COMPARISONS OF CHILEAN AND NEW ZEALAND RADIATA PINE PLANTATIONS

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ABSTRACT

Factors favouring development of radiata pine plantations in Chile are an abundant supply of cheap land (US$50-$100/ha) of fairly good site quality (24 to 30 m top height at age 20) and easy topography, that is rarely more than 120 km from ports. The trees lack multiple leaders and grow reasonably straight; dense stocking is maintained in stands up to at least age 25 years.

There is a 75% government rebate on direct establishment costs for new planting. Labour costs are US$2.40 to $8.00 per day. Extraction costs range from US$4.70/m³ for mechanised clearfelling to US$5.40/m³ for thinning.

Dothistroma has been present for at least 8 years but is not serious over most of the plantation area. Sporadic losses from Diplodia remain unquantified, although they are apparently increasing in severity.

The present cut is 8 million m³ per year. It is probable that volumes of 17 to 26 million m³ annually will be available from 1990, and at least 30 million m³ annually from 1996 to 2000 if net planting of 86 000 ha per year is sustained.

Management is, or will be, entirely in private hands; planning is under way on how best to utilise these volumes for export. Chile is the only large-scale producer of softwoods in Latin America, but this advantage may decrease if Caribbean pine plantations are successful in Brazil and Venezuela.

Export destinations and products are relatively diverse; the fastest growth at present is in the export log trade to Korea.

Top management calibre is high. The competitive position of Chile in radiata pine markets will be formidable if present trends and planting rates are continued.

INTRODUCTION

Few general accounts of Chilean plantation development have been published in English since the FAO publication (Scott, 1960), although much information is now available monthly in Chilean Forestry News. Since about 1960 there have been increasing numbers of New Zealand visitors to

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Chile who have been connected in one way or another with forestry, but no comparative accounts have been published. This brief paper does not claim originality, nor are the observations based on quantitative study; rather a description is given of tree, plantation, and management development in Chile as it appeared to the writer.

Basic Data

The population of Chile is over 10.5 million; about 80% live in urban areas, and the capital, Santiago, contains about 4 million people. Sixty-four percent of the population was 24 years or younger in 1971. The population increase in 1960-70 was 1.9% annually, but more recent data are hard to find. Chile, like New Zealand, is far from markets (outside Latin America). By sea Valparaiso is over 12,000 km from London, 15,000 km from Yokohama, 7,400 km from New York, 4,200 km from Panama (and 8,500 km from Auckland).

The great length of Chile may obscure the fact that it is a large country—over 74 million ha. There is a wide range of forest climates, but areas suitable for radiata pine are generally considered to lie between 35°S and 41°30’S.

The Plantations

Over 90% of Chilean plantations are of radiata pine. Chilean provinces are numbered from the north, and the main plantations are in Provinces VII to IX.

Over 90% of the plantations are planted at 2 × 2 m and left. An indeterminate area is 0/2 m pruned for fire protection, but this is generally done rather late by current New Zealand standards. A few areas have been pruned and are available for grade studies.

The climate in the plantation zone is mediterranean with dry summers (Scott, 1960), though rainfall increases to the south (Province X). This contrasts with New Zealand, where the relative frequency of summer rain distinguishes the radiata pine areas from those in other parts of the world.

The form and development of individual trees seems familiar (in contrast, for example, with radiata pine grown in East Africa) and trees are reasonably straight (Fig. 1). Evidently height growth is not sustained for as long as it is in most of New Zealand. Large branches can develop if there is sufficient light. “Stem cones” are about the same height up the stem as in New Zealand, apart from trees growing on exceptionally shingly and poor sites, where they are low. There seemed to me to be slightly more really multinodal trees than are found in New Zealand populations—with up to
Fig. 1: Region VIII, radiata pine age 14 after extraction thinning. Note small dead branches and straight stems.
six whorls of branches per year. The major difference is the absence of gross malformation—especially of forked or multiple-leadered trees. Tree growth evidently ceases at the end of the dry season but is active again by midwinter (June).

The stands, as distinct from the trees, are different in one important respect—the relative absence of mortality up to at least age 20. Dead trees, even among the suppressed class, are rare. This was true of all the stands seen over a wide range of sites. Consequently, forest floors are clear and felling operations are easier.

The importance of good form and of full stocking potential is considerable. The well-shaped, slender trees produce yields of relatively high volume per hectare. Typical stands on good sites are shown in Figs. 1 and 2.

One large company (Forestal Arauco) carries out a good thinning-to-waste operation in natural regeneration at about 1.5 m (8000-10 000 stems/ha thinned to 2000 stems/ha). Little other thinning-to-waste is being done, as far as could be ascertained.

Production thinning started about 3 to 4 years ago; pairs of yoked oxen are used (occasionally horses), pulling out logs mostly 2.4 m long but up to 4.8 m. Stands are generally between 14 and 18 years old and are densely stocked. Damage to residual trees is minimal, management control is good, and costs are favourable. Slopes up to 18° are being worked.

**Fig. 2:** A 28-year-old stand being clearfelled, Arauco Province. This stand had received a very light thinning at age 8-10(?). Tree height about 30 m.
Naturally, with such dense stands (1800 stems/ha, top ht. ca. 16 to 20 m), the thinning intensities being applied are light (50 to 100 m³/ha extracted) for fear of opening up the stands too much. The operation is reminiscent of the first thinning in South Australia. There seems to be general pride in these efforts (e.g., “Thinning is a good thing”), but there was some recognition that the profitability may be less than imagined. These thinned stands stood up to a severe gale (and 400 mm of rain in a week) in July 1978.

Thinning may play a big role in sustaining production through the 1980s when there could be some shortage of wood because of age-class problems.

**Felling/Regeneration/Soils Syndrome**

Many of the sites are on old agricultural (wheat land) soils, where a long history of cropping, without the use of fertilisers, led to soil deterioration and sometimes to sheet (and gully) erosion. Most of the plantations are still first-rotation, and problems may arise on marginal sites with the next crop.

Extraction after clearfelling is also usually done by animals. The use of draught animals—admirable for thinning operations—leads to problems in clearfelling. To allow the animals throughway, the slash has to be piled, usually in rows up to 6 m wide (Fig. 3). Obviously this interferes with growth of regeneration, and some companies burn the slash. As the summers are dry the fires burn fiercely, often destroying much topsoil and all litter. Some companies are using skidder/tractors for clearfelling, and neither windrow nor burning the slash. The potential nutritional problems are thus being reduced; but on the clay soils there are signs of soil compaction on skidder trails and loading sites. (The latter are not the big squares used in New Zealand as the logs are distributed alongside the roads, and this does reduce the intensity of compaction.)

In many areas there is abundant regeneration (20 000 stems/ha). Some companies avoid the burning of logging slash as otherwise the regeneration becomes too thick (40 000 stems/ha or more), and in these areas other potential problems are also avoided. Utilisation is close by New Zealand standards (see Fig. 3) and the relative lack of malformation helps reduce the logging waste.

The current management situation and yields are:

1. The rotations envisaged are between 20 and 30 years; most stands being clearfelled now are 24 to 29 years old. (Clearfelling stands of less than age 18 is illegal.)
Fig. 3: After clearfelling of 27-year-old, unthinned stands: stucch 2.4-m pulpwood. The slash is piled to give access for the oxen used in extraction of logs.
(2) Site indexes on the major areas range from 24 to 30 m (top ht. at age 20).

(3) There is remarkably little mortality in dense stands (2 × 2 m spacing).

(4) Stem form is reasonably good, and double leaders are rare.

(5) Extracted volumes (net on truck): Region VII (dry sites), 450 to 500 m³/ha at age 25; Region VIII, 500 to 600 m³/ha; best sites, 600 to 650 m³/ha at ages 25 to 29.

These show net annual increments of 18 to 25 m³/ha from fully stocked unthinned stands. There are theoretical calculations showing that annual yields up to 32 m³/ha are available. There are no formal yield tables, but they are being prepared.

**PLAGUES**

*Dothistroma* has been identified in Chile since 1970. The worst-affected stands seen were in Region X (high rainfall), where the young age-classes from 1 to at least 10 years were thoroughly infected, even close (5 km) to the coast. Most of the needles remaining appeared to be current year growth. It was also present (though not markedly) in the nurseries seen. Further north, the inland stands of Region VIII (dry summers) seemed little affected, but some areas with regeneration up to 5 m high were widely, but not intensely, infected. The effect of *Dothistroma* on increment is no better quantified in Chile than in New Zealand. Control measures are not taken. Overall, there does not appear to be much concern yet about it.

Apparently *Diplodia* is causing dieback and even death of stands over widespread areas in the drier zones. Publications will soon be available on this problem. The fungus is apparently behaving very differently from the (wound-induced?) infection pattern in New Zealand. Attempts are being made to quantify losses from pathological/entomological attacks, but in the meantime only tentative statements can be made. An FAO entomologist, R. Gara, thought *Diplodia* would be of major importance in Chile.

There were no signs of *Sirex*. Sawn timber is relatively free of the range of insect-induced or other resin streaks/pockets that can occur in New Zealand. There seem to be few insects of economic importance on radiata pine to date. *Pineus borneri, Buprestis novemmaculata,* and *Ernobius mollis* have been introduced, but appear unimportant. Apparently *Rhycopodium buoliana* (a shoot borer) prevents plantations of
radiata pine from being successful in Argentina, and could be a danger if introduced.

Fires

The forest areas are relatively widely dispersed, with a high boundary/area ratio. There are also families living in scattered houses through much of the countryside. These factors, with the dry summers, lead to formidable fire hazards, and losses are quite substantial. From 1971 to 1975, losses totalled about 15,000 ha. Naturally, with the intensification of forest management, the situation is being improved.

TIMBER CHARACTERISTICS

Most sawn timber is from stands 22 to 30 years of age, kept at dense stocking. This results in small logs, a relatively small number of bark-encased knots, a high proportion of small sound knots, and the resumption from a New Zealand viewpoint of pith and its associated defects, and “cone holes”, as the major defects. Pith appears to be slightly narrower in radiata pine grown in Chile. Most timber is sawn to 1-in. sizes (25 mm), though good-looking framing (very rarely as 4 × 2 in.; usually 5, 6, and 8 × 2 in.) is easy to produce. There may be data on stress-grade results, but I found none. There is limited kiln drying, and a lot of sapstain in the logs owing to delays in extraction.

A feature of the buildings of the forest utilisation plants is the high usage of wood and absence of steel in construction. Design is good, using light sections of young timber and nailed lamination techniques. This is the sort of development done in New Zealand 30 to 40 years ago (e.g., the Waipa box factory roof) and now forgotten in the abundance of a one-time resource of timber from 45-year-old or older stands.

Air-drying yard practice was usually good—all timber, without exception, was sorted into lengths for a start. Fillet alignment was good, and nearly all stacks were covered. There are some drying kilns and the schedules favoured are those developed in South Australia, but there seems scope for increased kiln drying. Wood preservation is not done on the lavish New Zealand scale, and the use of treated timber, at least for ground contact purposes, could be considerably expanded. Timber for general house construction appears to be largely untreated.

The timber characteristics were of great interest as they represent the quality that will be produced from the post-war crops of radiata pine in New Zealand (the “old crop” will be as relevant as indigenous timber).
LAND AVAILABILITY

Other Management Considerations

Land for forestry is cheap. Land of easy topography, without heavy scrub cover, within 80 to 100 km of a port, of an estimated site index of 25 m (or more), costs US$50/ha, with odd parcels rising to US$100/ha. If companies are asked $60 they tend to buy elsewhere.

The estimated plantation target by 1981 is 1 million ha. However, it is commonly assumed that the sudden release of state forests in 1978 (see later) will postpone the attainment of this target, as it will take some time to absorb the extra areas into private ownership.

Medium- and long-term prospects are bright. The use of other species—contorta pine, and possibly muricata pine and Douglas fir—could extend the forest areas into the Andes; Douglas fir grows well in the high rainfall country of Region X (which is still only 41°S), and maritime pine (or alternatively Quercus suber) could be productive in the largely unplanted areas in Region VI and further north. There are also good prospects for eucalypts. After the first x million ha of radiata pine has been planted, it should be easy to increase the plantation area, using species with lower growth potential.

Government Planting and Incentives

In May 1978 the government announced that all its production-plantation activities would cease—including both nurseries and planting. (Further, all State plantations are for sale—about 168 000 ha gross—within 2 years. Only one previously nationalised industrial plant remains unsold, and buyers for this are being sought.) There would be problems for the companies in raising the cash needed, even though they have up to 8 years to pay.

There has been a 75% refund of net planting cost on new plantations; this rebate has been in operation for at least the last 2 years. Apparently even greater incentives apply in Argentina and Brazil. It seems that management plans have to be prepared in order to get the planting grants, and that there is difficulty in having trained staff check these.

COSTS

The minimum wage rate paid was US$2.40 per day. Generally the companies appear to be paying more, especially in utilisation operations; US$7 to US$8 per day was the rate quoted for timberfellers.
Land costs have been given—about US$50 to $60/ha, and up to US$100/ha. Tree stock of 1/0 (8 months really) radiata pine costs up to US$3 per 1000. Total establishment costs for new land range from US$150 to $250/ha for 3 × 2 m and 2 × 2 m planting. The US$250 is for gorse areas (in Region X). Extraction thinning costs US$5.40/m³ to roadside (30% of basal area, ca. 100 m³/ha); cf. clearfelling cost of US$4.70/m³ using bullocks.

Costs of operations are published monthly in *Chile Forestal*, and a consolidated publication should be available soon.

**AGE-CLASS DISTRIBUTION**

There are firm proposals for a national forest inventory; the earlier one was completed in 1965 and is consequently of little use. A number of regional ones have since been made.

For radiata pine the estimated age-class distribution as at March 1977 is shown in Table 1.

**TABLE 1: ESTIMATED AGE-CLASS DISTRIBUTION FOR RADIATA PINE AS AT MARCH 1977 (GROSS AREAS).**

<table>
<thead>
<tr>
<th>Age-class (years)</th>
<th>Company Forests</th>
<th>Total Forests (incl. State)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Area (000 ha)</td>
<td>%</td>
</tr>
<tr>
<td>0–5</td>
<td>134.6</td>
<td>45</td>
</tr>
<tr>
<td>6–10</td>
<td>60.6</td>
<td>20</td>
</tr>
<tr>
<td>11–15</td>
<td>31.4</td>
<td>10</td>
</tr>
<tr>
<td>16–20</td>
<td>25.2</td>
<td>8</td>
</tr>
<tr>
<td>21+</td>
<td>39.0</td>
<td>13</td>
</tr>
<tr>
<td>&quot;Not known&quot;</td>
<td>8.4</td>
<td>4</td>
</tr>
</tbody>
</table>

**Note:** All figures are rounded.

Over 90 000 ha was planted from April 1977 to March 1978; the state planted 44 500 ha of this. It seems likely that the next year’s planting will drop to 50 000 ha. The reliability of the figures for area is not known. One study concluded that the figures were 20% too high, and represented gross rather than net areas. (Area could include unplanted patches—gullies, road lines, etc.) Against this, some (or most?) of the Chilean foresters thought this correction was too great and that, even after allowing for fires, the total plantation area is closer to 550 000 ha than 500 000 ha. Obviously the differences are of considerable order and importance, but resolu-
olution of the problem can only await better data. Most of the accounts obtainable gave somewhat different figures.

There was also general agreement that the old stands (10 years and older) were better established. On the areas actually seen by the writer, planting and replanting were both thorough and conscientious in the stands of the big companies. Elsewhere (smaller private owners) there were areas of unplanted gullies, neglected release cutting, “waiting for regeneration”, “it will come through” (gorse area), and other lax practices unfortunately only too familiar to New Zealand practitioners.

Nearly all the companies are planting further areas of radiata pine although they are not cutting more than 50% of their increment. The five largest companies were contacted and are all considering where future supplies can best be used, forest expansion being overwhelmingly for export.

So there is no reiteration of pulpmill expansion in Chile—they will do this only if it pays them. The contrast with New Zealand was marked.

Total wood production is about 8 million m$^3$. Available yields from clearfelling increase rather as in New Zealand, reaching 17 to 26 million m$^3$ annually by 1995 and over 30 million m$^3$ by 2000 if present planting trends are continued.

Forest expansion, as in New Zealand, is aimed at export markets. These have been diversified very widely after early sales, predominantly of sawn wood, to neighbouring Argentina. Currently timber is sold to over 20 countries—Argentina, Venezuela, and Brazil still being the main markets (Anon., 1977). The main products (in order of value in 1977) were wood pulp, sawn timber, and newsprint (Anon., 1977). There was a substantial increase in log exports in 1978, with emphasis on the Korean as well as the Japanese market.

Forest products account for over 8% of the value of all exports, and were worth US$180 million in 1977. As this is all coming from a plantation resource which is at least 20 years younger overall than that of New Zealand, the achievement is remarkable—increasing fivefold in 5 years.

Imports of forest products totalled US$25 million in 1977. The top management, of both the state and the private companies, is intelligent, far-seeing, questioning, and in control. They represent the complementary resource to the admirable sites available. Their success is reflected in the export figures. Overall, Chilean plantation potential is formidable.

ACKNOWLEDGEMENT

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REFERENCES