Establishment of conifer plantations in the South Island high country by direct drilling

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ABSTRACT

Exploratory trials were undertaken at two locations in the South Island high country to determine whether conifer plantations could be established by direct drilling. Direct drilling of pine species into unimproved short tussock grassland was successful, but in improved grassland competition from the resident vegetation inhibited establishment unless a herbicide was applied. Trials with Douglas fir were unsuccessful. At current costs it is cheaper to establish Corsican pine and lodgepole pine by direct drilling than by hand or machine planting.

INTRODUCTION

An increased role for exotic conifers in the South Island high country has been advocated recently by a number of authors. Nordmeyer (1979) suggested the region as a suitable location for the establishment of biomass forests for energy production after oil shortages developed during the 1970s. Ledgard and Belton (1985, 1985a) found good growth rates in the Canterbury high country for species such as Douglas fir *(Pseudotsuga menziesii)*, Corsican pine *(Pinus nigra)*, Ponderosa pine *(P. ponderosa)*, radiata pine *(P. radiata)*, and European larch *(Larix decidua)*, especially in the moist western zone. They suggested that forestry offered opportunities for diversification for high-country farmers, and presented a case for the establishment of a roundwood industry using Corsican pine and Douglas fir. In a recent review, O'Connor (1987) observed that the levels of soil phosphorus found under conifers by Ledgard and Belton (1985a) were generally much higher than under either unimproved or improved grasslands, and proposed that agroforestry systems might be developed to take advantage of this.

The establishment of conifer plantations on high-country farms presents different problems from those encountered elsewhere because of a limited labour supply, a greater distance from supplying nurseries, and a later planting date than at lower elevations. Additionally, in common with lowland farms, planting stock availability may coincide with other farm activities which have a high labour demand. Establishment by direct drilling offers a means of overcoming these problems because the labour requirement is limited, the operation is rapid, and drilling can be done at a time convenient to the farmer. This article describes exploratory trials at two locations to examine the possibility of using direct drilling for conifer establishment.

TRIAL SITES AND METHODS

Broken River

Two trials were established in mid October 1980 on a terrace adjacent to Broken River in the Waimakariri catchment (elevation 700 m). Precipitation here is approximately 1100 mm. In one trial, seed of lodgepole pine *(Pinus contorta)* was drilled into land which had been cultivated and sown with exotic pasture species some years previously; in the other, seed was drilled into unimproved short tussock/browntop grassland. Both sites had 100% ground cover. The seed was sown with an experimental drill being evaluated by the Agricultural Engineering Institute, Lincoln College. The drill cut strips of turf approximately 30 mm wide and 25 mm deep. These were cast to the side and the seed was sown into the bottom of the opened trough.

The effects of fertiliser (N + P) and herbicide (glyphosate) on seedling establishment were examined in both trials. The fertiliser was drilled with the seed at rates of 20 and 42 kg/ha for N and P respectively. Glyphosate was applied at a concentration of 1% by knapsack sprayer after the seed was drilled, to strips 25 cm wide either side of the drill row. The four treatments (control, herbicide, fertiliser, and fertiliser + herbicide) were replicated three times.

Ribbonwood Station

Two trials were established in early October 1983 on Ribbonwood Station, which is located at the south-western end of the Mackenzie Basin. In both trials seed was sown with a conventional triple-disc direct drill (Duncan 734) at a nominal depth of 20 mm. In practice the depth varied from 0 to 50 mm because of the uneven nature of the ground.

In one trial Douglas fir seed was drilled into an improved, white clover-based pasture which had been sprayed in August with glyphosate to eliminate competition from the resident vegetation. This trial was located on a relatively moist sheltered slope facing south-east (elevation 750 m). Rainfall here is approximately 800 mm.

In the second trial Douglas fir, Corsican pine, and ponderosa pine were sown into an unimproved browntop-hawkweed sward on a terrace adjacent to the Ahuriri River (elevation 700 m). Although rainfall is similar, the site is drier than the other one as it is more exposed and is located on a stony, free-draining soil. The trial site had been recently planted as a wide shelter belt, with pine species forming the outside rows and Douglas fir the central rows. Most of the Douglas fir had been killed by frost, and the drill rows were located along these now defunct planting lines.

Seeding rates

Seed characteristics and seeding rates are shown in Table 1. In all trials seeding rates were determined by collecting seed distributed by the drill coulters over measured distances after the drill had been calibrated. Stratified seed was used in all trials.

RESULTS

Broken River

On the improved block, competition from the grass/clover sward was severe, and herbicide had a strong positive effect on seedling survival at the end of the first growing season (Table 2). Fertiliser reduced the number of seedlings establishing

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TABLE 1.

Location	Species	Seed Wgt (no./g)	Viability (%)	Seeding Rates: along row total (no./m)	along row viable (no./m)	areal[1] (total) (kg/ha)
Broken River	Lodgepole pine	239	80	82	66	1.4
Ribbonwood	Douglas fir	55	40	51	20	3.7
	Corsican pine	53	90	42	38	3.2
	Ponderosa pine	16	79	30	24	7.5

[1] assuming a 2.5-m row spacing

TABLE 1. Seed weight and viability, and measured seeding rates at Broken River and Ribbonwood.

TABLE 2.

	Improved total seedlings[1] (no./m)	Improved survival (%)	Unimproved total seedlings (no./m)	Unimproved survival (%)
control	26.1 ± 1.3	0 ± 0.0	25.9 ± 3.3	99 ± 0.7
herbicide	20.6 ± 8.4	75 ± 10.9	36.2 ± 9.6	99 ± 0.7
fertiliser	12.3 ± 5.0	6 ± 4.2	28.1 ± 5.9	99 ± 0.9
herbicide + fertiliser	6.5 ± 0.3	89 ± 11.1	35.3 ± 6.7	100 ± 0.0

[1] living + dead seedlings

TABLE 2. Treatment effects on the establishment of lodgepole pine seedlings in improved and unimproved grassland at Broken River at the end of the first growing season (May 1981). Values are means of three replicates ± standard error.

because of increased competition from the resident vegetation, but had no significant effect on survival after one growing season. Stock gained access to this block over the winter of 1981 so that no further results could be collected.

On the unimproved block, there was little competition from the resident vegetation and establishment and survival was good in all treatments. Of the 66 viable seeds sown per metre, on average 31 seedlings (47%) had established by the end of the first growing season, and these had an average height of 2 cm. The seedlings were then thinned to allow full expression of possible treatment effects on plant growth.

Although fertiliser and herbicide had no effect on seedling establishment in the unimproved block they did affect later growth. Measurements taken after four years showed that fertiliser and herbicide applied together had a positive effect on both height growth and plant weight (Table 3). Fertiliser applied alone depressed growth because of increased competition from the resident vegetation. Herbicide alone had no effect.

TABLE 3.

	height (cm)	weight (g/plant)
control	82 ± 2.5	157 ± 19
herbicide	78 ± 0.6	150 ± 2
fertiliser	61 ± 7.3	88 ± 12
herbicide + fertiliser	91 ± 4.5	193 ± 20

TABLE 3. Treatment effects on growth of four-year-old lodgepole pine in unimproved grassland at Broken River. Values are means of three-replicates ± standard error.

Ribbonwood

The pre-sowing glyphosate application on the improved block gave good control of resident vegetation through most of the first growing season. Counts of Douglas fir seedlings at the end of the first growing season showed a mean establishment rate of 7.3 seedlings/m (36% of viable seed sown), and most of the seedlings survived the first winter. However they failed to grow beyond the seedling stage, and all seedlings eventually succumbed to competition from the reinvading herbaceous vegetation. An application of a proprietory simazine/atrazine herbicide spray on test strips at the beginning of the second growing season to give further relief from competition failed to arrest the mortality. Conventionally planted Douglas fir established adjacent to the trial site at the time of the direct seeding have grown well, indicating that the site is quite suitable for the species. This suggests that the failure of the seedlings to establish may have been caused by lack of mycorrhizae.

On the unimproved site 60% of the viable seed sown of both Corsican pine and Douglas fir had established by the end of the first growing season, but mortality of both species was high over the following seasons (Fig. 1). Douglas fir again failed to grow through the seedling stage, and all seedlings had died by the end of the fifth summer. At least 40% of the Corsican pine seedlings also died over this period, and of the remainder a further 10% were less than 10 cm in height at the last assessment and may not survive. The increase in numbers of Corsican pine seedlings over the 1985-86 growing season was the result of delayed germination. Ponderosa pine germinated slightly faster than Douglas fir or Corsican pine, but establishment was not as good (30% of viable seed sown). However less mortality (26%) occurred in this species over the following seasons. Stocking at the end of five years, assuming a 3 m row spacing, was equivalent to about 44,000 stems/ha for Corsican pine, and 18,000 stems/ha for ponderosa pine.

Ponderosa pine showed more rapid early height growth than Corsican pine (Fig. 1). This difference in height growth was reduced by the end of the fifth growing season, when the best plants of Corsican pine (30 cm) were as tall as the best ponderosa plants. By comparison the best lodgepole pine plants in the control treatment at Broken River were about 1 m tall after four years' growth. Douglas fir seedlings did not exceed a height of 4 cm.

DISCUSSION

The trials show that it is not difficult to establish pines by direct drilling into unimproved short tussock grassland with conventional drilling equipment (see Fig. 2). In improved grassland competition is severe, and the use of herbicides would be essential to achieve successful establishment. Herbicide requirements under these conditions need further trials. Douglas fir is more difficult to establish than the pines, and mycorrhizal inoculation may be necessary to achieve success with this species.

The seeding rate used for ponderosa pine at Ribbonwood resulted in the establishment of just over five plants per metre after five years, which should be more than sufficient to allow for later thinning to a desired spacing. The seeding rates used for Corsican pine, and also for lodgepole pine at Broken River, gave excessive numbers of plants, and could be reduced.

The uneven ground at Ribbonwood resulted in uneven sowing because the drill coulters rode over hollows and dropped seed on the soil surface, or sliced through humps and sowed seed too deeply. Improvements in drill design to allow greater independence in coulter vertical movement may result in more even distribution of seedlings down the row. This would allow seeding rates to be substantially lowered.

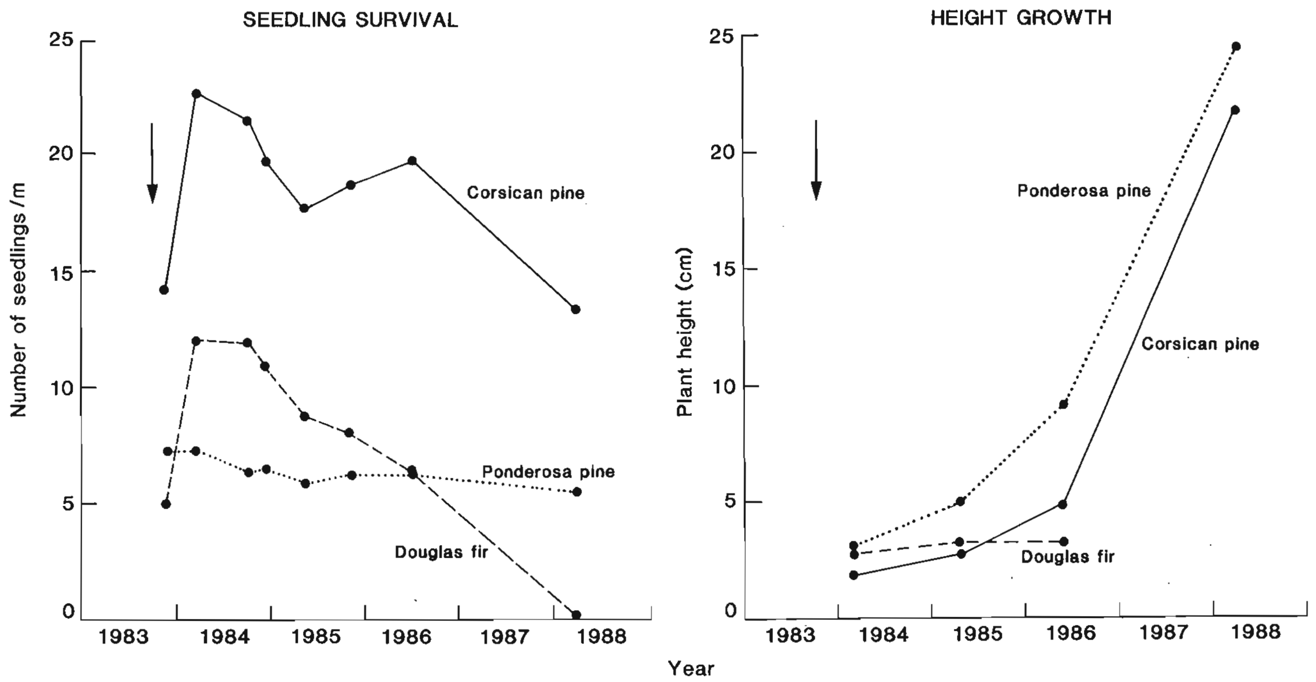

Figure 1: Establishment, survival, and height growth of direct-drilled tree seedlings in unimproved grassland on Ribbonwood Station. Arrows indicate time of seeding.

However, despite the somewhat uneven seeding, there were few gaps where seedlings were more than 2 m apart in the several kilometres of ponderosa pine and Corsican pine sown.

Whether or not direct drilling will appeal to farmers will ultimately depend on the cost as well as the convenience of the technique. Hand and machine planting costs are compared with drilling costs in Table 4. Compared to both forms of planting, direct drilling of the large-seeded ponderosa pine is prohibitively expensive, but it is much cheaper to drill than to plant Corsican pine, and very much cheaper to drill the small-seeded lodgepole pine (Table 4). Direct drilling of lodgepole pine would be a strong option if it becomes necessary to establish plantations for energy production in the future. However, a comparison of direct drilling with the planting of nursery-grown stock must take into account costs other than those involved in the establishment operation alone. For example, direct-drilled seedlings would need a heavier and earlier thinning than planted stock. A further cost associated with direct drilling is the time delay for seedlings to reach the height of hand-planted stock. This delay amounted to three years in lodgepole pine, and four-five years in ponderosa pine and Corsican pine.

TABLE 4.

Species	Planting[2] Seedling price[3] (cents/tree)	Hand ($/ha)	Machine ($/ha)	Direct drilling Sowing rate[4] (kg/ha)	Seed price ($/kg)	Total cost[5] ($/ha)
Ponderosa pine	35	1140	780	6.8	300	2100
Corsican pine	38	1190	810	1.3	300	450
Lodgepole pine[6]	35	1140	780	0.5	240	180

1 As at April 1989.
2 Assuming a spacing of 2.5 x 2.5m and the following costs: hand planting 32¢/tree; machine planting 8¢/tree; seedling transport 4¢/tree.
3 Timberlands Rangiora nursery prices except for Lodgepole pine (not available)
4 To give 5 plants/m after 5 years, assuming a 2.5m row spacing, and seed viability of 80%.
5 Includes drilling at $60/ha.
6 Sowing rate calculated using mortality data of Corsican pine.

TABLE 4. Comparison of establishment costs.

CONCLUSION

These exploratory trials indicate that direct drilling may be a viable option for the establishment of conifers in unimproved short tussock grassland. In addition to being rapid and convenient, the technique offers the potential of considerable cost savings in establishment of some species. Further work is required to determine if these advantages outweigh the disadvantages of time delay and increased thinning costs. Research is also required to determine optimum seeding rates and whether mycorrhizal inoculation can improve establishment of Douglas fir.

Figure 2: The conventional agricultural triple disc direct drill used to establish the trials at Ribbonwood Station. (Photo: N. Ledgard)

ACKNOWLEDGEMENTS

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Figure 3: Three rows of five-year-old ponderosa pine seedlings established by direct drilling in unimproved browntop/hawkweed grassland, Ribbonwood Station. (Photo: M. Davis)

INSTITUTE NEWS

Object of the Institute – proposed constitutional change

As noted in previous issues of the journal, the Institute Council has been giving considerable thought to the matter of policy, and associated issues. One of these issues is the object of the Institute, or "What are we here for?" At its think-tank session in Hanmer last year, the Council considered this question in some detail and concluded that the role of the Institute was to be:

- a major advocate for forestry
- a forum for discussion on forestry-related matters
- a fraternity for members.

The existing section of the constitution dealing with the objects of the Institute is section II which currently reads as follows:

> "The object of this Institute shall be to promote the best use of New Zealand's resources, to encourage the wise use of forests and forest land, and to further the interests of the profession of forestry."

Given the change in the name of the Institute to the Institute of Forestry, and the intent to have as members not just professional foresters but also professionals in other areas related to forestry, a more appropriate object is in order. A number of wordings have been considered, and the following is put forward for comment by members before being formally advised as a proposed constitutional change:

"The objects of the Institute shall be:

1. To be an independent advocate for forestry
2. To serve its members by
   (a) affording them opportunities to express and exchange views
   (b) overseeing members' ethics
   (c) encouraging fraternity and 'esprit de corps'
   (d) providing recognition."

Several desirable features of the above wording and construction should be noted. Firstly, it clearly sets out a primary role in advocacy, and secondly, it makes it clear that one of the functions of the Institute is to serve its members. Thirdly, it sets a mandate for the journal and the annual conference.

Council is aware that considerable care needs to go into the wording and construction of the objects of the Institute, as in future years both the Council and the Institute will be judged by how well they have been able to meet the Institute's objectives.

Members are invited to comment on the above revised objectives for the Institute before they are formally adopted by Council and put forward as a proposed constitutional change. The revised objectives may provide a good topic for discussion and debate at local section meetings. Please send your own or your section's views to the Institute Secretary.

Ben Everts

Frank E. Hutchinson award

Nominations are called for the award which commemorates Frank Hutchinson, a foundation member of the Institute. Until his death in 1982 Frank was an active member of the Institute and was elected an honorary member in 1964.

The award, which will be in the form of a certificate and a book, is for significant postgraduate work related to reforestation in New Zealand.

Members wishing to apply for this recognition or who wish to nominate Fellows, Full and Honorary members, should apply, with supporting details to:

The Secretary,
Institute of Forestry,
P.O. Box 12-314,
Thorndon,
Wellington.

Applications close on January 31, 1990.