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Genetic Gain from Scots Pine: Potential for New Commercial Seed Orchards

INFORMATION NOTE

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SUMMARY

During the 1950s and 1960s, 1065 Scots pine plus trees were selected as the first part of a breeding programme. The genetic quality (or *breeding value*) for height and stem form has now been estimated for 918 of these original plus trees. A breeding population of the top 200 plus trees has been created by re-selecting amongst the original selections based on their breeding value estimates. Further re-selection of the very best 40 plus trees for height and stem form means that new production populations could now be established offering considerably increased predicted gains relative to existing orchards. This marks the end of the first generation of testing in the Scots pine breeding programme.

INTRODUCTION

1. Scots pine (SP) was the first commercial conifer species in Britain to be subjected to a continuous programme of selection and testing for growth rate and stem quality. Figure 1 (see overleaf) is a flow diagram outlining the sequence of events involved in this first generation of genetic improvement.

2. Plus tree selection commenced in the early 1950s. A total of 1065 plus trees was selected over the next 20 years. Grafted replicates of 967 of the original selections have been planted in either of the two SP clonal archives at Newton, Morayshire or Bush Estate near Edinburgh.

3. The first SP progeny tests were planted in 1953. Over the next 30 years progeny tests designed to estimate the genetic quality or *breeding value* for height and stem form of the parental plus trees were established in areas thought typical for plantation SP (see Lee, 1986 or 1991). The last progeny tests were planted in 1984. Breeding value estimates are only considered reliable if plus trees are represented in progeny tests on two or more sites.

4. There are currently five Scots pine seed orchards. Three of these orchards (SP 70, SP 71 and SP 74) are clonal seed orchards containing grafted replicates of plus trees found to have high breeding values for height estimated from data collected in early progeny tests. The other two seed orchards are seedling seed orchards which consist of pair-wise crosses among tested parents selected for the early breeding population. Details of predicted genetic gains for all seed orchards are given in Table 1.

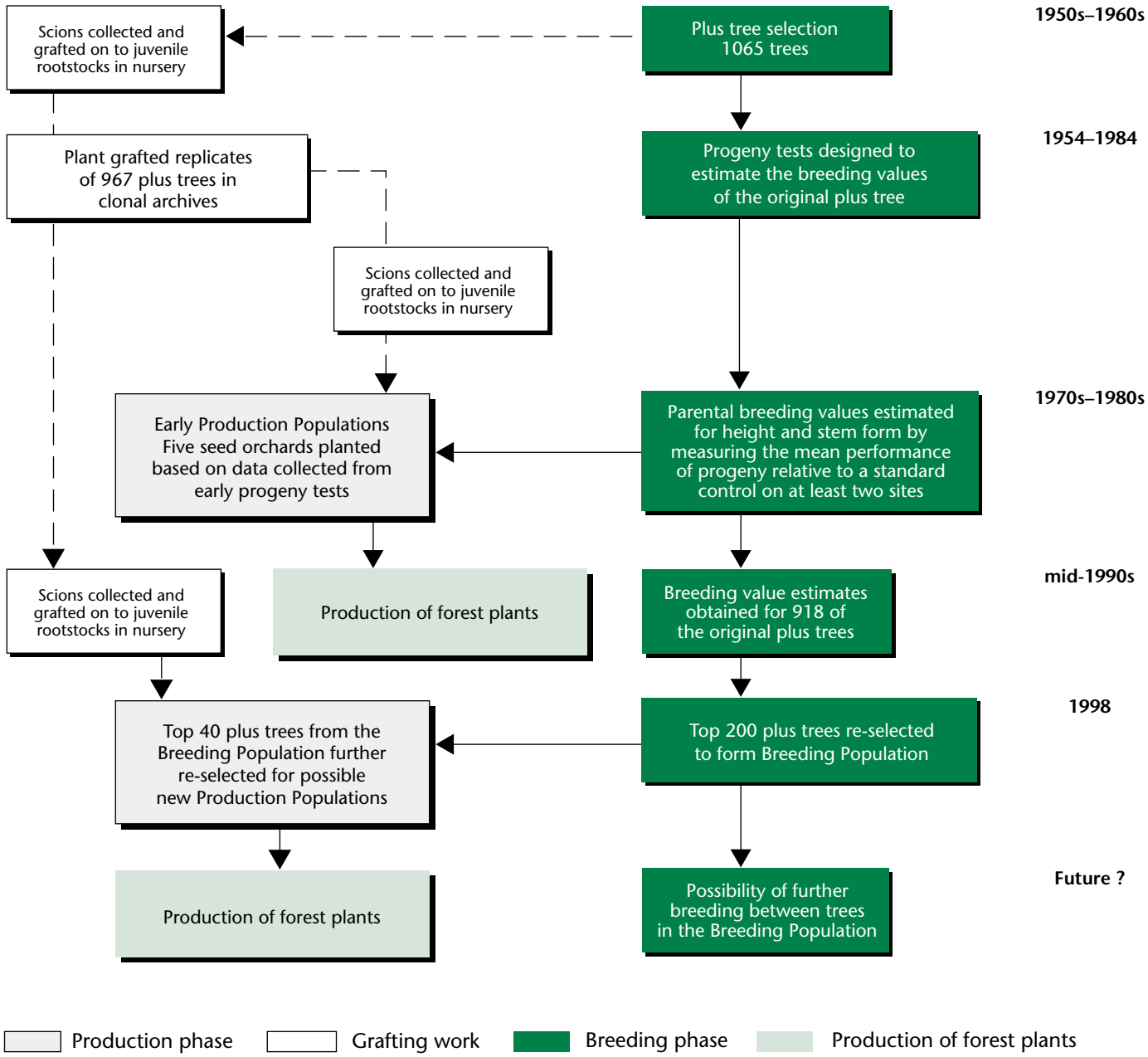
5. Predicted gains are based on measurements of progeny in replicated tests. Gains only become realised (i.e. can be measured directly) once planting stock derived from seed collected in the various orchards are assessed relative to a standard control in specially designed trials referred to as Genetic Gain Trials (Lee, 1994).

Table 1 **Predicted gains for height and stem form at 10 years old for existing and possible new Scots pine seed orchards**

Orchard	Gain relative to seed from a registered stand	
	Height %	Stem form %
I. Existing seed orchards		
SP 70	8	0
SP 71	9	2
SP 72	10	1
SP 73	9	1
SP 74	12	3
II. Possible new seed orchards		
Option A	20	5
Option B	17	15
Option C	14	19

Note: Figures are given to allow managers to make relative comparisons across seed orchards. Gain figures cannot be confirmed as realised gains until a Genetic Gain Trial has been carried out. Forest managers should always contact the nurseries who are offering improved planting stock to ask for details regarding genetic gains.
SP 72 and SP 73 are seedling seed orchards; all the other seed orchards are clonal. SP 72 is owned by Altyre Estates, Morayshire; all the other seed orchards are owned by Forest Enterprise.

Figure 1 Flow diagram showing the stages involved in the production of improved Scots pine



6. To date, the only productive Scots pine seed orchard is SP 70 from which large quantities of seed have been harvested for a number of years. It has rapidly become the industry standard for commercial Scots pine plantations.

ASSESSMENT OF BRANCHING QUALITY

7. Stem form is assessed on a 1 to 6 subjective score (1 = good; 6 = poor). Branching quality has not been assessed as a separate trait, but trees which were considered to have particularly poor branching quality were marked well down on the 1 to 6 stem form score. It is therefore not possible to state genetic improvements in branching quality, but breeders are confident that original plus trees with poor branching quality have effectively been screened out of the breeding population.

CREATING A BREEDING POPULATION

8. A complete analysis has now been carried out of the height and stem form data collected from all Scots pine progeny tests designed to estimate the breeding values of parent plus trees. A total of 918 of the original 1065 plus trees had progeny established on at least two sites.

9. The 200 top-ranking plus trees for height and stem form have been identified to create the Scots pine breeding population.

PREDICTED GAINS FROM POSSIBLE NEW PRODUCTION POPULATIONS

10. Production populations constitute the very best of the breeding population. Grafted replicates of the 40 top-ranked plus trees within the breeding population could now be brought together to inter-mate in new clonal seed orchards.

11. Tree breeders are faced with the problem of trying to predict the relative weightings to be placed on height and stem form, in order to maximise end of rotation value. Straight trees are clearly of more value than twisted trees but to date it has not been possible to predict how the price-size curve should be adjusted for each percentage increase in stem form.

12. The mean genetic correlation between 10-year height and stem form in Scots pine is estimated as r= -0.32. This is only a moderate negative genetic correlation but it does mean that the fastest growing trees will not necessarily be the straightest.

13. Table 1 includes the predicted genetic gains for 10-year height and stem form which would be possible from three different tested clonal seed orchards containing 40 parent clones selected from the new breeding population. Option A places greater gain on height than stem form, whilst option C places considerably more weight on stem form at the expense of a fall in the predicted gain for 10-year height. Option B represents a compromise between Options A and C. Other orchards of intermediate gains would also be possible depending on the demands of managers.

    The predicted gains from Options A, B and C are all a considerable improvement on those from the five existing seed orchards for both 10-year height and stem form.

14. The establishment and management of a seed orchard prior to it becoming productive, can be costly and time consuming. Grafted replicates have to be made of the 40 selected plus trees which make up the production population and then planted on a site which is conducive to the production of male and female flowers. The site then has to be managed until the grafts are physiologically mature. It commonly takes 15 years between initial grafting and the first harvest of seed.

15. Further advice on the cost of establishing a seed orchard and the likely returns in terms of harvested seed over the life of the orchards is available from Dr S. J. Lee at the address on page 4.

CONCLUSION

16. Now that breeding values for 10-year height and stem form of 918 Scots pine plus trees have been estimated we have reached the end of the first generation of testing in the Scots pine breeding programme. New tested clonal seed orchards can now be established with considerably increased predicted genetic gains relative to existing orchards.

17. The final composition and predicted gains of the selected seed orchard will depend on the relative weight given to 10-year height and stem form. It is quite possible to ensure that any new Scots pine seed orchard will have significant improvements in quality without having to sacrifice volume.

ACKNOWLEDGEMENTS

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