

# SEED STAND ESTABLISHMENT PROCEDURES FOR *PINUS OOCARPA* AND *PINUS CARIBAEA* VAR. *HONDURENSIS* IN THE NATURAL FORESTS OF CENTRAL AMERICA

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## SUMMARY

Seed stand establishment provides a useful interim measure to obtain seed of improved genetic quality until more intensively selected material is available from seed orchards. In addition increased seed production, improved seed physical quality and greater ease of cone collection provide extra benefits. To realise these benefits detailed procedures for stand selection, mapping, inventory, thinning, isolation, registration and future management are required which are suitable for application in the unmanaged, heterogeneous stands of *Pinus oocarpa* and *P. caribaea* typical of many parts of Central America. The results of the CFI international provenance trials of these species provide useful guidelines in assigning priorities in seed stand establishment. Seed stands can play an important role as *in situ* conservation stands in areas of severe dysgenic exploitation.

## RESUMEN

El establecimiento de rodales semilleros es una medida intermedia valiosa para conseguir semillas de una calidad genética mejorada hasta cuando las semillas de huertos semilleros con una intensidad de selección mas fuerte sean disponibles. Más que esto, una mayor producción de semillas, el mejoramiento de la calidad física de las semillas y la facilidad de la recolección de conos son otros beneficios de rodales semilleros. Para realizar estos beneficios se necesitan procedimientos detallados para la selección de rodales, cartografía, inventarios, raleos, aislamiento, registro y futuro manejo, los cuales sean útiles para el bosque natural, heterogéneo y disetáneo, sin manejo intensivo de *Pinus oocarpa* y *P. caribaea* típico de muchas partes de Centroamérica. Los resultados de los ensayos de procedencias internacionales de CFI proveen una pauta útil para asignar las prioridades en el establecimiento de rodales semilleros. Otro papel importante de rodales semilleros es la conservación de los recursos genéticos en las áreas de explotación disgénica fuerte.

## Introduction

The selection and establishment of seed stands represents a quick and inexpensive method of obtaining seed of improved genetic quality. As reforestation programmes increase in many tropical countries and demands for seed increase it has been estimated that demand for seed of *Pinus caribaea* alone will reach 11,000 kg. by the mid 1980's (Bell, 1979). Seed stand establishment represents a valuable interim measure until more intensively selected material becomes available from seed orchards.

Up to now all seed collection has been in the form of general collections of provenance identified material with control to avoid collection from particularly poor phenotypes. This paper, based on experience in the natural forests of the

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Republic of Honduras, aims to set down establishment procedures for seed stands in the natural forests of *Pinus oocarpa* Schiede and *P. caribaea* Morelet var. *hondurensis* in terms of stand selection, inventory, stand treatment, isolation and future management.

A seed stand may be defined as a plus stand that is upgraded and opened by removal of undesirable individuals and then cultured for early and abundant seed production (Barner, 1973). This description corresponds with the O.E.C.D. (Organisation for Economic Cooperation and Development) category of "selected reproductive material" (OECD, 1974), and it is intended that seed stands should follow these guidelines.

Three main objectives of seed stand establishment have been widely recognised (Matthews, 1964) and these are to:

- 1) Produce seed of improved genetic quality.
- 2) Increase the quantity and physical quality of the seed produced.
- 3) Concentrate seed collection operations in a small area thereby lowering costs and making control and organisation easier.

General aspects of seed stand establishment have been frequently reviewed in the literature (Barrett, 1980; Quijada, 1980; Keiding, 1978). In addition some of the problems of applying the seed stand concept to the natural forest of Honduras have been discussed by Robbins (1980).

### Stand Selection

Stand selection involves the consideration of a complex of factors and represents one of the most critical and problematical stages in seed stand establishment.

Firstly, it is important to locate seed stands in the most important provenance regions and in situations which will be representative of a given provenance region in terms of altitude, climate and soil.

Secondly, the area of stand required to supply sufficient seed to meet likely demands should be estimated. It is likely that for a stocking of 150 trees per hectare seed production will be between 5 and 10 kg, per hectare per year for *P. oocarpa* and somewhat lower for inland provenances of *P. caribaea*. Approximately half the yield per hectare may be expected for coastal provenances of *P. caribaea*. Thus to meet a demand of 200 kg of seed of *P. oocarpa* an area of between 20 ha and 40 ha would be required. In addition isolation of the seed stand from outside inferior sources of pollen must be considered in relation to stand area and shape. In general however, larger near circular or square shaped stands can be more efficiently and effectively isolated than small ones and thus one large stand is preferable to several smaller ones in any provenance region.

The stand characters that should be considered in selection are age, phenotypic quality, density, uniformity, seed production, topography and the stand floor.

The ideal age for selection is around 20 years to ensure that the trees are sufficiently mature to permit reliable selection for form characters and produce heavy cone crops. It has been shown that qualitative traits such as stem straightness, forking and branch characteristics are under stronger genetic control than quantitative traits such as volume production (Barnes *et al.*, 1980), and the selected stand should be of above average phenotypic quality in terms of these more heritable traits. Stand density should be at least 400 stems per hectare to permit a reasonable selection intensity but not more than 1000 stems per hectare to avoid suppressed crowns with a low potential for rapid development. The stand should be as uniform as possible in terms of age and density. Finally the stand floor should

be such as to permit easy cone collection in terms of topography and ground vegetation.

The concept of a seed stand has been developed and applied mainly in managed plantations where the criteria of age, phenotypic quality, density and uniformity are relatively simple to apply. In the unmanaged, uneven-aged natural pine stands typical of much of Central America, it is more difficult and it may be necessary to start selection in younger candidate stands (10-15 years) so that management can be introduced before the over-dense suppressed condition occurs.

In addition to these factors, ownership, access, sale of thinnings and protection from cutting and fire are all important. In general it is preferable to locate stands on nationally owned land. Access must be adequate to allow entry of a four-wheel drive vehicle for cone collection operations. The lack of a market for small roundwood can be a major obstacle to thinning and this should be considered before selecting the stand. Finally the ease of protection of the stand from serious fires or illegal cutting may also influence stand selection.

Given such a large number of factors it may not be possible to satisfy all criteria and find the ideal stand. In Honduras, the stand requirements can usually be met for two or more alternative locations within a given provenance region for *P. oocarpa* and final selection can be based on the all important factors of ownership, access, sale of thinnings and protection. For *P. caribaea* however, suitable stands are rarer and selection must be based largely on stand density, quality and uniformity.

In the natural forests of Honduras, comprehensive surveys to locate the best stands are beyond the capacity of the seed centre staff. Thus for efficient stand selection the advice of local district staff is invaluable to locate a shortlist of possibilities which can then be visited and if necessary inventoried. Aerial photographs also provide a useful aid to stand selection. Finally all available information on stand history in terms of regeneration, thinnings and fires should be sought as a further guide to the final selection.

### **Mapping**

A map at a scale between 1:5000 and 1:10000 is essential for defining seed stand boundaries, designing inventory sampling, fixing isolation zones, control of thinning and for subsequent registration and control of seed collection. The map should outline roads, tracks, rivers, gullies, ridges and the stand limits and can be readily drawn from aerial photographs which also help in studying topography and stand distribution.

Stand boundaries may be demarcated on the map and where possible should follow features such as tracks, rivers or ridges which are easily recognised on the ground.

### **Inventory**

The inventory of seed stands is required for several reasons. Firstly two or more alternative stands may be compared as an aid to stand selection. Secondly the inventory results will form the basis for calculating selection intensities for thinning. Finally, the changes in stocking and phenotypic quality after thinning can be assessed.

The inventory should aim to yield information on both quantitative characters such as number of trees per hectare, tree height and diameter, and basal area and qualitative traits such as stem forking, stem straightness, branch characters and

natural pruning. These phenotypic characteristics may be divided into quality classes to form a basis both of the qualitative inventory assessment and guidelines for marking thinnings.

### Thinning

Seed stand establishment commonly involves a heavy thinning which has two main objectives. Firstly trees with defects are removed in order to improve the genetic quality of seed from the remaining trees. Secondly, tree crowns are freed reducing competition and allowing the crowns to develop thereby promoting flowering and hence cone production, and seed yield.

There is little information available on optimal stocking levels for seed stands established in natural forest. Florence and McWilliams (1954), working with *Pinus elliottii* and *P. taeda* in Queensland, Australia point out the distinction between maximum cone production per tree and maximum production per hectare. The economic optimum is likely to lie between these two maxima since a large fraction of the cost of cone collection is incurred in tree-climbing. Clearly the optimal spacing depends on tree height and a spacing of between  $\frac{1}{2}$  and  $\frac{1}{3}$  tree height has been adopted. Thus for a mean tree height of 20 m the final spacing should be around 8 m which corresponds to a stocking of approximately 150 stems per hectare.

From the results of the inventory the optimal spacing or stocking can thus be calculated.

Given the initial stocking and the optimal stocking the thinning or selection intensity can be calculated as a guide for marking. For marking, a two-stage procedure has been adopted which reflects the dual objectives of genetic improvement and crown development. Firstly all trees with defects are marked. Given the difficulty of selecting for volume production in natural forests and the generally low heritability of quantitative characters it is advisable to concentrate on selection against poor form characters which are generally under closer genetic control. These include forked and twisted stems, trees with thick branches or high branch angle and trees with poor natural pruning.

Having marked the trees of poor form a second marking is carried out to improve the distribution of stems and tree spacing. This second stage has more in common with a routine silvicultural thinning and is designed to promote crown development.

Given that the thinning is much heavier than a normal silvicultural thinning it is important to bear in mind the hazard of windthrow or snap. Thus the thinning should be carried out in two or even three stages over a period of about five years.

Co-operation between the local district staff and the Seed Centre is essential for successful establishment. The Seed Centre should be responsible for final stand selection, inventory and marking and may give financial assistance towards the thinning operation. The thinning and sale of timber are best carried out by the district staff.

### Isolation

In order to achieve the desired genetic gain it is important to isolate the seed stand from inferior pollen sources outside the seed stand. Complete isolation is not possible since wind-borne pollen may travel great distances and since seed stands must be located in heavily forested areas. Heavy production of pollen within a seed stand is most important for diluting outside contamination effects. Area and

shape of the seed stand are also important as contamination decreases rapidly away from the stand boundaries towards the centre.

The most practical way to isolate a stand is to create a 100 m wide isolation fringe around the stand which is thinned to remove all inferior phenotypes. However, well formed trees remain within the isolation fringe to act as a physical barrier and will also produce significant quantities of pollen. Seed collection is restricted to the central portion of the stand surrounded by this 100 m wide dilution zone.

In designing the isolation zone the prevailing wind direction and topography should be taken into account.

### Registration

Seed stands should be registered with the local office the district office and the central office of the national forest authority giving details of location and stand boundaries, and legal documents concerning land ownership should be put in order.

### Future Management and Seed Collection

The future management of seed stands will depend on the results of longer term studies. Depending on the response of the tree crowns, it is likely that a further thinning will be required within five years to reduce stocking to the final goal of around 150 stems per hectare. Application of nitrogenous and phosphate fertilizers is the most generally accepted means of increasing cone crops (Puritch, 1977). However information on dosage rates, timing of application and cost-benefit analysis of such operations is lacking. It is apparent that timing is critical and should be just prior to flower bud differentiation. For *Pinus oocarpa* a tentative estimate for differentiation date is mid-September to October based on female flower receptivity in December (Houkal, 1980). The response of cone and seed production to fertilization should be assessed on the basis of small-scale trials as seed stands are established. The effects of fire on seed production are largely unknown. Clearly protection from crown damage is essential and a prescribed burning programme to keep fuel loadings below dangerous levels may be necessary.

Cone collection in seed stands must be strictly controlled to ensure that collection remains within the limits inside the isolation zone. It is of paramount importance to avoid damage to the trees to ensure continued cone crops in subsequent years. It is possible that greater use of the tree bicycle in place of climbing irons will be advisable. However the most important factor is careful use of cone cutters to avoid damaging subsequent years fruits and tree climbers should be specially trained for seed stand collections (Robbins *et al.* in press).

### Discussion

Although 280 plus trees of *P. oocarpa* have been selected for wood and resin properties in Honduras, seed supplies from seed orchard material will not be available until 1987 and are unlikely to reach the final goal of 250 kg of seed per year until after 1990 (Houkal, 1977).

It can be seen that seed stand establishment provides a useful interim measure to obtain seed of improved genetic quality until more highly selected material is available from seed orchards. Despite the limited selection intensities that can be achieved through thinning, genetic gains for highly heritable characters such as stem straightness as high as 5-6% may be expected from seed stands (Shelbourne, 1969) with resultant benefits to national reforestation programmes and higher prices for seed exports. Further than this increased seed production, improved

seed physical quality and greater ease of cone collection provide extra benefits. Experience in Honduras suggests that if the wood from thinnings can be sold it is likely that this will cover the costs of seed stand establishment.

A further important role of seed stands is the conservation of genetic resources. The high rate of cutting for industrial uses and fuelwood in many parts of Central America has created a situation of severe dysgenic exploitation which can be mitigated by setting aside high quality stands for seed production which will act as *in situ* conservation stands.

At the present time only a very small area of seed stands has been established in the natural pine forests of Central America. In the Republic of Honduras a total of 81 ha have been established for *P. oocarpa* in two provenances and stands have been selected for a further provenance of *P. oocarpa* and two provenances of *P. caribaea*. In Belize some initial steps towards stand selection have been taken by H.B.L. Evans, Forest Research Officer at Melinda Forest Station, Stann Creek Valley, and according to W.S. Dvorak, Director of CAMCORE, North Carolina State University, School of Forest Resources, Raleigh, USA, seed stand establishment is at a similar stage in Guatemala.

Ideally a sufficient area of seed stands to supply seed for both national use and export should be established in each provenance region of importance. The results of the C.F.I. international provenance trials indicate that there is no one universally superior provenance and it is likely to be advantageous to include a number of provenances in any commercial of breeding populations (Barnes *et al.*, 1980). The results of the C.F.I. trials provide useful guidelines indicating which provenances should be given priority for seed stand establishment.

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