CONSIDERATIONS OF TIMING AND GRAFT DENSITY OF FUTURE SCOTS PINE SEED ORCHARDS

Dag Lindgren[1), Finnvid Prescher[2), Yousry A. El-Kassaby[3), Curt Almqvist[4) and Ulfstand Wennstrцm[5)

[1) Department of Forest Genetics and Plant Physiology,
Swedish University of Agricultural Sciences, Umee, Sweden
[2)Svenska Skogsplantor AB, Seed Production, Lagan, Sweden
[3) Faculty of Forestry, University of British Columbia, Vancouver, Canada
[4]Skogforsk, Uppsala Science Park, Uppsala, Sweden
[5]Skogforsk, Sдvar, Sweden

Background

In Sweden and Finland, Scots pine seed orchards are usually established with initial density of around 400 grafts per hectare. By production time, this initial density is reduced by mortality and/or thinning. Density in existing seed orchards is estimated at 267 and 318 grafts/ha in Finland and Sweden, respectively (Kang et al 2001). At present, newly established Scots pine orchards are planned to be at an initial density of 400 grafts/ha or slightly more with an expected operational lifespan of 40 years. Cone collection from new orchards is often recommended first at the stage where orchard's pollen production reaches 20 kg/ha, which typically occur after 15 years to reduce the influence of pollen from other sources. Seed production form newly established seed orchards is projected to reach 8 kg/ha between year 20 and 40.

Objectives:

The objective of this study was to explore some factors of relevance for advanced generations seed orchards, in particular those associated with planting density, start and end of seed collection, costs and cost components and the genetic value of the crop.

Methodological framework:

A program was developed that considers: 1) seed orchard area (size) 2) planting density, 3) establishment and management costs, 4) cone harvest and seed processing costs, 5) annual genetic progress available for new seed orchards, 6) impact of pollen contamination; 7) value of seed, expressed as a function of their genetic quality; 8) first and last year of operation (the productive period of the orchard). The developed program uses linear interpolation among a matrix of seed production and seed collection costs (approximated by different harvest costs on cones above and below 3m) as a function of graft density (160, 400 and 1000 grafts/ha) and orchard age. The orchard area was set to meet a projected demand of 10 million seeds annually over the life time of the seed orchard. The «benefit» was expressed as the value of a seed with the cost of production subtracted.

Runs

The estimate of inputs was based on experiences, suggestions and projections developed in discussion with a number of well informed people assuming intensive management adjusting to spacing and expected life time including branch and top pruning. Some basic information for the estimates is found in Rosvall and Eriksson (2002), Almqvist (2004) and Prescher et al. (2005). Different seed orchard sizes corresponding with the specific spacing was used and seed harvest periods ranging in the interval from age 8 (=early) to age 50 were tested to identify efficient designs.

Results and Discussion:

Benefit expressed in financial terms as a function of the orchard life time for 400 and 600 grafts/ha spacing and cone harvest starting at age 8 and 15, respectively, were compared (Figure 1). The comparisons showed the following: 1) to start the harvest early (age 8) was considerable superior

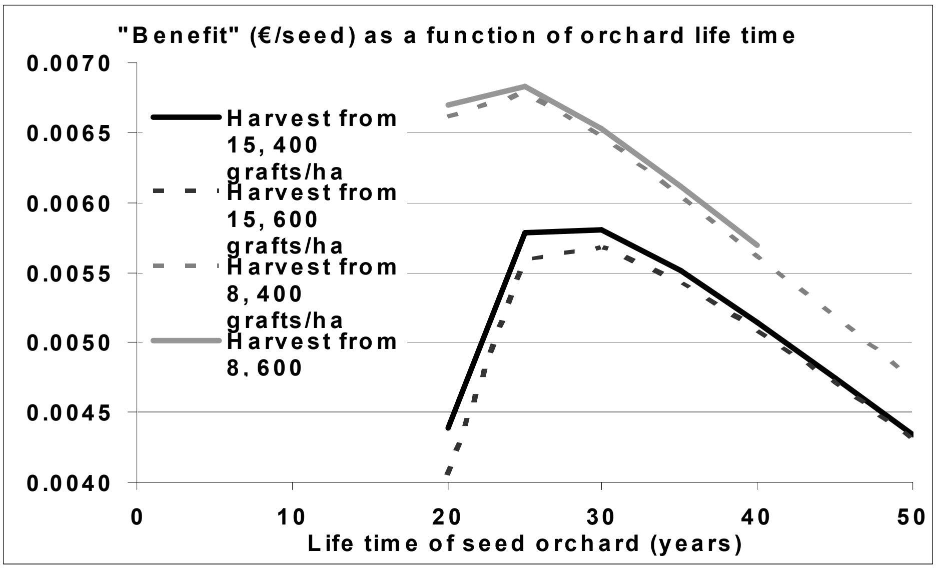

Figure 1. Benefit/seed (the «value» of a seed with production cost subtracted), comparison between 400 and 600 grafts/ha, for early (8 yrs) and late (15 yrs) initiation of harvest as a function of seed orchard life time. The genetic consequences of pollen contamination are considered.

to wait for pollen production (age 15), 2) the superiority declined as the life time of the orchard got longer, 3) the benefit as a function of life time peaked at 25 when harvest started early and at 30 when the first harvest was postponed, 4) for longer seed orchard life times the benefit sunk approximately proportional to the life time, 5) absence of an important difference between 400 and 600 grafts/ha.

The comparisons above favor faster turn-over of seed orchards. The advantage is that we can capture higher gain as seed orchard cycles are progressing with a pace closer to breeding population advancement and also that cone harvest becomes cheaper as younger trees are harvested. An advantage not considered in the calculations which could be visualized by adding an interest is that the return on investment in establishing seed orchard will appear earlier.

Cost breakdown comparison for the same production target is illustrated in Figure 2 for early (8 yrs) and late (15 yrs) harvest for 400 grafts/ha. The following points highlight the comparison between larger orchard with shorter productive time and early initiation of harvest (8 yrs) and smaller orchard with longer rotation and later initiation of harvest (15 yrs): 1) establishment cost is considerable higher for shorter rotation comparing to that of longer rotation orchards caused by larger orchard size and more frequent establishments, 2) management cost is slightly increased because of larger seed orchard area, 3) total harvest cost is lower, which is associated with more easily accessible cones, and 4) seed extraction cost is identical.

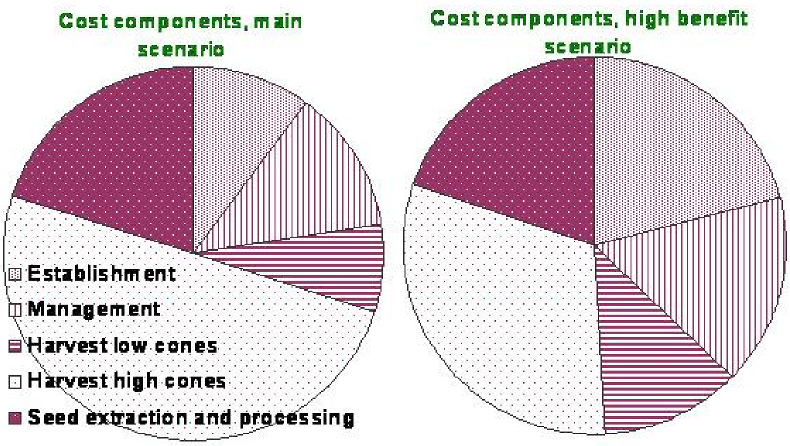

Figure 2. Cost breakdown comparison between a main scenario (400 grafts/ha) initiating cone harvest at age 15 and ending at age 40 (left figure) and a «high benefit» scenario initiating cone harvest at age 8 and ending at age 25.

Cone collection from younger orchards with low pollen production (<20 kg/ha) increases the vulnerability to high contamination rate. Longer rotation is expected to reduce pollen contamination by increasing the within orchard pollen cloud density. The current study suggests that early cone harvest is justified, at least if the contaminating pollen has similar adaptational characteristics as the seed orchard pollen. Per seed cost was marginally lower for 400 grafts/ha than 600 and about 5% lower for initiating the harvest early compared with waiting for pollen production.

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References

Almqvist C 2004. Effekter av fųrband och ymphųjd pe den tidiga produktionen av kott, frų och pollen i frųplantager av tall – Resultat fren modellfrųplantagen Drųgsnдs eren 1996-2003. Arbetsrapport 579, Skogforsk, 26 s.

Kang KS, Harju AM, Lindgren D, Nikkanen T, Almkvist C & Suh GU 2001. Variation of ramet number and effective number of clones in seed orchards. New Forests, 21(1): 17-33.

Prescher F, Lindgren D, Wennstrųm U, Almqvist C, Ruotsalainen S & Kroon J 2006. Seed production in Scots pine seed orchards, current proceedings.

Rosvall O & Eriksson B 2002. Nya frųplantager i Sverige – underlag fųr beslut. Arbetsrapport nr 499, Skogforsk, 27 s.