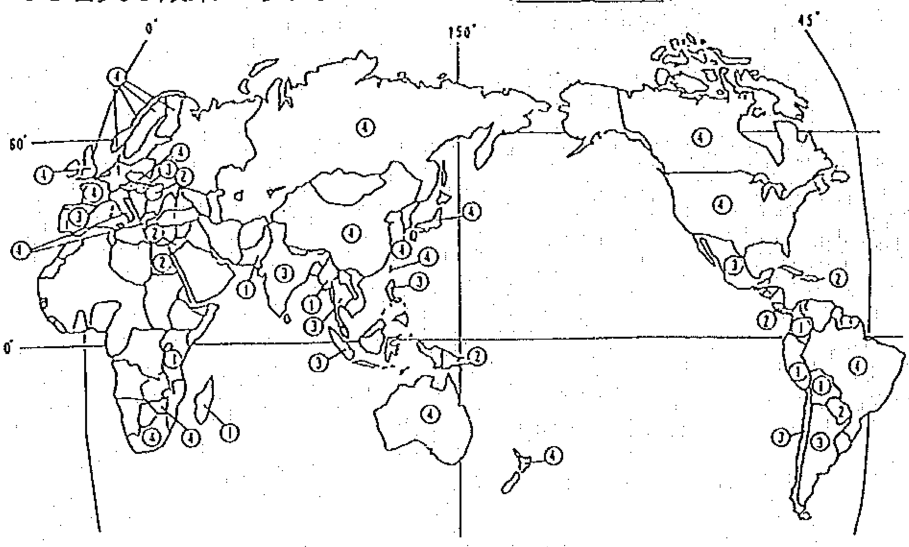
Table 9　Tree breeding activities in several countries

Country	Promoting Organization	Main species	methods of breeding
Sweden	Cooperation of the Government and Industries Central organization-The Institute of Forest Improvement Financed by Government 50% and Industries 50%	Pinus sylvestris Pinus contorta Picea abies Larix	Selection Crossing Tissue Culture
USA	Tree Improvement Cooperatives, consisting of Industries, governments and universities Tree improvement business projects to assure superior varieties and disease and insects resistant varieties Close combination of actual plantations and research	Pinus taeda Pinus elliottii	Selection Crossing
Korea	Government-lead tree breeding from research to operational seed production Central organization - The Institute of Forest Genetic, Forestry Agency	Rigitaeda pine pinus densiflora Pinus thumbergii Abies holoplylla Castanea crenata	Exotics Crossing Selection
China	Cooperation of the Central and local Governments The Provincial Seed Corporations produce and distribute seeds Universities and research organizations assist in actual operation by technical guidance.	Cunninghamia lanceolata Pinus massoniana Larix spp Populus spp Eucalyptus spp	Selection Crossing

5．その他

その他，各国の林木育種は，ドイツ，デンマーク，オーストリア，ニュージーランド等においても着実な成果があげられている。（Ｆｉｇ．８）



① On the stage of conserving genetic resources

② On the stage of primary research for tree breeding

③ On the stage of model breeding activities

④ On the stage of regular breeding activities

Fig. 8　Stages of tree breeding activities in the world

III．林木育種技術協力の考え方

ここまで，わが国における林木育種事業の歴史，現在行われている事業の目的，基本方針，体制，運営方法，育種方法及び今後の課題等について説明し，また，各国の育種事業についても紹介した。

一方，わが国による林業分野の海外技術協力は約２０年前に始まり，現在，東南アジアを初めとする世界数十ヶ国で２０プロジェクトが実施されている。林木育種専門のプロジェクトもここインドネシアと南米ウルグアイの２カ国で実施中であり，わが国の林木育種センターでは，年間１００名近いカウンターパートの受け入れ研修や，数十名の技術協力専門家を海外に派遣している。林木育種分野での技術協力の要請が年々高まっているが，

森林造成，保全の基礎である林木育種の重要性から，この分野での技術協力を積極的に進めていく考えである。

最後に，育種事業を適切に進めていく上での一般的ないくつかのポイントについて述べる。

１．森林・林業の背景と国家目標の設定

その国の森林・林業がたどってきた歴史，現在おかれている状況及び将来その国で森林・林業が果たしていくべき役割等を十分吟味し，林木育種事業を進める上での国家的な目標を設定することがまず第一に重要なことである。

この国家的な目標は，然るべき形できちんとオーソライズされることが望ましいことは言うまでもない。（例：日本の「林木育種推進目標」「林木育種基本計画」）

２．林木育種の推進体制の整備

目標を設定し，計画を作成しても実行がなされなければ何の意味もない。育種事業の推進体制の形はII．でも触れたように，国によって様々な形をとりうると考えるが，いずれの場合でもしっかりした体制を作り上げ，組織的，効率的に継続して林木育種事業を推進してことが肝要である。

３．育種計画の策定

林木育種事業を確実に進めていくためには，長期的視点に立った国家育種基本計画を策定する必要がある。この計画の中では，特に次のような項目が重要である。

（１）育種区と育種事業の目標

わが国では，樹種，気象条件等により全国を５つの育種基本区に区分し，さらに土壌，品種等を勘案して育種区を設定している。このことは，地域特性を考慮した育種事業の適切かつ効率的な推進等のため非常に重要なことである。

また，どのようなことを重点に育種事業を展開していくかの育種事業目標を明確にすることも重要である。

（2）対象樹種と改良形質

社会的背景，ニーズとともに地域特性を十分考慮し対象樹種を選択する。

また，求める改良形質すなわち成長，材質，抵抗性等の育種目標は，地域特性，ニーズ等をふまえ明確に設定することが重要である。

（3）育種事業量の策定

育種素材の選抜，交雑，保存，原種の配布，検定林の設定・調査・解析及び採種園・採穂園の造成等について具体的な事業量の計画を策定するとともに，事業統計をとり，常に進行管理を行うことが大切である。

（4）遺伝資源の保全

将来の育種素材となる林木の遺伝資源を適切に保全していくために，遺伝資源保全のためのプログラムを育種計画の中に必ず取り込んでいくことが必要である。

（5）育種研究計画とデータベースの構築

育種研究については，先ほど述べたとおり事業との関連を密接にし，各研究課題から品種の育成が円滑に行えるよう設定するとともに，研究課題の一元的な管理を行っていくことが重要である。また，各種の試験地からは，多年にわたり多数の調査データが得られるのでデータベースの構築も重要である。

また，育種研究を確実に進めていくために必要な研究予算，設備，スタッフ等についても十分配慮されなければならない。

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Consideration on a choice of establishment methods of seedling seed orchard for fast growing species related to a tree improvement strategies in Indonesia

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1. Introduction

A technical cooperation of forest tree improvement between Indonesia and Japan had been started at Yogyakarta in June 1992. A primary purpose of the project is to support several ongoing re-afforestation programs by conducting executors of re-afforestation to establish seed soureces. The seed sources here are mainly seedling seed orchards of their major reforestation species, because it would be the most reliable way to meet an urgent demand of genetically improved seed within a limited project period of five years. At the same time they would hopefully become breeding populations to start more intensive tree improvement in Indonesia.

During the last few decades, many of the active tree improvement programs had changed their strategies from managing single large population to sub-population management (Lowe and van Buijitenen 1981, Barnes 1984, Hodge et al 1989). A practical reason of the renovations of their strategy was the simplicity of pedigree control (Barnes 1984), because minimizing the effect of inbreeding by pedigree control is an essential factor to maximize long-term genetic gain (Matheson 1990). Thus it might be necessary to examine the establishment methods of seedling seed orchard in conjunction with the long-term strategies of tree improvement in Indonesia, because it is quite sure that a rapid turn over of generation here will raise this problem in near future.

In this paper, alternative methods of seedling seed orchard establishment, namely conventional method and that specifically for subline formation, were presented with the idea on how to connect with the long-term tree improvement strategies in Indonesia. Then expecting forms of implementations with related organizations were also proposed for each method. A discussion at the seminer would be a good ground for the project in determining the approaches of seed sources establishment.

2. A back-grownd information in organizing subline system in Indonesia

2.1 Subdivision of breeding populations adopted in the advanced programs

As described in the Introduction, a shift from a single large breeding population to multiple sub-populations is a world wide phenomenon. Untill now, the subdivisions of breeding population are made by two different concepts as multiple populations or sublining (Burdon and Namkoong 1983).

Although selections and matings are practiced within the subdivided population in both method, different selection criteria will be used in multiple population whereas sublines are just sub-units of breeding populations having the same criteria of selection. A primaly purpose of multiple population is to maintain or amplify genetic diversity among the sub populations to meet the future change of breeding goals, while that of subline is to ensure completely outbred offsprings in seed orchard by using a few best seed parents selected from each subline.

There are three levels of pedigree control in sub-population management; full sib, halh sib and simple mass selection (Barnes 1984). Many of the advanced tree improvement programs intend to adopt complete pedigree control by using full sib families (Lowe and Buijitenen 1981, Hodge et al 1989), however it needs reliable controlled pollination techniques and it generally takes a long time to turn over generation (Cotterill 1986). A sub-lining system using half sib pedigree control was proposed for black walnut whose controlled pollination was not efficient (McKeand 1980). More recently, Nikles (1989) proposed the sublining system which is applicable widely to tropical Eucalyptus, and he also showed how to procced from presently avaiable resources toward sublining system and hybrid or clonal breeding.

2.2 Tree improvement objectives and related factors in Indonesia

Target species of tree improvement by the project were tentatively determined as Acacia mangium, Paraserianthes falcataria, Eucalyptus urophylla (Kurinobu and Soecipto 1992). They are the main species in re-afforestation programs of Indonesia for the present. However, a history of large scale plantation establishment outside Java is relatively new, thus there would be a change in the choice of species with the accumlation of experiences on utilization of final products or outbreaks of epidemics caused by mono culture (Zobel et al 1987). Therefore it might be safe to consider the present choice of species is not a permanent one. The project have to choose an efficient way to manage breeding populations on those species so as to meet the above-mentioned situations; change of target traits or species.

Traits to be improved for the above-mentioned species would be growth, stem form and wood quality, even if priorities of the traits may be different depending on the species or utilization purposes. Wood of A. mangium is maily used as industrial materials for pulp and papers but it would be used sawn timber also (Werren 1991, Mead and Miller 1991). A. falcataria is the most common multi-purpose species in Indonesia (Hendi 1992) and it has an acceptable wood quality for pulping materials (Peh and Khoo 1986) and particle boards (Tachi et al 1988). E. urophylla is considered to be one of the most promising species for pulping material (Ikemori 1984) as well as having good potential for timber use (Darrow and Roeder 1983). Therefore improvement in traits related to wood quality of sawn timber might be possible and necessary on those species, it is especially true when we think about the future timber supply after the exploitation of natural forest in Indonesia.

With regard to the sub-division of breeding areas, it might be reasonable to start by establishing same set of seedling seed orhards in major areas of reforestation programs. This approach would ont only provide information on genotype x environment interaction, which will be the theoretical bases for a sub-division of total area of Indonesia, but also have practical advantages. One of the advantages is that the selections in S.S.O. could be used as seed parents directly for reforestation programs in the respective areas. Another advantage is that the final selections from S.S.O. would become the members of multiple populations when genotype x environment interaction is large. Even if the interaction is negligible, it is still effective to increase the precision of family selection by combining data from different areas.

In addition to the factcrs mentioned in the above, availability of techniques for vegetative propargation and controlled pollination are matters of consideration. Althogh the research on those techniques had been started in the last dacade, it seems to be very difficult to forecast when they will be implemented as reliable tools in operational tree improvement programs. Thus it might be safe not to take them into consideration when formulating tree improvement programs at this moment, otherwise the delay of the implementation of those techniques would seriouly affect the progress of tree improvement. In another word, a rapid turn over generation with more simple selection and pollination might bring sufficient amount of gain to offset the expecting gain to be realized with using more elaborate techniques such as the case of Eucalyptus in Florida (Reddy and Rockwood 1989).

2.3 Organizing sublining system for the fast growing species in Indonesia

A sublining system with half-sib pedigree control seems to be the most realistic strategy for the above-mentioned three species in Indonesia. In order to establish this system, at least ten sub-lines of each containing 25 families would be required (Nikles personal com.). Because ten sublines is the minimum number to establish composite orchards (Nikles 1989) in which one or two individuals and/or families per subline will be used to enhance out-crossing for operational seed production in the later generations (See Fig.1).

Reported number of families per sub-line are varied from 25 to 40 depending on the literatures (Lowe and Buijitenen 1981, Mckeand and Beineke 1980, Hodge et al 1989). According to the simulation study on positive assortative mating, elite population of 12 individuals reduced gains from reselection below that of the main-line (N=498) by three generations (Mahalovich and Bridgwater 1989). Although the situations of the subline population may not be the same as that one, the progress of inbreeding would be faster for half-sib pedigree control than that of complete pedigree control. Therefore starting with reasonable size of families per subline and relatively strict repetition of within family selection in each generation (Namkoong 1990) would be essential to reduce the progress of inbreeding.

The first generation seedling seed orchards should be allocated not only to detect genotype x environment interaction but also with the intention so as to develop different sub-populations adaptable to specific areas for reforestation when subdivision of the area proved to be necessary. In Zimbabwe, a large family x region interaction was the main reason that they had to develop multiple populations (Barnes 1984). As the target area of re-afforestation in Indonesia is quite large with varying climate or soil conditions, it seems to be quite probable to detect such kind of interactions. Therefore measures to treat that problem should be taken beforehand as long as the fund and collaborators available. An idea on how to deploy the seedling seed orchards is a matter of considerations to be discussed in the subsequent cahpters.

3. Two alternative methods of seedling seed orchard establishment

In this chapter, alternative methods of seedling seed orchard establishment, namely conventional method and that specifically for subline formation, were described with the idea on how to organize sublines and to reach the second generation seedling seed orchard.

3.1 Conventional seedling seed orchard

Conventional seedling seed orchard will contain around hundred families including twenty to thirty common families as genetic checks. As the seed of two to three hundred families are planned to be procured for each major species (Kurinobu and Soecipto 1993), two to four types of seedling seed orchards testing diffrent set of families would be established in each area such as south Sumatra, south Kalimantan and Java.

With using measurement at around half-rotation age, a magnitude of family x area interaction will be assessed. If the interaction is large, plus trees would be selected in each area to develop different set of sublines separately. While a single set of sublines would be feasible when the interaction is small. Most of the plus tree selection would be made in a form of within family selection (Namkoong 1990). Family selection will be practiced only when the total number of families is much larger than the required number of plus trees to form sublines.

After the selection of plus trees, thinnings will be made to leave the best individual per plot of the best families (Wright 1976). Then seedling seed orchards could be used for seed production purposes. According to the preliminary analysis of optimum allocation of selection intensities, around 40% of families will be retained at the final stage (Kurinobu 1993). Therefore, considerations to leave plus trees of poorer families might be necessary until they are used in subline formation.

In order to regenerate sublines they need to be propagated vagetatively (Nikles 1989), because open pollinated seed in the seedling seed orchard is not acceptable due to possible relatedness of common male parent. Plus trees will be divided into around ten sublines, then breeding orchards for each subline would be established with clones of plus trees. The breeding orchards should be located sepalatery each other in order to avoid inter mating. Composite clonal orchards with the mixtures of plus trees from different sublines may be established when necessary (Nikles 1989).

When breeding orchards start seed production, the open pollinated seed will be collected by clone. Then they will be used to establish the second generation breeding orchards to regenerate the respective subline for the next generation. The same as clonal breeding orchards mentioned in the above, each breeding orchards should be established sepalatery by location. The best individuals in each of the families will be selected as plus trees and retained in the orchards. Then the open pollinated seed from them will be used to regenerate subline in the subsequent generation.

Beyond this stage, the breeding operation would be just a repitition by generation as mentioned in the last paragraph; establishment of breeding orchard with open pollinated progenies, within family selection, inter mating among the selections to produce open pollinated seed. If new seedlot unrelated with any of the plus trees are available, they will be added to the sublines individually to relax inbreeding or to form new ones in order give wide choice in establishing composite orchards.

3.2 Seedling seed orchard for subline formation

Seedling seed orchard will contain around 30 families specifically to regenerate sublines for the next generation. As each of the seedling seed orchards corresponds to the respective subline, at least ten orchards should be established at different locations in order to establish composite orchards in the later generations. Accordingly two to three hundreds of families should be divided into at least ten sublines. For the purpose to avoid relatedness among sublines and to adjust the timing of folwering, subdivision of families by provenance ~~would be~~ was recomended (Nikles 1989).

While the seedling seed orchards here are small in size, they could be used for seed production also after the family and individual selections practiced. As the predicted gain in properly designed seedling seed orchard will be almost constant regardless of their size (Kurinobu 1993), they would bring nearly the same amount of genetic gain to be expected in the conventional seeding orchard. ~~and at the same time~~ Furthermore they will give user more flexibility to choose different type of seed depending on their reforestation purposes.

As the open pollinated seed from the above-mentioned orchards might be unrelated between sublines, breeding orchards to regenerate subline for the next generation would be established immediately after the plus tree selection. Therefore the process to establish clonal seed orchard could be omitted in this scheme and it would reduce approximately one generation interval to reach next generation compared with that of the conventional method. The composite seedling orchards would be established concominantly by using open pollinated seed of the top ranked plus trees from each subline.

In order to asses family x area interaction and genetic equalization among the sublines, trials to sample families from all possible sublines might be necessary with this scheme. It would be desirble to establish them with a set of seedling seed orchards in each major area. With this allocation of trials decisions as to take whether multiple population aproach or that of simple sublining will be made. Assesment on genetic equality among sublines will be made by comparing the performances of sample families in the trials, then newly introduced families may be added to some of the inferior sublines to grade up their genetic quality by family selection.

Beyond the second generation breeding seed orchard, the procedures to turn over generation would be exactly the same as mentioned in the conventional seedling seed orchard.

4. Advantages and risks with the altanative methods

Possible advantages and risks with the alternative methods until the establishment of second-generation seedling seed-orchard are discussed respectively, then the common problems with both methods are examined also.

4.1 Conventional seedling seed orchard

A practical advantage with this procedure is the simplicity for plannig and implementation. As seedling seed orchard is one of the well known approach to improve forest trees, establishment of conventional seedling seed orchard might be accepted by many of the collaboraters. Programs of seed proquement and allocation of families would be easier for this scheme compared with the alternative, because there is no need to pay much attention on how to divide families into several sublines as far as enough number of families collected.

Another advantage would be the possibility to obtain reliable information for genotype x environment interaction when common families are added to each of the seedling seed orchards. Accoding to the deployment of seedling seed orchards mentioned in the last chapter, data of common family performances in six to nine locations; 3 areas x 2 or 3 sets, would become available for the main species. That amount of data seems to be feasible for the initial assesment of the interaction.

Another possible advantage may be the proper allocation of families when organizing sublines, because they will be formed after the plus tree selection. The family data, which will be collected to select plus trees, could be used effectively to achieve genetic equality among the sublines (Nienstaedt and Kang 1987).

A critical risk with this procedure might be the vegetative propagation techniques to be used in establishing clonal breeding orchards. If a reliable vegetative propagation techniques is not available on certain species until the end of their plus tree selection, tree improvement with that species would be halted. The technique should be applicable not only to a few clones but also to most of the plus trees, otherwise the subline could not be formed. Thus it seems to be safe to take the alterative scheme for the species with a low possibility of vegetative propagation within these five years.

Another drawback is the delay to get to the establishment of second generation breeding orchards. Even if the vagetative propagation is possible, the delay; during from the establishment of clonal breeding orchards until their seed production, will still remain compared with the alternative. And who will be responsible to establish clonal breeding orchards is also a matter of consideration at the implementation.

4.2 Seedling seed orchard for subline formation

A major advantage with this scheme is that the vagetative propagation is not an essential technique to turn over generations, because this scheme assumes a simple repitition of within family selection; open pollination among plus trees and establishment of breeding orchard with open pollinated progeny. Composite orchards may be established with open pollinated seed also in the later generations. Thus whole cycle of breeding could be carried out by already established techniques.

Another advantage is the rapid progress to the second generation breeding orchards. As the open pollinated seed from plus trees in the first generation seed orchards will be unrelated between sublines because of their separation by location, breeding orchard could be established with using those seed. It would save approximately one generation interval as mentioned in the preceding paragraphs.

A probable but practical advantage is the selective use of seed from specific provenance. Once some of the provenances were found to be promising based on the measurement of family sample trials, the first generation seedling seed orchards made up of those provenances would be used intensively for seed production. Because the seed produced from those orchards would not be diluted by the pollen from another provenances as expected in the conventional seedling seed orchards.

Planning of seed procurement may be the first obstacle to realize this idea into practice, because it should be set up so as to form at least ten sublines classified by provenances and they hopefully have similar genetic quality. Even with some prior knowledge about provenances, however, it might be quite difficult to achieve it, because provenance variations on major tropical species are generally large (Oemi 1987, Risto 1992).

Another practical difficulty would be the increase in the number of orchards. Even if the size of the orchards are small, many separate locations should be secured for that purpose. It seems to be quite difficult for a single organization to achieve. Thus some form of collabolation with many organizations might be inevitable to attain it completery.

Information on genotype x environment interaction would be less reliable in this scheme compared with that of the conventional one, because the number of trials to be used for that purpose is small; Only the number of family sample trials. Thus a supplemental analysis using measurement of the first generation seedling seed orchards might be necessary to estimate family x area interaction.

4.3 Common problems

One of the practical problems with seedling seed orchards is that it is generally difficult to find a good site fulfilling both the testing and seed production at one time (Zobel and Talbert 1984). Therefore as discribed in the above, several tests having a same set of families need to be established in respective areas simultaneously by supposing the situation that some of the seedling seed orchards are used for testing purpose only. At the same time, developmet of techniques to induce flowering is necessary not only to solve that situations but also to collect open pollinated seed from plus trees in order to turn over generation.

Another problem is that the selections in seedling seed orchards are seriously affected by genotype x environment interactions. Thus to choose the sites for seedling seed orchards in reforestation areas is of critical importance and to use data from multiple tests would be effective to minimize that bias in the family selection.

If a large genotype x environment interaction exsists, the number of sublines to be handled will increase as a result of choosing multiple population strategy. One of the technical solutions to reduce the number would be to let some of the sublines showing large interaction develop locally while others being developed as single population adaptable across the areas.

In the second or third generations, breeding orchards will lose their seed production functions due to the progress of inbreeding, hence they would be replaced with the composite orchards. Accordingly breeding orchards should be established concurrently with the establishment of composite orchards. Until that stage, some reliable techniques of controlled pollination and vagetative propagation need to be developed in order that most of the breeding work could be compleated inside the greenhouses or small spaces concentrically.

Seed procurement of new families which would be unrelated any of the breeding populations should be continued by introducing new seedlings from foreign countries or by domestic selection. They will be used to achieve equalization among sublines, to relax the progress of inbreeding within sublines or to add another sublines so as to give flexibility in establishing composite orchards. Composite seedling seed orchards may be used to get monitering information for the first two activities.

5. Ideas of the implementation in cooperation with another organizations

5.1 The cooperative approach of tree improvement

Tree improvement is generally best suited for a cooperative approach by government, companies and universities, because it requires a large expediture of effort and money, trained people and suitable facilities (Zobel and Talbert 1984). With the establishment of cooperation, members share costs and returns as well as exchange of ~~equipment,~~ plant material and information.

The form of cooperative approach is different depending on the status of forestry. In the United State the cooperative of private companies and state governments headed by the universities is popular, because major executers of re/afforestation are private companies. While in Japan tree improvement is conducted by national tree breeding institute under the close linkage with national forest service and prefectual governments (Ohba 1991).

In either case, progeny tests and seed orchards were established and measured by the executors of re/afforestation; private companies in the U.S., national forest service or prefectual governments in Japan, with the technical advice and material supply from conducting agencies; universities or state governments in the U.S.; national breeding institute in Japan. This type of sharing roles seems to be well in accordance with the following basic principles of breeding (Kurinobu and Soecipto 1992);

1) Genetic gain will become large with the increase in population size and with the increase in number of trials,

2) Genetic gain will be realized more quickly, if seed sources are established in cooperation with the executors of forest plantation programs.

Judging from the present situation in Indonesia, the most probable form would be the cooperation with (1) a national forest tree improvement center, which is still a project, (2) state and private companies and (3) research institutes; universities and national instiutes. An idea on how to share the roles among the three organizations having different purposes is given in Table [illegible] (Kurinobu and Soecipto 1992).

In order to make the cooperation effective, administrative support by the upper organization RLR seems to be indespensable. The support might be necessary to compile documents describing about each roles of the three organizations at the implementation of tree improvement. Their support is also necessary to hold annual meeting for the coodination committee at which annual work plans of the cooperaters would be discussed and approved.

5.2 The share in roles of seedling seed orchard establishment

A general idea on how to share in roles of establishing seedling seed orchards is shown in ~~Chart~~ Fig. (Kurinobu and Soecipto 1992). The relevant organizations to this activity would be the tree improvement center and state or private companies. However, advices and suggestions from universities and research institute are also important for the implementation.

State or private companies will establish seedling seed orchards by providing their labour and land with the support of tecniques and material from tree improvement center. Thus the center will be responsible to design orchards and to procure necessary seed. Most of the field operations would be carried out by the companies. The staff from the center will be dispatched to give technical advice to the companies in order that the orchard could be established properly. Then the final maps showing allocation of families in the orchard will be sent to the center so as to be used at the time of measurement.

The successive activities; maintenance and measurements, are carried out by the companies also. The center will send staff to explain how to conduct measurement in seedling seed orchards. Then the field notes of measurment will be sent to the center. The center will analyse the data and the results will be sent back to the companies. The data will be kept by the center in order to use at the time of roguing of orchards and finally they will be analised to select plus trees.

Roguing and operational seed production will be carried out by the comapies with the advice from the center, while the plus tree selection will be conducted by the center staff. Scions or open pollinated seed from plus trees will be collected and kept by the center. Those materials would be used for the second generation breeding work. They are also provided to the companies to establish composite orchards up on their requests.

Above-mentioned idea would be applicable directly to the case of the conventional seedling seed orchard, whereas it needs some modification on how to share in roles when the second alternative is chosen; establishment of seedling seed orchard for subline formation. One of the solution to establish too many small orchards may be that a group of companies operating in the same region will share in roles what a single company going to share in the above-mentioned idea.

Additionally the center is going to establish some demonstration orchards near the office. Thus a part of the seedling seed orchard establishment will be carried out by the center itself. They would be established at an earlier phase of the project so as to be used to standardize methods of measurement.

5.3 Future share in roles of tree improvement

When the first alternative is chosen, how to share roles to establish clonal breeding orchards would be the matters of consideration. As the purpose of the orchard is mating only, there is no need to look for suitable sites for testing. However, the number of locations is at least around ten and they must be sepalated each other. It would be the problem with the implementation. Thus it is desirble to share in roles between the center and companies to establish those orchards.

Beyond the second generation breeding orchard, there would be no difference in the procedures between the alternatives. The orchards have dual purposes as testing and mating. Thus the orchards need to be established by the companies in their reforestation areas because of its testing purpose. With regard to the composite seedling seed orchards, their primary function is a seed production, however, it may serve to monitor sublines of their progress of inbreeding as well as the achievement of genetic equalization. Thus the information from the composite orchards will become important in the future.

When reliable techniques of vegetative propagation and controlled pollination become available, separation of mating function from breeding orchard might be possible. Mating may be carried out by using clones of plus trees in a small space or facilities inside the center. Then the selection may be practiced in large family block plantings, because the dominant selection procedure would be within family selection. Therefore the responsible role of the company may become somewhat simplified.

6. Related research items to be conducted

Research items related with seedling seed orchard establishment are mentioned below, many of which the center needs cooperation with universities and research institutes to promote tree improvement successfully.

Vegetative propagation techniques should be developed, especially when the first alternative is chosen. Although the second alternative is chosen, it is still important. Because it will give much flexibility in choosing site and clones to establish composite clonal orchards. A high successful ratio of multiplication from most of the matured ortets would be the requirement to that techniques for the implementation.

Study on genotype x environment interaction is also an urgent subject to be done, because the size of the interaction will determine the choice of tree improvement. It could be started with analysing already establised trials, such as the provenance/progeny tests of E. urophylla. When the data from newly established trials become available, more detailed study; zonation by species, investigation on the optimum area for testing or seed production, might be started.

Studys of flowering phenology and developing techniques for flower induction and controlled pollination are of practical importance. The first two subjects might be effective to reduce bias of open pollinated seed caused by the differences in fqlowering period within the sublines. While the latter two may become useful to save the total expenditure of the project, if they are used for controlled pollination in conjenction with vegetative propergation techniques. In the future, these are the technical bases to start hybrid breeding (Nikles and Griffin 1991) or nuecleus population breeding (Cotteril 1989).

To estimate the degrees of inbreeding depression and prediction on the progress of inbreeding within sublines are also important in managing breeding population properly. Even if a part of the subjects may be a theoretical study, it is necessary to start with practical experiments; such as an assesment of inbreeding depression by selfing. This sort of information would become necessary in near future, because the interval of generation is much shorter than the warm temperate zone species.

The techniques of DNA or Isozyme analysis may become convenient tools, when they are used to asses the progress of inbreeding in each of sublines or to select minimum related individuals within sublines. They may be useful also when some of the highly inbred sublines need to be reorganized in the future.

7. Conclusions

The two alternatives proposed here may not be new from a technological point of view, however, it might be better to take a steady way for the operational tree improvement programs. Because a primary purpose of the program is an immediate genetic gain to be realized in a wide range of re/afforestation activities with using presently available techniques. At the same time the program needs to have good possibilities to be developed in the future generation's breeding work as well as to have sufficient flexibilities to meet the future change of objectives or renovations with newly developing techniques.

In addition to the ideas on the program mentioned in the above, how to organize an implemention system is of practical importance, because an operationanl tree improvement program will not be carried out successfully without an agreement by the expecting members in the program on each roles. Based on the results of discussions at the seminor, the project will take one of the two alternatives with modifying it so as to reflect suggestions and requests

~~requests~~ proposed by the members.

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Table 1. An idea on the deplyment of the conventional SSOs in several regions.
(A hypothetical example of two regions with three hundreds families)

Location / Family No.	Region I SSO-1	Region I SSO-2	Region I SSO-3	Region II SSO-1	Region II SSO-2	Region II SSO-3
1, 2, ¦, 20	Families to be used commonly to all SSOs.					
21, ¦, 100	Set 1			Set 1		
101, ¦, 200		Set 2			Set 2	
201, ¦, 300			Set 3			Set 3

Table 2. An idea on the deplyment of SSOs for subline formation in several regions.
(A hypothetical example of two regions with three hundreds families)

Sub-line	Family No.	Region I SFT	Region I SL-1	Region I SL-2	---	Region I SL-10	Region II SFT	Region II SL-1	Region II SL-2	---	Region II SL-10
1	1, ¦, 30	Sample fam.	SL-1				Sample fam.	SL-1			
2	31, ¦, 60	Sample fam.		SL-2			Sample fam.		SL-2		
3	61	¦					¦				
¦	¦, 270	¦			¦		¦			¦	
10	271, ¦, 300	Sample fam.				SL-10	Sample fam.				SL-10

Table 3. A comparative table showing advantages and risks with the two alternative methods of seedling seed orchard establishment.

Factors	Conventional SSO.	SSO. for subline formation
Major Advantages;		
	Wide acceptance with the method,	No-vagetative prop. tech.
	Reliability on GxE interaction,	Rapid progress to reach 2nd gen.
Major Risks;		
	Dependance on Vagetative prop.,	Difficulty to attain Genet. equal.
	Too many sites for CBO.,	Too many sites for SSO.s
	Slow progress to 2nd gen.	Complexity of seed procurement

Table 4. Major obligations and privilleges for the three different organizations to promote tree improvement programs.

Organization	Obligation	Privillege
Tree improvement center	Supply of materials Technical support	Retentions of materials
Executors of reforestation	Provision of land & labor Execution of measurements	Retentions of seed sources Benefit from seed production
Universities, R & D agencies	Information & technical advice	Utilization of materials & data for research purposes

Fig. 1 A concept of sublining system and composite seed orchard.

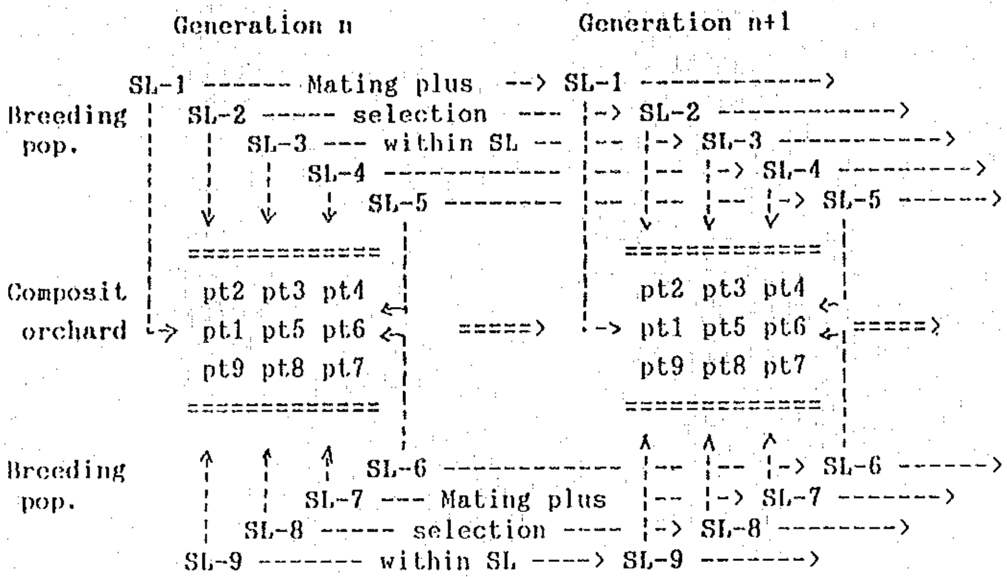

Fig. 2 Outline of conventional seedling seed orchard establishment scheme

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Gener. No.  Breeding population establishment        Production seed orchard

     Establish conventional seedling seed orchards
   containing around hundred families plus thirty common families.

 1       SSO.1      SSO.2      -------  SSO.10  ---   ->  Culled SSO
       +common    +common             +common
       families   families            families
          ↓          ↓                    ↓
     Plus tree selection mainly by within family selection,
   Vagetative propagation of plus trees to form sublines by CSO.
       Each subline is made up of 25 to 30 families.
          ↓          ↓                    ↓
        CSO-SL1    CSO-SL2   ---------  CSO-SL10      ->  CSO or com.CSO
          ↓          ↓                    ↓
     Cull CSO in case of multiple plus trees per family,
   Collect OP-seed from clones to form sublines by SSO.
          ↓          ↓                    ↓
 2      SSO-SL1    SSO-SL2   ---------  SSO-SL10      ->  SSO or com.SSO
          ↓          ↓                    ↓
     Cull SSO then select plus trees by within family selection,
   Collect OP-seed from plus trees to form sublines by SSO.
          ↓          ↓                    ↓
 3      SSO-SL1    SSO-SL2   ---------  SSO-SL10     ->  SSO or com.SSO, com.CSO
          ↓          ↓                    ↓
     Repeat the same procedure mentioned in the second generation.
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Fig. 3 Outline of seedling seed orchard for subline formation establishment scheme

Gener. No.	Breeding population establishment	Production seed orchard
	Establish seedling seed orchards corespond to each subline containing around thirty families.	
1	SSO-SL1 SSO-SL2 -------- SSO-SL10	-> Culled SSO
	Cull SSO then select plus trees by within family selection. Collect OP-seed from clones to form sublines by SSO.	
2	SSO-SL1 SSO-SL2 -------- SSO-SL10	-> SSO or com.SSO
	Cull SSO then select plus trees by within family selection. Collect OP-seed from plus trees to form sublines by SSO.	
3	SSO-SL1 SSO-SL2 -------- SSO-SL10	-> SSO or com.SSO, com.CSO
	Repeat the same procedure mentioned in the second generation.	

Fig. 4 Schematic flow chart of seedling seed orchard establishment in cooperation with state or private companies

Operations in order	State or Private companies		Forest Tree Improvement Center		Directotare General of Reforestation of Land Rehabilitation
Planning of stablishment	Request to establish S.S.O.s	->	Prepare draft of SSO establishment	->	Give authorization to the program by holding annual meeting
Establishment of S.S.O.s	Execution (land and labor)	<-	Support (seed and technical guidance)	<--------	
	Map of S.S.O.	-->	Recording		
Maintenance	Provide labor	<--	Give technical advice		
Measuremant	Execution (labor)	<--	Technical support		
	Data	-->	Recording & Analysis	->	Hold annual meeting
Roguing	Execution (labor)	<--	Technical support		
Seed production	Execution	<--	Technical support		
	Commercial use	<--------------------------			Give recommendation for the usages
	Results	-->	Recording		
Plus tree selection	Provide labor	-->	Execution & Retention for supply		

Two alternatives in establishing seedling seed orchards

1. Conventional seedling seed orchard establishment

Gener. No.	Breeding population establishment	Production seed orchard
	Establish conventional seedling seed orchards containing around hundred families plus thirty common families.	
1	SSO.1 +common families, SSO.2 +common families -------- SSO.10 +common families ---	---> Culled SSO
	Plus tree selection mainly by within family selection, Vegetative propagation of plus trees to form sublines by CSO. Each subline is made up of 25 to 30 families.	
	CSO-SL1 CSO-SL2 - - - - - CSO-SL10	---> CSO or com.CSO
	Cull CSO in case of multiple plus trees per family, Collect OP-seed from clones to form sublines by SSO.	
2	SSO-SL1 SSO-SL2 - - - - - SSO-SL10	---> SSO or com.SSO
	Cull SSO then select plus trees by within family selection, Collect OP-seed from plus trees to form sublines by SSO.	
3	SSO-SL1 SSO-SL2 - - - - - SSO-SL10	---> SSO or com.SSO, com.CSO
	Repeat the same procedure mentioned in the second generation.	

2. Seedling seed orchard for subline formation

Gener. No.	Breeding population establishment	Production seed orchard
	Establish seedling seed orchards correspond to each subline containing around thirty families.	
1	SSO-SL1 SSO-SL2 -------- SSO-SL10	------> Culled SSO
	Cull SSO then select plus trees by within family selection, Collect OP-seed from clones to form sublines by SSO.	
2	SSO-SL1 SSO-SL2 -------- SSO-SL10	------> SSO or com.SSO
	Cull SSO then select plus trees by within family selection, Collect OP-seed from plus trees to form sublines by SSO.	
3	SSO-SL1 SSO-SL2 -------- SSO-SL10	--> SSO or com.SSO, com.CSO
	Repeat the same procedure mentioned in the second generation.	

3. Advantages and risks with the two alternative methods of SSOs

	Conventional SSO.	SSO. for subline formation
Advantages;		
	Wide acceptance with the method,	No-vegetative prop. tech.
	Reliability on GxE interaction,	Rapid progress to reach 2nd gen.
Risks/drawbacks;		
	Dependence on Vegetative prop.,	Difficulty to attain Genet. equal.
	Too many sites for CBO.,	Too many sites for SSO.s
	Slow progress to 2nd gen.	Complexity of seed procurement.

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