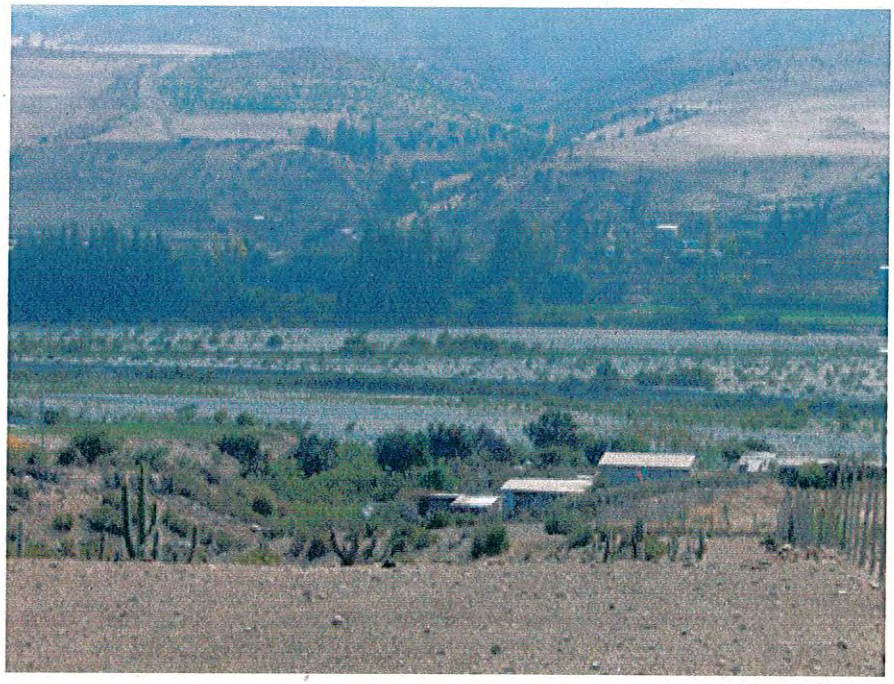
Review of the development of Acacia saligna as a multi-purpose plant species in the semi-arid zone of Chile



Report of field visit
Prepared for
Revegetation Systems Unit
Department of Conservation and Land Management
Western Australia

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July 2005

Contents

Additional material

Papers, introductory promotional material from agencies, species information, monographs, magazines, etc., on file with the hard copy of this report

Maps

Explanation of acronyms used in this report

CIACEF	Centro de Información de Experiencias de Adaptación y Crecimiento de Especies Forestales en Chile. Extensive database maintained by INFOR, collating history, species and data for a range of trial sites.
CIREN	Centro de Información de Recursos Naturales. Database of climatic, geological, land use, etc data. Topographic and contour maps, air and satellite imagery.
CONAF	Corporación Nacional Forestal National Forestry and Conservation agency. Role similar to the operational side of CALM, does not do research. Relies on INFOR for forestry research, and other agencies, Universities and overseas collaborators for nature conservation research.
CONYCIT	The Chilean Science Commission. Approves funding for high level research.
CORFO	Corporación de Fomento de la Producción. National agency for management of project finances. Collates and prioritises public spending for all departments.
CORMA	Corporación Chilena de la Madera. Timber Corporation.
CUC	Pontifica Universidad Catolica de Chile. Catholic University of Chile.
FDI	Foreign Investment Committee. Encourages and promotes foreign investment in Chile
FIA	Fundacion para la Innovación Agraria. Under the Ministry of Agriculture, promotes Agricultural innovation.
FUNDEF	A fund for the promotion of scientific and technological development. Administered by CONYCIT.
INDAP	Instituto de Desarrollo Agropecuario. Institute for agricultural development. Responsible for financial and technical support to landholders. Also collates and prioritises agricultural development projects.
INFOR	Instituto Forestal National Forestry Institute. Hosts for the visit. Responsible for research and information generation for public agencies and private companies
INIA	Instituto Nacional de Investigaciones Agropecuarias. National agricultural development agency. Has a research focus.
INNOVA	An entity of CORFO, for the promotion and facilitation of innovation, aiming to make Chile more economically competitive.
UC	Universidad de Chile University of Chile.

Summary

This document reports on a field trip to look at the current state of utilisation of *Acacia saligna* in the central north region of Chile. It also begins an examination of the potential for collaboration between Chile and Western Australia in the further development of this species as a multi-purpose tree crop for semi-arid regions.

The Chilean Forestry Institute (INFOR) has been a generous host for this preliminary investigation of the opportunities for collaboration. The organisation appears to have excellent working relations with other agencies and research institutes.

Our principal contact at INFOR at the time of this visit, David Campos has a substantial history in both the public and private forestry sectors in Chile. He has a keen sense of project development, and an understanding of the subtleties involved in obtaining funding for such work. However, shortly after this visit, a new administrative region was created within INFOR, based at La Serena (in the north of Region IV), meaning Sr. Campos will no longer be directly related with research at the Fourth Region. He will continue as Manager of the Santiago office. Sandra Perret will lead the new region. Sra. Perret has a history of working with *Acacia saligna*, and is the author of several publications on the species, including the INFOR monograph on the species.

Chile is divided into 13 administrative regions, with Region I being the northernmost, Region XII the southern most. Santiago is the thirteenth region, nestled into Region V. Santiago is at a similar latitude to Perth, but sits at around 300m altitude, and 100km from the coast. It has an annual rainfall of 300-350 mm. Most of the *Acacia saligna* work is in Region IV, 200-500 km N of Santiago, a region with an average rainfall of around 150mm.

Chile has a long history of using Australian plants in forestry and agriculture. Part of the substantial pulpwood industry in the south of the country is now based on eucalypt species, and some 70,000 ha of *Atriplex nummularia* have been planted in the semi arid zone. There are now 4762 ha of *Acacia saligna* planted in Region IV (M. Cerda Berrios, *pers comm.*), most established in the last four years. Most of these plantings have been established from seed of Chilean land races. These land races show very high morphological variability, not neatly representing any of the recently identified Western Australian 'types'.

Acacia saligna is growing well in Chile, even in harsh conditions high in the landscape, in areas sometimes receiving no more than 100mm annual rainfall. It is extremely unlikely that the plants in many of these locations will have access to significant ground water. This success may be accounted for by the persistence of a maritime mist controlling the evapotranspiration rates in these areas. Such observations have been made as a contributing factor in the growth of *Prosopis tamarugo* populations in the even lower rainfall areas to the north of the study area (Sudzuki 1985).

Most of the *Acacia saligna* has been established under a plantation subsidy scheme that pays landholders a generous amount of money per hectare (significantly higher than the establishment cost). The amount of this subsidy is related to the plantation survival at year one, and is assessed by CONAF.

Acacia saligna (and *Atriplex nummularia*) are established among existing native vegetation, a mixture of low growing shrubs and grasses. They are being established to

increase the productivity of rangelands, none were seen established on cleared farmland. Despite this competition, growth rates were surprisingly good and survival was excellent.

Although promoted and established as grazing crops, neither the *A. nummularia* or (especially) the *A. saligna* are being utilised to full advantage by stock. Other benefits such as shade, erosion prevention, and the generous subsidy payments partially off set this disappointment, and a significant amount of biomass is accumulating in Region IV. While this lack of grazing is not seen as a significant problem yet, the removal or reduction of subsidies in the future may curtail planting unless landholders are convinced of the other benefits of the plants.

Improving the attraction of these plants to stock will be central part of any future for this species in Chile. Work has begun exploring the species' genetic variability, as well as variation in palatability and digestibility. There is a keen team of researchers in Chile to further this work. Chile has an incomplete collection of the WA forms in provenance trials at this stage, and trialling and analysing the remaining forms is a high priority.

Chile will benefit from collaboration with Western Australia through access to the remaining types, plus access to a wider range of genetic material from those provenances with most promise.

There is also scope in the low rainfall zone of Chile for the increased use of other species, especially low rainfall eucalypts. The mallee group of eucalypts are not utilised to advantage in this country, and species better suited to the environment than those commonly in use at the moment can probably be found through trial work.

For Western Australia, a good opportunity exists for collaboration on unravelling the genetics of the species, and better understanding its palatability. There may be application for strains of low palatability, for example as unfenced tree belts for biomass production in WA.

Both countries have practical applications for biomass use, for example for localised power generation, and collaboration in this area may be possible.

International collaboration is viewed favourably by the funding authorities in Chile. There appears to be a high level of cooperation and collaboration between agencies and universities. Both research and administrative staff were positive about the prospects of collaboration with Western Australia, and I would recommend pursuing these opportunities.

Introduction to Forestry in Chile.

Outline based on presentation from David Campos (Manager, INFOR Santiago), and notes from general discussion with Patricio Rojas (Forester, INFOR).

Chile is a country of some 15million people, with 5 million living in the capital, Santiago. The economy relies on export income, principally from mining, (especially copper), and agriculture (especially horticulture). Chile has a number of free trade agreements, most notably with the United States and The European Union. Export of Chilean forestry products reached $3,3966mUS in 2004.

About half the country is forested, with 21% formally classified as 'forest' and some 15m ha of woodland, mostly native species. Around 33% is considered as 'barren', reflecting the extensive dry areas in the north of the country and the steep rocky mountain slopes.

Plantation forestry has been dominated by *Pinus radiata* in the past, and this species accounts for over 70% of this resource. The next most common plantings are of eucalypts, especially *E. globulus* and *E. nitens* (70/30%). Other species include poplar, Douglas fir, and the native *Prosopis tamarugo*. During the last ten years other species for high value timber and other products have been trialled by INFOR as part of Chilean forestry policy to diversify forest resources (P. Rojas, *pers comm.*). There is a 60% compliance rate with ISO1401 and other international standards within commercial forestry operations. Production of wood panels is a traditional forestry operation in Chile, and is being modernised through the manufacture of MDF, OSB and chipboard.

Pulpwood production is now sourced entirely from plantation species, 80% of which is processed locally. There are currently four Kraft mills for paper production in Chile. The top pulp player in Chile, Celulosa Arauco y Constitución, will start up a new 625,000-tonne line at Valdivia in southern Chile by the end of 2005. The company is also moving ahead with a similar 700,000-tonne mill in Chile's Bío Bío region, planned to start up in 2006. It is expected that the Arauco mill Line 1, which now produces both pine pulp and eucalyptus pulp, will be switched to produce only pine. With a second pine only line of 475,000 mtpy of capacity, the mill could be producing 725,000 tonnes of radiata pulp once the Valdivia mill is commissioned. Arauco's Constitución operation can produce 365,000 tonnes of unbleached radiata pine, while its Licancel mill makes 120,000 mtpy of bleached radiata pine. In addition, its Alto Paraná mill in Argentina was expanded in 2001 and now can export 300,000 mtpy of softwood pulp made from taeda pine.

The Celulosa division of the other major player, CMPC, currently produces more than 1.1 million tonnes of pulp at three mills, including 910,000 tonnes for market. The Laja and Pacífico mills produce 800,000 tonnes of radiata pine pulp. At Nacimiento, the Santa Fe Mill produces 350,000 mtpy of eucalyptus pulp. After recent upgrades, the Laja pulp mill has a capacity of 350,000 mtpy of bleached and unbleached radiata pine, half of which is feedstock for the production of 50,000 tonnes of printing & writing paper and sack kraft, as well as the CMPC tissue operations in Chile and Argentina.

Wood chip is also exported to Asia, with market price determining what product goes to which market. Arauco and CMPC have both been finding it increasingly difficult to access land at acceptable prices for plantation expansion, and are increasing their operations in Argentina and Brazil.

access land at acceptable prices for plantation expansion, and are increasing their operations in Argentina and Brazil.

The main target area for *A. saligna* is Region IV, where much of the landscape is covered with an open shrubland, seldom more than 1.5 m tall, with only scattered tree species. *Acacia caven* is common throughout this area. It is a low growing, spreading spiny shrub used for browse by livestock, mainly goats. The native species *Caesalpinia espinosa* (tara), used for tannin production, and *Quillaja saponaria* (quillay), used for saponin production occur naturally here. The range of the Caesalpinia extends into Bolivia and Peru, the Quillaja into Peru and Ecuador. Other conspicuous species are the cactus *Trichocerus chilensis* and the bromeliad *Puya chilensis*. Recent clearing of these native species is conspicuous on the steep slopes adjoining the valley floors through the northern part of Region V and in parts of Region IV. Most of this newly prepared land is being planted to irrigated avocados. Substantial government subsidies are available for irrigated horticultural crops like the avocado as part of a push to increase high value exports. Such clearing and water allocation is contentious.

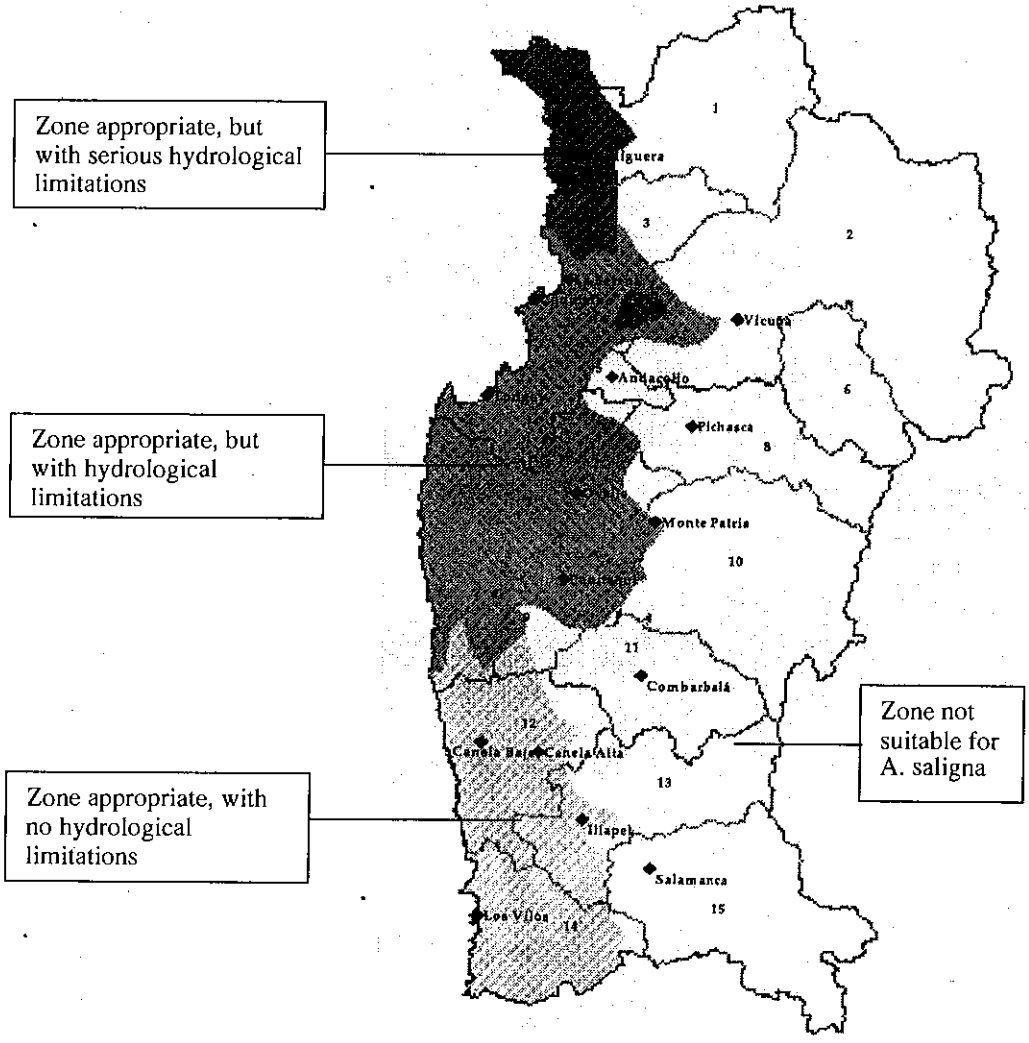
Most of the *Acacia saligna* has been established under a plantation subsidy scheme that pays landholders a generous amount of money per hectare (significantly higher than the establishment cost). This concept is covered in more detail in the report from a meeting with CONAF in Illapel.

In common with Australia, government funding in Chile is generally allocated to research programs (FDI, FONDEF, INNOVA, FIA grants) for a period of up to three years. Staff commented that this makes assessment of growth and potential in forestry crops difficult.

An excellent review of the state of Chile's forestry industry prepared by the UNECE/FAO is appended to this report.

Acacia saligna at El Tangue community, Tongoy, Region IV, Chile

Map 1. Chile Region IV. Study area for this report. (Adapted from Turismo y Comunicaciones S.A. 2004)



Map 2. Chile. Region IV. Potential areas for the cultivation of Acacia saligna. Scale approx. 1:1 600 00. (Adapted from Perret *et al* 2001).

Sites visited during tour of Region IV.

1. Longotoma species introduction trial.

This site trials a range of eucalypt species for the semi arid zone. It was planted between 1966 and 1972. Species tested included *E. astringens, E. globulus* subsp. *globulus, E. behriana, E. brockwayii, E. camaldulensis, E. diversicolor, E. resinifera, E. sideroxylon, E. citriodora, E. cladocalyx, E. salmonophloia, E. torquate, Casuarina obesa* and *Pinus radiata.* It is a high landscape, dry site. It is now dominated by *E. camaldulensis* and *E. sideroxylon*, both showing big differences in edge effect. The form is fair. Also remaining on this site some *E. astringens*, which is highly variable, with the form generally poor, but some trees with very good biomass for the site. This species is now self-seeding around the edge of the plot. Some *Casuarina obesa* remains, but survival is poor.

After assessing species introduction trials such as this one, INFOR selected three species for more intensive work in the semi-arid region: *E. cladocalyx, E. sideroxylon* and *E. camaldulensis*. More recent trials have included collections of open pollinated families for progeny testing of *E. cladocalyx* (best provenance to date Wirraburra), and *E. camaldulensis* (best provenance Lake Albacutya).

2. Caracas Farm.

A 5000ha farm in the 200mm rainfall zone near the town of Los Villos. The owner, Eduardo Collante provided an informative tour of his tree planting activities. The farm has extensive plantings of *Atriplex nummularia*, as well as commercial plantings of *E. globulus* and 12 ha of *Acacia saligna.*

The *A. saligna* is planted at 4 x 1.5m spacing, with two rows of *Atriplex* in between. Site preparation was good, with all sites ripped to 60-70 cm and then mound ploughed. The planting is now four years old and has achieved excellent growth, with most plants being over two meters tall, with good basal diameter. The survival is 93%. The *Acacia saligna* was planted as a forage plant, but the cattle here are extremely selective of individual plants, and will not eat any more that 5% of the plants. Sr Collante says the cattle will die of starvation in difficult years and still not browse the remaining plants in the *A. saligna* plantings.

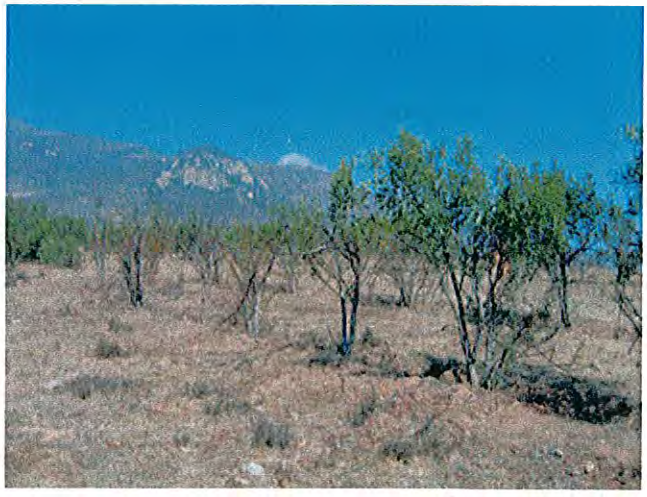


Photo 1. Selective grazing of *A. saligna*. Caracas Farm.

This site was established with the Chilean land race of *A. saligna*. There is extreme variability between plants, none clearly representing any of the recently constructed 'forms' in Western Australia. Glaucous and subglaucous foliage is common, with many plants superficially resembling form 'cyanophylla'. Occasionally these plants would have a short broad foliage, a characteristic of the 'Tweed' variant. Bark characteristics on the largest plants were closest to the 'forest' form, but no suckering was seen. Many of the green plants have the branch architecture and weeping branch tips of the 'typical' variant.

Management of the plants was discussed with the landholder. He was not concerned that the plants were not being grazed (although he would prefer that they were), as the area allocated to them was a small fraction of the land area of the farm, they were providing protection and shade for stock and the land. Additionally, the landholder is eligible for substantial incentive payments to establish these plants, significantly higher than the cost of establishment, making the decision to plant financially prudent. It was noted that some plants had branches broken down but still attached, and in these cases the broken branches were grazed, but the remainder of the plant was not. Suggested experimenting with cutting or partially cutting and breaking some plants to explore if this desiccated material is more palatable to stock. Also discussed was the possibility of selecting seed from plants that had been grazed for future plantings. These trees will need fencing out from stock to be able to set seed, as grazing is heavy.

The farm has a long experience of growing *E. globulus*, with some plantings around the house over 50 years old. On low rainfall sites such as this the expected yield was about 10-12 MAI. This compares to an average yield in the southern part of the country of 25-30 MAI. This yield was still considered to be commercially attractive, and Sr. Collante had established an additional 50ha last spring, on a broad ridge between seasonal creek lines. The site was well prepared, deep ripped and mounded, and the trees received two waterings of two litres each time in January and February. Survival at 8 months was close to 100%, and growth was impressive for the site conditions.

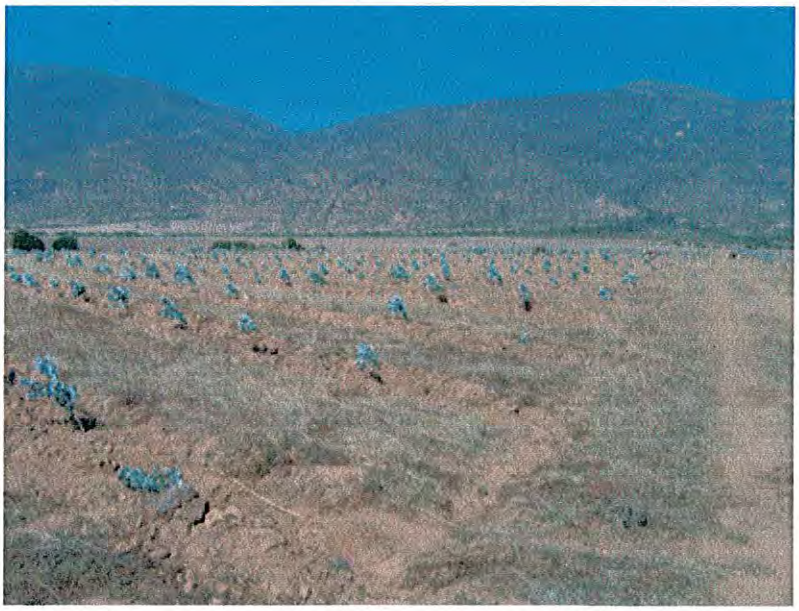


Photo 2. Eight month old Eucalyptus globulus in 200mm rainfall. Caracas Farm.

The farm also hosts a four year old INFOR *Eucalyptus cladocalyx* trial of 47 open pollinated families from 5 provenances. This trial has a twin at Valle Ilta (see below). The trees were arranged in randomised one tree plots across the site. The site was very poor soil and extremely dry, with little chance of access to ground water. It had been deliberately selected because it was the type of land commonly on offer from landholders for revegetation work. Despite these limitations of site, the trees were extremely healthy, with very good form, although there was significant variation between provenances.

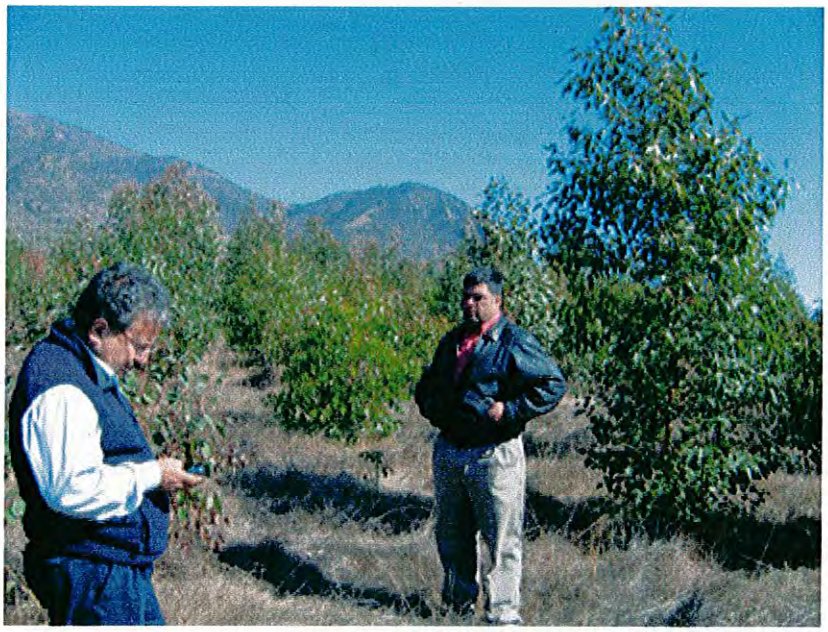


Photo 3. Four year old family and provenance trial of *Eucalyptus cladocalyx*. Patricio Rojas (left), Eduardo Collante (right). Caracas Farm.

3. Agua Armarilla Farm.

This is a large, sub-coastal, corporate farm just north of the town of Los Vilos. The rainfall is 200mm at most. The driveways are lined with old *E. globulus* and most of the grazing lands are rowed with *Atriplex nummularia*.

We visited an approximately 10 year old trial plot of *Eucalyptus cladocalyx* and *E. sideroxylon* growing on a dry sandy site. The *E. sideroxylon* was showing poor form and growth, although survival was good. The *E. cladocalyx* was variable, but included trees with good form and acceptable growth. Density was such that site capacity had probably been reached, and little change could be expected without silvicultural treatment.

Photo 4. *Eucalyptus sideroxylon* and *E. cladocalyx* trial site. Agua Armarillo Farm.

4. Cavilolen Nursery.

This is a private nursery operated by a forester, Carlos Bobadilla. Its production is around one million trees per year, of which about 800,000 are *Acacia saligna*. The trees are grown in small black plastic bags, approximately 25 x 75 mm x 125 mm when filled. The potting mix is soil from the local area with the addition of about 10% compost. Innovative simple equipment has been manufactured on site to facilitate bag filling, allowing one person to fill between 7-8000 bags per 12 hr day. The *A. saligna* seed is collected from a 25 year old plantation on the nursery site, from trees with dense canopies and heavy seed crops. Seed is hot water treated overnight, and sown at a rate of 4-5 per bag, and thinned later. The bags are packed together in shallow terraces, and flood irrigated. Despite the weight of the bags, they are dispatched to clients up to 200km away, in 75,000 tree lots by truck and trailer, each load weighing 14 tonnes.

Photo 5. *Acacia saligna* production from flood irrigated plastic bags. Cavilolen Nursery.

The nursery also produces *E. globulus*, and a range of native plants including *Schinus latifolius* and *Caesalpinia spinosa ("tara")*.

Photo 6. Grading *Eucalyptus globulus* seedlings. Cavilolen Nursery.

When I expressed surprise at the age and health of the *Acacia saligna* seed production trees in the nursery, the staff at the nursery pointed out lines of 25-30 year old *A. saligna* in the surrounding country side. Most of the trees in this area closest resembled the 'typical' variant.

While some inefficiencies in the operation of a nursery such as this may be apparent to outsiders, consideration must be given to cultural aspects such as employment and available capital. Any recommendations for improvement need to separate the production of healthy disease free plants, from the economic considerations that may dictate the use of labor and machinery in an Australian setting. A discussion about some of these aspects, such as elevated benches, soil hygiene and watering systems was held with my INFOR guide Patricio Rojas as we traveled between sites.

5. Valle de Ilta.

A provenance and family trial of *Eucalyptus cladocalyx* planted in 2001, in a 200mm rainfall. There are 47 open pollinated families, as well as two Chilean land races as controls. The trial is a randomised block, one tree plot design.

The best performance to date among the *E. cladocalyx* provenances has been Wirrabara (near Pt Pirie, SA). Intraspecific crosses in the *E. cladocalyx* have been created between the top ten performing families, selected on a genetic ranking.

Photo 7. Patricio Rojas with four year old provenance trial of *Eucalyptus cladocalyx*. Valle de Ilta.

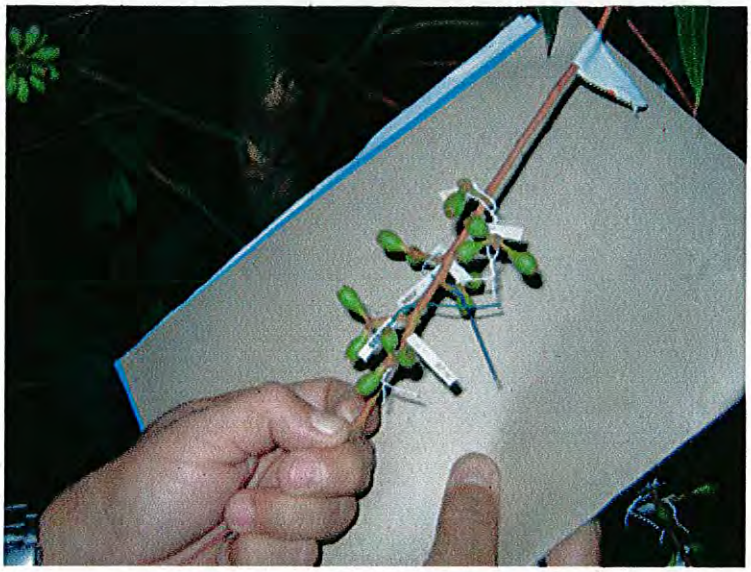


Photo 8. Maturing capsules on successfully pollinated intraspecific crosses in *Eucalyptus cladocalyx*. Valle de Ilta.

Good success was achieved in 2004 in producing *E. camaldulensis* x *E. cladocalyx* hybrid seeds. Seedlings of this material are being raised in the INFOR nursery in Concepción (500 km south of Santiago). Attempts to produce *E. cladocalyx* x *E. globulus* hybrids failed, but good success was achieved with *E. camaldulensis* x *E. globulus*, and *E. camaldulensis* x *E. grandis*. All were produced using the one step pollination technique (OSP). Select pollen for this project was obtained from Australia, in an agreement with ALTRIG/CSIRO to produce seedlings for the semi-arid zone. The project partners will receive some seed in exchange for the pollen supply.

6. Mincha Sur Community-demonstration planting, Canela.

This is a demonstration planting of 70 hectares of *Acacia saligna* and 80 ha of *Atriplex nummularia* established in 2001. It is in an area of 8-9 communities (See later notes under CONAF Illapel for an explanation of the community structure). The site was ripped prior to planting. It was planned for the development of technical prescriptions for plantation management. It had an additional role of building trust within the communities, a component seen as very important for CONAF.

The plantation was established at 1250 stems per hectare, which is too dense for the site, and limitations of site are now starting to thin it out. Locals report that the *A. saligna* commonly looks stressed at this time of year, but recovers well with the rain, which starts as early as May.

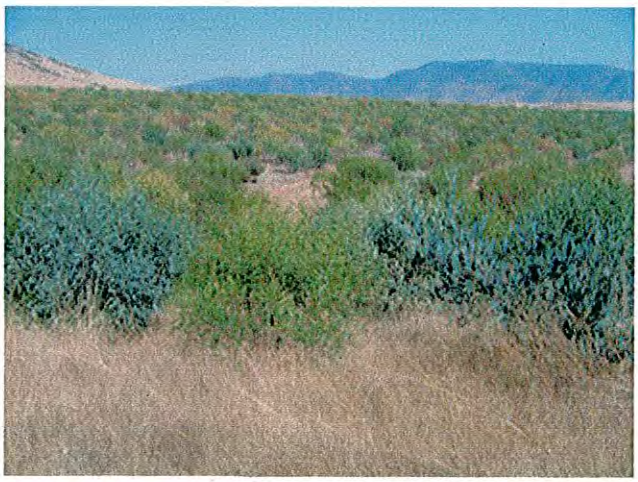


Photo 9. Variation in *Acacia saligna* seedlings, and scattered deaths at the driest time of the year. Canella demonstration plot, Mincha Sur.

The plantation was established using seed of the Chilean land race of *A. saligna*. As seen elsewhere, the plants are highly variable, and include forms not resembling any of the types identified in Australia.

Seed crops, inferred by the pods remaining on the plants, are commonly very heavy on these plants. Seeding is at the same time as in Australia.

There is work in progress experimenting with height of cut for harvesting *A. saligna*, at different times of year. The plants are typically 40-50mm diameter at ground level, and plots have been cut at three different heights (ground, 0.5m, 1.0m) at three different times of year (July, December and March). All are responding well, and landholders have not expressed a preference yet. Some coppice response was apparent from the most recent cut, after only twenty days.

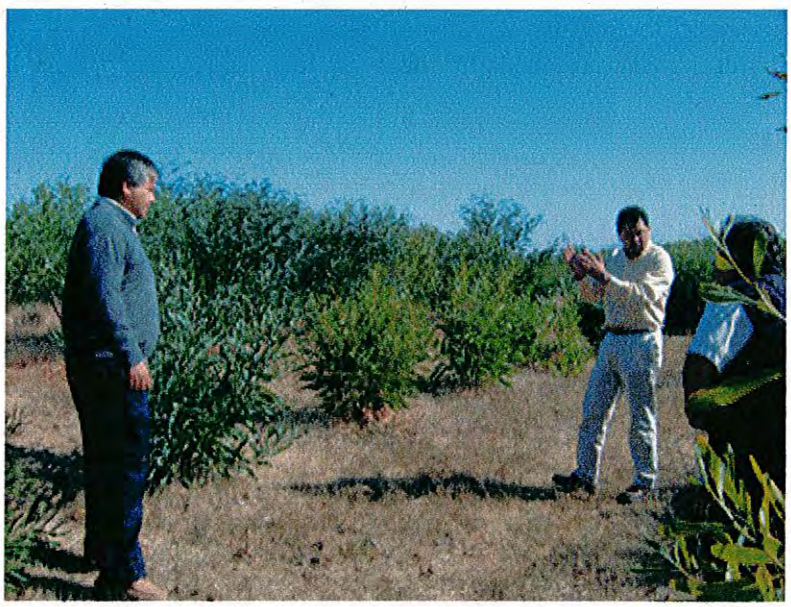


Photo 10. Coppice response in *Acacia saligna*. CONAF Illapel staff (left), Marcel Cerdo (centre), Patricio Rojas (right). Canella demonstration plot, Mincha Sur.

Photo 11. Coppice response in *Acacia saligna* twenty days after harvesting. Canella demonstration plot, Mincha Sur.

The *Atriplex nummularia* planting was upslope from the *A. saligna*. It was well established and looking healthy. *Atriplex* is considered to produce between 2-4 t of green matter per hectare per year under these conditions.

Photo 12. *Atriplex nummularia* plantings above *Acacia saligna*. Canella demonstration plot, Mincha Sur. "Living fence' of *Trichocerus* in foreground.

The surrounding countryside shows that prior to establishing these plots the surrounding hills were virtually bare of any vegetation, a result of a long history of overgrazing in an extremely arid environment.

7. Species introduction trial, Mincha Sur.

A trial of a diverse range of native and introduced species, also planted in 2001. The trees are in plots of 49 trees, at 2m x 2m spacing. The site was ripped prior to planting. The site was especially difficult, high in the landscape, with no conspicuous access to ground water or surface water flow, and outcropping granite suggesting shallow soil profiles. Despite these limitations, survival was good for most species, although growth rates were highly variable. *Acacia saligna* and *Acacia cyclops* were by far the best biomass producers on the site, followed by *Eucalyptus cladocalyx.*

The site also had a native senna, *S. candoleana, Prosopis chilensis (*Algorrobo*) Leucaena leucocephala, Atriplex nummularia, A. semibaccata, A. repanda* (a native sp), *Jubaea chilensis* (the Chilean wine palm), *Cassia closiana?* (Quebracho), *Caesalpinia spinosa* (Tara), *Trevoa quinquenervia* (Talhuen, a native species used for fuelwood*), Schinus latifolius*, and *Quillaja saponaria* (Quillay, historically, a very important native species, the high saponin bark was removed for soap production. Now, considered an important industrial product, with the whole plant cut and processed for saponin production. A large tree, attaining 20m height, recovers well from harvest with coppice growth. Much information about this species on the web).

Photo 13. Significant difference in growth rates between *Acacia saligna* (rear) and the native *Quillaja saponaria* (front). Canella species introduction plot, Mincha Sur.

8. Las Cardas Experimental Station

This is a 5400ha farm in a 120mm rainfall zone near La Serena. It is operated by the University of Chile's Faculty of Agricultural Science, and managed by Claudia Torres. The farm trials and develops selections of commercial plants for the semi-arid zone. There are breeding, selection, and production areas for jojoba, fig, capparis and pomegranate trees.

Acacia saligna is a recent addition to the research program at Las Cardes. Twelve hectares of land were prepared for planting last year, but most was not planted as it was considered there was insufficient soil moisture. A trial area of two ha was planted, in September, and this has achieved almost 100% survival after six months, and good growth.

Ground was prepared using a D8 to rip an inconsistent hardpan at 60-70cm depth, and then high mounded with a Savannah mound plough. (Like all *A. saligna* and *A. nummularia* sites, the plants were established among existing native vegetation, a mixture of low growing shrubs and grasses).

Alex Navarrete, a contractor working for the INDEF company performed the site works. He has significant experience in the high rainfall forestry area in southern Chile.

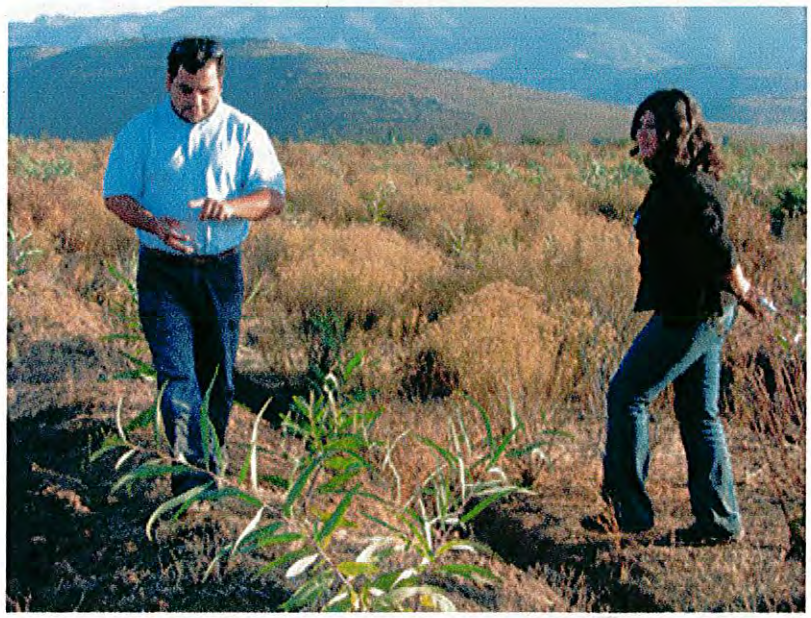


Photo 14. Alex Navarette (left) and Claudia Torres (right) with seven month old Acacia saligna planted on deep ripped, savannah mounded rangeland. Las Cardas Experimental Station.

Alex Navarrete has also leased a series of shade houses on the research station for seedling propagation. He growing 2 million *A. saligna* this year, as a 'trial', and intends to increase this to 3 million next year. The operation is very different to the Cavilolen nursery inspected the previous day, with plants in multi-cell foam boxes, and seedling soil volume probably around 25cubic centimeters. Plants were vigorous, healthy and nodulating well.

Photos 15 and 16. Acacia saligna seedling production area, Los Condes Experimental Station.

Of the other plants, the jojoba work is the most advanced, and ten high production clones have been selected and matched to different regions in the north of the country. The plants are selected for their productivity and salt tolerance, the latter because they are targeted at marginal soils. Production of this species is most important in the Copiapo area (Region III, north of this study area). Orchards of mother plants are maintained, and plants produced clonally, selling for about US$1 plus tax (now at 19%)

Photos 17 and 18. Jojoba production area. Cutting production on heated concrete floor (left) and select mother plants (right). Los Condes Experimental Station.

The farm has a collection of 123 provenances of *Atriplex nummularia*, (an assessment of which has been done at PhD level), as well as a 300ha plantation of this species for fodder production. Native species of *Atriplex* are grown here as well, but the Australian species is preferred, as it is seen to recover better from heavy grazing. The native species (*A. repanda*) also grows quite large, but tends to increase in diameter rather than height like *A. nummularia.*

Extensive studies have been carried out on *A. nummularia* here. These include looking at the effect on livestock (for example, feed value), utilisation of the plant (for example, part of plant used, effect of age of plant), and the effect on the environment (effect on native pasture species, effect on soil, nutrient and salt levels etc). Claudia Torres thesis on *Atriplex* looked at levels of nutrients, salts, pH etc in the soil, relative to the distance from the plant. The results show lower levels for most nutrients, and suppression of grasses under the plant, but increases in the area immediately surrounding the plant. The use of *Atriplex* as a broadscale grazing plant remains controversial in Chile, with some agricultural scientists arguing that the plant causes an unacceptable increase in surface soil salinity.

With age the *Atriplex* become large and woody, and reduce in value as grazing plants. The height of old plants can be a problem for animals accessing feed. The woody fraction is however highly regarded as fuelwood. The research station has an extremely high power bill as a result of their electrically heated concrete slab hothouses for clonal production of jojoba and other species. This situation lead to a discussion of the feasibility of using the biomass of *A. saligna* and especially *A. nummularia* for power generation via a small scale biomass plant, if something of an appropriate scale exists. Sra Torres is very keen to further explore this option.

9. El Tangue Community, Tongoy.

Ten kilometres from the coastal town of Tongoy, this is one of the largest communities in Chile, covering over 45,000 hectares. It is a well managed community of 250 people, 70 of who actively work for the community, including those in paid administrative and organisational roles. At EL Tangue, our guide was Sr. Tomás Cuevas , the Subgerente (manager) of the Community "Sociedad Agrícola El Tangue".

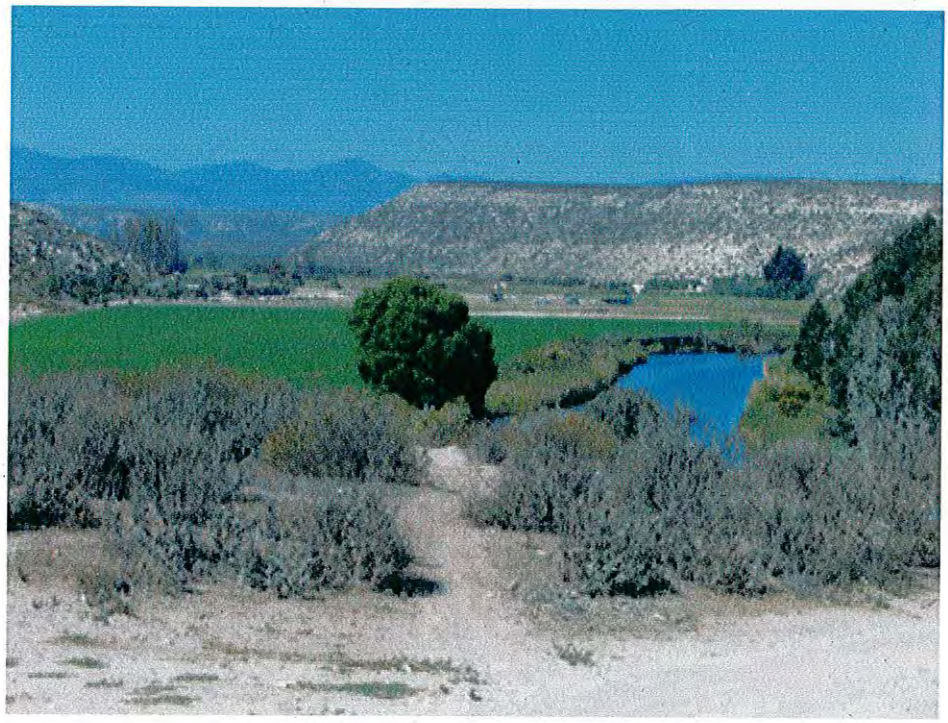


Photo 19. El Tangue. Well watered flats contrast with arid hills and plains.

Most of the land is extremely dry and harsh shrubland, but there are six valley systems with well-watered flats. El Tangue has cattle, goats, and a flock of 10,000 merino sheep for the production of export wool. They have 42 ha of vineyards for the production of red wine, with an additional 70 ha of white wine grapes going in this year. Small areas of horticulture and fodder crops are grown on the river flats. A gypsum mine operates from the property. The community operates its own basic (plastic bags in flood irrigated beds) nursery for the production of *Atripex, Acacia saligna* and *Caesalpinia spinosa*. They are producing around 600,000 plants for this years planting, mostly *A. saligna*.

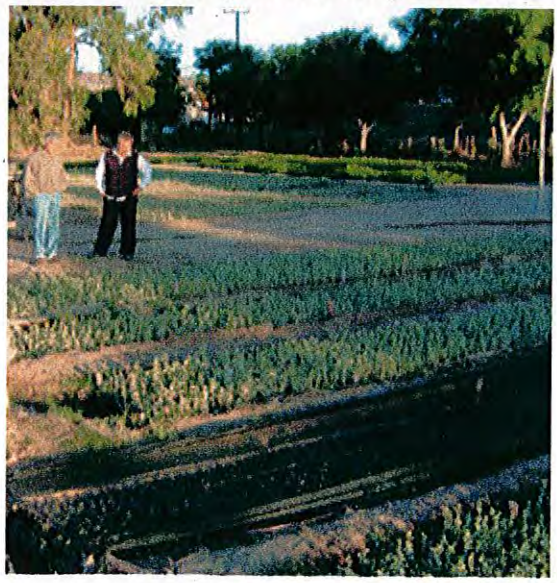


Photo 20. El Tangue community nursery.

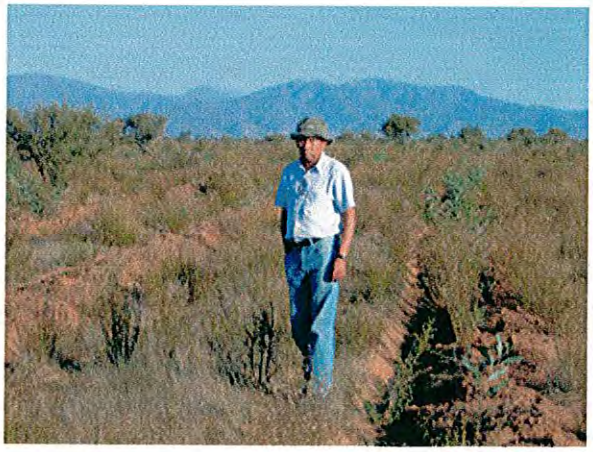
The property has planted 10,000 ha of *Atriplex nummularia* as a fodder shrub, including one single planting of 2000 ha. The first *Atriplex* plantings were done in 1983, and many of the early plantings are now too tall to be accessed by the sheep, a problem for the community. The plantings have provided an unbelievable biomass resource for this low a rainfall.

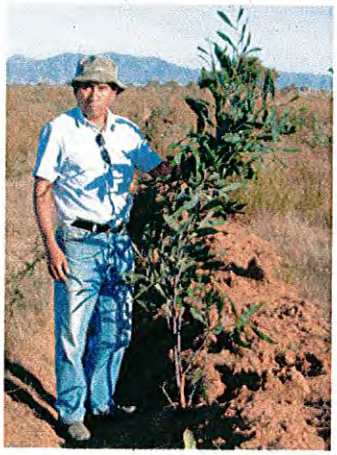
They have a long experience with eucalypts, with 50 years old plantings on the valley floors, and several species trial plots of different ages. Chile's first trial plantings of six species of 'palmitos' (palms cultivated for edible palm hearts) were being established on one of the fertile flats by INFOR when we were visiting.

The property now has in excess of 600ha of *Acacia saligna* plantation. We inspected a 200 ha planting of 3 year old *A. saligna* growing in sandy soils. These plants had been established from 'speedling' trays, although generally the community preferred to use the planting stock from plastic bags on sandier sites, equating these with a higher survival. The trees were planted in August, and received two waterings, a total of 3 litres per plant, in October and November. There were some plants showing signs of stress and yellowing, which I though was drought stress, but our guide attributed this to the activities of the 'Cururu', a small native Chilean mouse, that tunnels in the sandy soils and eats the roots. Certainly the population of these animals is healthy, as it was difficult to walk without the soil collapsing with every step due to their tunnels.

Photo 21. El Tangue. 200 ha of 3 yo *Acacia saligna*. Seventeen year old *Eucalyptus globulus* plot in the background.

A 375 ha *A. saligna* planting from August 2004 was inspected. There has been one rainfall event since planting, and a total of 100mm for the year. The survival is close to 100%, the soil is a sandy loam and the best plants are more than 1.5m tall.





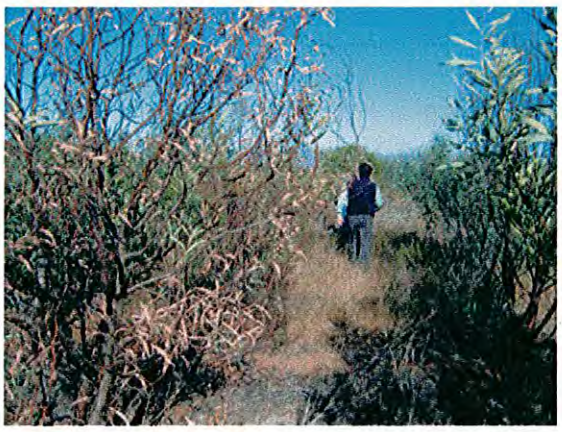
Photos 22 and 23. El Tangue. Tomás Cuevas with average and best 8 month old *Acacia saligna* seedlings.

An *A. saligna* provenance trial established in 1999 was inspected. This is one of two replicates, the other being at Cuz Cuz, further south from here. It was established as a silvo-pastoral trial for the Coquimbo region, to demonstrate the potential of *A. saligna* as a multi purpose species.

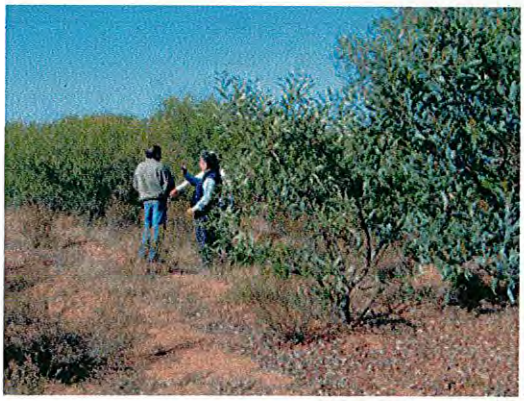
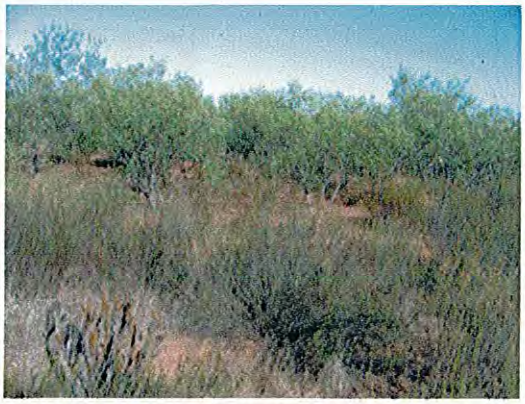
It is a randomised block design, at a 2 x2 m spacing, with three replicates of thirty plants (6 x5). It contains 14 Western Australian provenances, and 5 Chilean land race collections. (See Appendix for complete provenance list). The 'typical' form is well represented in the trial, with differences between individuals within a plot at least as significant as differences between provenances in most cases. There appears to be one 'Tweed blue' collection (Lake Muir). Some notes on individual seed lots follow:

Lake Muir. Huge variability between plants, may be explained if the collection is from the north side of Lake Muir where 'Tweed' co-occurs with 'forest'. Is expressing itself differently to what we see in WA, developing a longer leaf. The biggest plants are developing a crumbly bark, a characteristic not commonly seen in the land race in Chile. Survival is lowest with this provenance, and the trees appear to be now suffering drought stress and dying out.
Kelmscott. Despite its origin, this looks like 'typical', not 'cyanophylla'. Provenance details of this collection should be checked, as there does not appear to be any 'cyanophylla' in the provenance trial. Performance is acceptable, and consistent.
Moora. Small plants with yellowing foliage.
Greenough River. Small plants, poor condition.
Lancelin. resembles 'typical', or a green foliage 'cyanophylla'. Smooth grey bark. May be the 'coastal' variant from this location. Worth checking provenance data and ground truthing this collection. One rep (III) has plants that resemble 'tweed'. Contamination of seed lot or nursery?
Sanford. Very narrow foliage on some plants.
Murchison River. Low spreading and very healthy. The form of this provenance is preferred by the local people. Consistent, good survival.

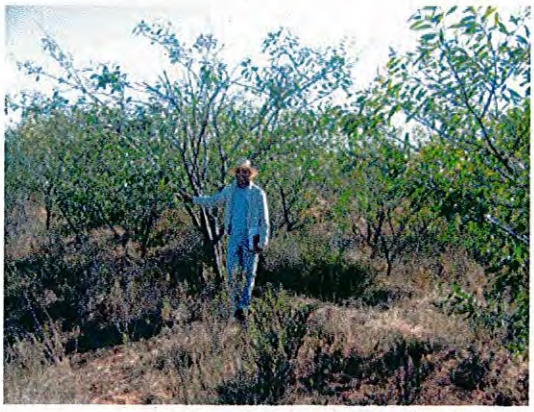
Adjacent to the provenance trial is a silvicultural trial, using the Chilean land race (also planted in 1999). The treatments were designed by CONAF, and based on added water, mulch and fertiliser. No significant differences were observed, and the genetic difference between plants was still much more significant.



Photos 24 and 25. El Tangue Acacia saligna. 'Muir' provenance. Some good growth, but poor survival and deaths starting to occur. Highly variable phyllode morphology.

Photos 26 and 27. El Tangue Acacia saligna. Left: 'Greenough' (rear) and 'Muir' (front)provenances. Right: 'Murchison' provenance.

Photos 28 and 29. El Tangue Acacia saligna. Left: 'Lancelin' provenance, showing highly variable phyllodes. Right: 'Mingenew' provenance.

A small planting of *A. saligna* planted in 1983 was inspected. It was difficult to believe that the planting was this age, and I checked a number of times, because it appeared as though it was about three years old. The site was very sandy, and the plants are effectively in suspended animation. None were bigger than 50mm base diameter, most plants about 2.5m high. The plants appeared healthy.

Generally, the communities experience of planting *A. saligna* has been good, their worst sites, and only failures have been on clay soils. The *A. saligna* was not being grazed. Sheep will not eat any of the plants at all, but this was not a problem due to the small area of the property it occupied. The financial incentive was sufficient to make the planting of these trees on marginal land financially prudent.

The property has various aged species introduction trials, dominated by eucalypt species. One 1982 planting on a deep sandy soil relatively high in the landscape had a mixture of *Eucalyptus camaldulensis, E. salmonophloia, E. torquata*, and *E. socialis*, (the only mallee species seen on this visit). The site also had *Atriplex nummularia* and *A. saligna*, still alive and looking healthy.

A similar site, same age but lower in the landscape (still dry and sandy) has *Eucalyptus spathulata*, looking remarkably healthy, and 5m tall, *E. salmonophloia* at a similar height but thin with erect form and heavy seed crops, and *E. gomphacephala*, with

variable growth, some very good. All healthy and carrying seed crops. Some healthy *Acacia cyclops* on this site also had a very heavy seed crop.

Several hectares of *E. diversicolor* have been established for over 50 years on the community, on fertile river flats in broad valley floors. The trees have reached diameters of 80cm or more, and have been harvested for timber. The coppice growth is now more than 20m tall, and very healthy. No silvicultural work is done on these trees and the stand density is quite high for timber production, averaging around 300 sph.

Photo 30. El Tangue. Coppicing *Eucalyptus diversicolor* on river flats.

El Tangue also has long established scattered plots or individual trees of *E. camaldulensis, E. globulus, E. salmonophloia, E. leucoxylon,* and *E. botryoides*(?) on the valley floor. All are growing well, all have been coppiced in the past, all have good seed crops.

Some interspecific hybrid work is also being carried out on the trees at El Tangue, including some crosses using pollen from CSIRO.

Photo 31. El Tangue. Coppice *Eucalyptus camaldulensis* used for hybrid work.

The palmito trial involves six species. They are being planted on good, alluvial, flat sandy loam site, which has been ripped and mounded. An irrigation system is in place, some plants are on drippers, others with sprinklers. The species in the trial are *Bactris gasipaes* (the major species grown for this purpose), *Archontophoenix alexandrae, A. cunninghamiana, Chamaerops humilis* and *C. humilis var microcarpa.* Amazingly, even in a trial of palms, Australian species show up. There are 315 of each palm in the trial, planted in three replicates, at a spacing of 2 x 1m.

Photo 32. El Tangue. Site preparation on river flats prior to planting trials for the production of edible palm heart species.

The level of interest, history of involvement, scale of property and professional approach to management shown at this community suggests they should be involved in any future development on this species for the region.

Other meetings with institutions and agencies

INIA Research Facility, Intihuasi, La Serena.

After meeting with the Director of the research facility, Alfonso Osorio Olloa, a brief meeting was held with Principal Researcher Dr Raul Meneses. Sr. Meneses has significant experience with the development of *A. saligna* for its fodder potential in Chile. He has given us a number of papers on this subject, including two that are in draft form. He is enthusiastic about the work, and clearly a keen observer of variation in the species, but is constrained by funding, access to which is highly competitive in Chile. International collaboration is viewed favorably in allocation of resources. Would be an essential part of any team if fodder assessment is a consideration.

INIA Research Facility, La Platina, Santiago.

A meeting was held with the sub director of research and development, Gabriel Selles Van Schouwen, who was enthusiastic about prospects of any collaboration. A meeting was then held with the biochemist responsible for the genetic work on *Acacia saligna*, Patricio Hinrichsen. He is still working on the development of genetic markers in a range of species (plants and animals), and is keen to be kept informed of any development in this area.

Later in the week a meeting was held with Carlos Muñoz Schick, from the same institute. Sr. Muñoz in an agronomist, and seems to be the chief genetic researcher for the Institute. He gave a detailed explanation of the evolution of government policy towards research, and was more optimistic about the future than other researchers. The government currently spends 0.7% GDP on research, but is committed to increasing this to 1% over the next 10 years. For success, research grant applications must have an industry partner willing to put up 25% of the cost in real (not in kind) funding. International collaboration increases chances of success greatly.

He stressed again the governments export focus, and how this favored research on high value irrigated crops such as horticulture. This research was seen to be at the expense of funding for projects on rangeland, or those designed to improve the sustainable management of small properties operated by poor farmers, often no bigger than 10-20 ha with 10-25 sheep, for example. This land use dominates the area between Santiago and the coast, and to the south of Santiago, into the coastal range above the central valley (a zone averaging about 600mm rainfall).

Sr. Muñoz reinforced my observations that Chile needs to be much clearer about exactly what they want the *Acacia saligna* for, before research proceeds. He gave as an example the cultivation of *Prosopis tamarugo* in the north of the country, where the government has supported the establishment of 30,000 ha of these trees as a fodder system. Early assessments of productivity over estimated the pod production and the use of the pods by the animals, which has proven to be minimal. This experience was followed by the establishment of 70,000ha of *Atriplex nummularia*, which again is only being selectively grazed by animals. *Acacia saligna* is the latest crop, and again is being left almost untouched by stock, despite its promotion as a fodder plant.

Despite (or perhaps because of) these shortcomings, Sr. Muñoz is keen to work on resolving the genetics of the Chilean land race and is keen to see the work we have done on the genetics of this species to date. He is also interested in the work being performed at the CRC in Perth on the native herbaceous leguminous perennials.

CONAF, Illapel.

This regional CONAF office has seven staff, servicing a population of 30,000, from the town of Illapel (18,000 people). The provincial head, Marcelo Cerda, (similar position to a CALM District Manager?) and his staff presented a detailed and informative introduction of the role of CONAF in the Choapa province. It provided a good explanation of the interaction between the cultural and social considerations and government agency aspirations.

Four hundred hectares of *A. saligna* was planted in this province last year, and is increasing each year, with total plantings in the Choapa Province now 790 ha, accounting for some 20% of revegetation in the province. Most is planted by small landholders as a forage crop for goats. The government provides a subsidy of 500,000 Chilean pesos per hectare (about $1100 AU), substantially above the cost of establishment. This level of subsidy was available in the past to establish *Atripex nummularia*, but is now at a reduced rate for this species. There is 3000 ha of *A. nummularia* established in the same area.

Much of CONAF's revegetation work is with the agrarian communities, an organisational structure that is a legacy of Spanish rule in the past. Some of these communities manage significant parcels of land. In this province they are up to 30, 000 ha, with some in northern areas even larger (for example El Tangue). There are 25-30 communities in the province. Land within the communities is divided into three classes.

1. An allocation for individual community members to use for house and garden, usually about 0.5-1 ha. This is called in Spanish 'Goce singular', a 'single possession'- your own piece of land.
2. Small parcels of land that community members can apply for to use for a project of their own, usually 4-12 ha. Called in Spanish 'Lluvia', translates as 'rain'.
3. The remainder of the community ground, usually common grazing lands. In Spanish this is the 'Tierra común', the 'common land'.

CONAF works with both type 2 and 3 lands in the communities. The public agency INDAP will lend money at low interest rates to landholders for projects on these lands.

The office maintains administrative and technical records electronically, with a comprehensive paper file back up. Field records are on ArcView, by species and farm. This information is overlain on a topographic map, important in this mountainous country, and allows easy access to information on planting date, area per species, etc.

The planting subsidy scheme is governed by law (DL 701, designed to stimulate reforestation). The scheme is open to all land owners, small and large, private and corporate. Target areas are determined by a national mapping program which has Chile broken into 8 land classes, based on soil type and topography. Land classes 1-4 are reserved for different classes of agriculture, class 5 is for grazing, classes 6-7 are for forestry and type 8 is for environmental protection.

Nominal costs of establishment for different species, determined for the whole country, are listed on a table. Subsidy rates vary with species, to encourage planting. For example, *Atriplex* is subsidised at 0.8 of cost, *A. saligna* at 1.3 times cost, and some native species at twice the cost of establishment.

Plants are established under a CONAF / Community / INDAP agreement. INDAP are involved because *Acacia saligna* is still considered more of an agricultural crop than a forestry crop. The relationship between departments is good, but conflict can arise when annual programs do not match, for example this year the funding provided by INDAP was insufficient to fund CONAF's target planting area. The landholder fills in an agreement form and applies for funds, INDAP provides the funds, and CONAF provides technical assistance, such as determining species suitability, spacing, density, etc. Where CONAF does not have the staff their role in this agreement can be performed by a contractor or consultant through an open tender process, and the work overseen by CONAF. CONAF will still manage all data for the central database.

Landowners must pay the up front cost of establishment (this money can be borrowed from INDAP). An inventory of costs and survival counts of the plants must be presented to CONAF for repayment of costs. The payment is determined by the density of plants per hectare multiplied by the survival count. Landholders are responsible for the survival counts, but are subject to random inspection by CONAF staff for verification.

The subsidy scheme has three stages:
1. Proposal. All technical aspects must be covered in the application. This application must be completed by an agriculture or forestry specialist, and will often be completed by the contractor negotiating with the community to do the establishment work. This application is checked by CONAF, and either accepted or rejected.
2. Implementation.
3. Review. On the first of April of each year landholders must submit a report and survival count. The work performed must be consistent with the original application. CONAF will re-inspect the work and will accept or reject it. If the report is accepted, the payment is adjusted for the percentage survival.

CONAF, La Serena.

A meeting was held with the Director of CONAF for Region Four, Waldo Ernesto Canto Vera. This role is similar to that of a Regional Manager within CALM. Sr Canto is supportive of an increased role for *Acacia saligna* in the region.

University Del Mar, La Serena

The Director of the School of Agronomy of this northern University, Jorge Carrasco Contraras, attended the talk in La Serena. He was enthusiastic about the potential of *Acacia saligna*, and had made interesting observations about the differences in palatability of seed from the species, as demonstrated in preference by browsing animals. He was not aware of the potential of *A. saligna* seed as a human food, and is very keen to pursue this avenue.

The potential for human food has not been realised in Chile yet, and the scope for this product is probably much greater here than it is in Australia. Small scale poor farmers, who could potentially make good use of an additional cash crop and/or a dietary supplement, inhabit much of the area where the trees are being planted. Additionally, the *A. saligna* here commonly carries very heavy seed crops, even in the driest regions, and on small plants. Sr Carrasco and/or Proffesor Montenegro (see below) may be well placed to conduct further research on this area, especially on the Chilean land race.

Catholic University of Chile

Professor Gloria Montenegro rules over the School of Botany at this well regarded University. She is part of the international working group on Mediterranean ecosystems (with for example, Richard Hobbs). She has published extensively, including work on the role of lignotubers in the native flora, and the sustainability of different harvesting methods for sustainable production in native plants, both from a theoretical methodology perspective and a hands-on field and market approach. Some examples of this work are included in the appendices of this report. She has worked extensively on screening native plants in Chile for chemical compounds and pharmaceutical potential. Her laboratory has a commercial chemistry operation screening honey production in Chile for certification for the international market. She has a strong interest in the use of native flora, both modern and traditional, but firmly sees her work as science, not ethnobotany. Additionally, Professor Montenegro sits on a government technical reference committee, screening projects for access to funding (CONYCIT). She has agreed to review any proposal for joint agency work on *A. saligna* to help speed its path through government approval.

Professor Montenegro has generously offered the use of her laboratory facilities for any collaborative work. They have histology and anatomy laboratories for morphological and taxonomic analysis, as well as scanning electron microscopy and gas chromatography labs.

Associate Professor Miguel Gomez, a botanist and taxonomist is available in this same department to assist should Professor Montenegro be unavailable.

Dr Carlos Magni D. of the same University was party to the discussions with Carlos Mùñoz (above). A geneticist and very keen to help unravel the mystery of the Chilean land race of A. saligna. Is with the School of Forestry, has recently completed his PhD in tree breeding, in France.

Abbreviated contact list

INFOR

Sandra Perret Duran. Regional Manager, La Serena. Now managing the target region for *A. Saligna* planting in Chile. Principal author of the INFOR monograph, and other papers on the species. sperret@infor.gob.cl

J. David Campos Roasio Responsible for the Santiago Region. Responsible for significant developments in Chile's forestry history, including the formation of INFOR. Host and organiser of the visit. Well connected with other agencies, making visits and access very easy. Santiago. dcampos@infor.gob.cl

Patricio Rojas Forester, translator, guide, driver and negotiator for smooth field visits and bargain accommodation. This study would not have been possible without Patricio's efforts. He has broad experience in other agencies and in the private sector, both in the office and in the field. Has spent time studying in Australia. A brief background is appended to this report, as any collaborative venture between Australia and Chile would be foolish not to take advantage of his skills, should he be available. Santiago. parojas@infor.gob.cl

Susana Benedetti Forester. Manager of projects at INFOR. Has significant research experience with *A. saligna*, especially as a component in forage systems. Also a key contact for work on the database of research sites and references. Santiago. sbenedet@infor.cl

Germain Ortiz Economist working with INFOR. Has recently returned to Chile after working with the New Zealand Forest Research Institute for 8 years. Santiago. gortiz@infor.cl

CONAF

Waldo Ernesto Canto Vera. Director of CONAF Region IV, where most of the *Acacia saligna* work is being conducted in Chile and very supportive. Closest equivalent would be that of a CALM Regional Manager. Office in La Serena. wcanto@conaf.cl

Marcelo Cerda Berrios. In charge of the Illapel office of CONAF, closest equivalent is that of a District Manager in CALM. Knowledgeable and keen, in a region with substantial interest in *A. saligna*. Office in Illapel, in the Province of Choapa. mcerda@conaf.cl

INIA

Dr. Garbriel Selles Van Shouwen. Agronomist and Sub-director of R and D at the La Platina research facility. Supportive, based in Santiago. gselles@platinainia.cl

Alfonso Osorio Olloa Director of the Intihuasi, Research Facility. La Serena. Supportive of his institutes role in the analysis of A. saligna potential.

Dr Raul Meneses. Principal Researcher. Intihuasi, Research Facility. La Serena. Substantial research published on fodder value of *A. saligna,* keen for collaboration.

Dr Carlos Muñoz Schick. Agronomist and genetics researcher at La Platina research station. A key genetics research contact. Santiago. cmunoz@inia.cl

Dr Patricio Hinrichsen R. Biochemist and genetics researcher, La Platina research station, Santiago. Very keen to work on untangling the genetics of *A. saligna*. phinrich@platina.inia.cl

UNIVERSITIES

Professor Gloria Montengro. Professor of Botany at the Catholic University of Chile. President of the Latin American Botanical Network (RLB). Santiago. A wealth of global experience, valuable ally. rib@uchile.cl and gmonten@puc.cl

Miguel Gomez. Associate Professor of Botany at the University of Chile. Botanist and taxonomist.

Claudia Torres. Manager of the University of Chile's Las Cardas Research Farm in Region IV. Enthusiastic about developing new commercial crops for the semi arid zone. Very interested in biomass potential. Large property and good support for trials. Near La Serena. ctorresp@uchile.cl

Dr Carlos Magni D. PhD in genetics, Forester. Department of silviculture, Faculty of Forest Science, University of Chile. Keen to be involved in the untangling of the genetic confusion of the Chilean land race of *A. saligna*. Santiago. crmagni@uchile.cl

Jorje Carrasco Contraras. Head of the School of Agronomy at University Del Mar. Interested in use of Acacia seed. La Serena. jcarasco@udelmar.cl

Other useful sites and locations

http://www.infor.cl/ciacef/
CIACEF is the Centro de Información de Experiencias de Adaptación y Crecimiento de Especies Forestales de Chile. Centre for consideration of species introduction. This data base holds all the information on trial sites in Chile. Data can be searched for by geographic region, species or type of trial. Trial sites are linked to any reports on the work.

http://www.meteochile.cl/climas/climas_cuarta_region.html
(Dirección Meteorológica de Chile). Has climatic data for Region Four.

http://www.ciren.cl/index_ingles.html
CIREN is a public agency, and one of the best information centres on natural resources of Chile (soil maps and classification, agriculture resources, land available, forestry resources, etc). The information is in English and products (digital maps and reports) are available for sale.

General discussion.

The sites visited in north-central Chile demonstrate the importance of evapotranspiration rates in WA, as a component of moisture balance. This is the only explanation I can provide for the Chilean's ability to grow *A. saligna*, let alone *E. globulus*, in dry soils in a 200 mm rainfall zone. The maritime mist must be compensating for the lack of soil moisture. This is reinforced by the maps in the *Acacia saligna* monograph showing the areas suitable for its cultivation, which limit its range to the provinces adjoining the coast.

The Chilean land race does not resemble any specific form of *A. saligna* in Western Australia. It is a complex mix of highly variable plants. There is some `blue´ material from Tweed (most likely) or cyanophylla in the brew, but mostly the influence is the typical form. Suckering is almost non existent (one very old plant at El Tangue may have had a few suckers around it). This suggests little influence of the forest form, which is probably not important, as it has low fodder value and a high rainfall distribution.

The low incidence of grazing of the Chilean land race of *A. saligna* is difficult to explain. It is possible that the other feed on offer from the grasses and shrubs that they are planted among is adequately supplying the animals diet, and there is nothing special that they need in the *A. saligna* that overcomes their aversion to the low palatability. This does not explain the observations at Caracas farm, however, where the animals will lose condition rather than browse the *A. saligna*.

The profitability of *E. globulus* in Chile is evident in its ability to compete for space on the limited, prime horticultural land of the broad river valleys that dissect the semi-arid zone. They are competing with vineyards, avocado and other fruit trees, and vegetables

Plant production facilities are highly variable in Chile. *A. saligna* is commonly grown in soil gathered from the adjoining area, in small plastic bags, packed into holding ponds dug into the earth and flood irrigated. Other nurseries were seen using small containers ('speedling'trays), open potting mix, elevated benches and sprinkler watering. Differences are dictated by cultural beliefs, capital and differences in observed performance on different sites, soil types, availability of site preparation equipment etc.

The agrarian community structure in Chile may create an opportunity for long term production of high quality saw log material. A permanent on site labor force is a key component of this. This will require careful species selection and a well planned silvicultural prescription. This work is not apparently being performed in Chile, at least not in the northern areas.

What is in a Western Australian-Chilean collaboration for Chile?

1. Access to additional or improved genetic material.

Chilean forestry is dominated by Australian species, in all rainfall zones.

Acacia saligna. Chile seems keen to continue with trial work to improve the use of this species. Including some selections from the `cyanophylla´ should be considered. Particular northern provenances, for example Murchison River appear to perform well in Chile. Consideration could be given to a family trial of this provenance. This should be planted with good separation from other plantations, to preserve its potential as a seed production area if performance is satisfactory.

Chile needs to be clear about the reasons it is cultivating *A. saligna*. It is being promoted as a fodder crop (as part of a multi-purpose species approach), but the plants are not being grazed. Data collected by INIA suggests that the fodder values are very low, with digestibility barely above 40% (Meneses and Flores, 1999). This is lower than the data collected in Australia (George. pers comm.). There is scope for collaboration on selecting lines of plants for digestibility, protein and palatability. Chile may wish to monitor the pending work on fodder values in Australia, and use this data to guide and improve selections.

If biomass production is the aim, there is ample well adapted, healthy material to select from in the land race that could be selected into seed production areas.

Tree species. The wide spread distribution of *E. globulus* in Chile, in regions with rainfall as low as 150 mm suggest good scope for other eucalypts here. Public perception is that *E. globulus* is the tree to grow, and it is used extensively in the round, as fuelwood, and as a small landholder crop for woodchip production. This cultural perception will take time to address.

I believe there is very good scope for sawlog production from the small, well watered valley floor areas of Region Four, especially among the communities. Provenance trial work is underway with *E. cladocalyx*, but it is being restricted to extremely marginal sites, on degraded soils high in the landscape. Despite these limitations, the species is showing good form, and in some situations good rates of growth. Shifting species such as this to positions lower in the landscape should produce excellent results, based on the growth of *E. globulus*. David Bush visited Chile from Australia last year and recommended the introduction of *E. tricarpa* and *C. maculata* for trial work. I agree that these could be excellent candidates for development.

Other species that may be considered are:

E. astringens	Observed in Longotoma species trial, thirty plus years old. Variable growth, but some very good size. Other mallet species such as *E. argyphaea* may be considered as well.
E. occidentalis	Apparently tried in the past with limited success. None seen. I think worth revisiting, some low landscape areas close to the coast with potentially brackish ground water may be very suited.
E. gomphocephala	Seen in species trials at El Tangue, showing good size and health, but only average form. Provenance and site selection may

	improve performance of this species for the alkaline sandy sites near the coast.
E. wandoo	consider trialling for better sites currently occupied by *E. cladocalyx*, to produce a dense wood for fuel and construction.
E. accedens	as above.

This list can be expanded.

Mallee eucalypts One small trial plot of *E. socialis* seen at El Tangue trial site. The mallees are under represented in the eucalypt collection in Chile. As much of the demand for timber is small roundwood and fuel wood, and many of the sites available are high and dry, they should be considered for trial work. Growth rates can be expected to be slower, but timber strength and calorific value will be higher. A list of species for trial could be prepared for consideration by INFOR, as part of a collaborative working arrangement.

Pinus pinaster. This species was tried in the past but abandoned because of poor form. Sub coastal sandy areas may be suited to this species, and consideration could be given to re-evaluating with improved seed material, developed in Western Australia, if available.

2. Collaboration on biomass utilization

Atriplex already forms an enormous underutilized resource in Chile. The native *Prosopis tamarugo* is apparently the same in the northern part of the country (not seen this trip). Many of the plants are now overgrown and of little use for grazing. The current accelerating rate of adoption of *Acacia saligna*, coupled with its non-palatable status is likely to see it head the same way. Chile may choose to assess the feasibility of using this biomass (from introduced plants) for other commercial purposes. Experience has shown that *Atriplex* recovers well from hard grazing, but the response to harvest would have to be assessed.

A potential approach may be to chip and separate the material into woody and fodder fractions, to produce stock feed and fuelwood, as is being considered in Western Australia. Chile has no fossil fuel reserves, and relies on supplies of natural gas from neighboring Argentina for electricity generation. The reliability of this supply has been questioned recently in the face of increasing industrialisation in Argentina. The Las Cardas Research station or the El Tangue community would both be appropriate places to trial small-scale operations.

What is in a Western Australian-Chilean collaboration for WA?

The apparent extremely low palatability of the Chilean land race may be worth experimenting with, for a biomass crop that does not need fencing in broad spaced alley plantings. Chilean researchers attribute this quality to the presence of tannins.

Are we using the OSP technique to produce improved material, for example in the oil mallee seed production areas? Although laborious, the technique may have application. Chile has good experience in this area.

Some aspects of the administrative systems for funding revegetation work are worthy of review, for example:
Linking revegetation payments to quality of work and survival.
Low interest loans for landholders to establish revegetation plantings, with the prospect of this money being recovered in less than a year if the job is well done.

The commonly held belief that *A. saligna* needs to be cut to maintain its vigor will see extensive cutting trials, both formal and informal performed in Chile. While such data will not be directly transferable to Australian conditions, generalised data may be useful for guiding our work.

Australia and Chile are both working on the genetic analysis of the variation in this species. Breeding programs and analytical work can almost certainly be performed in Chile at lower cost than in Australia. This may be a consideration in assessing the worth of a collaborative research program for this species.

The database CIACEF is very good, and user friendly. Do we have a similar system to coordinate all our trial sites? If not, can we do a deal on the software to save some time and money?

References

Meneses, R and Flores, H. 1999. Evaluacion de *Acacia saligna* como forraje suplementario de caprinos de reemplazo y adultos en el ultimo tercio de preñez y lactancia. Agricultura Technica. 59(1).

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Perret D, S., Delard R, C., Mora P, F and Jara M, R. 2001. Monografia de *Acacia saligna* (Labill.) H. Wendl. Especie multiproposito como alternativa silvopastoral para las zonas aridas de Chile. INFOR, FDI, CORFO. Santiago de Chile.

Sudzuki, F. 1985. Environmental moisture utilisation by *Prosopis tamarugo*. In: *The current state of knowledge of* Prosopis tamarugo, 33-47. FAO.

Appendix

Diary of activities.

April 9, 2005.
PM. Arrive Santiago airport, travel to Hotel Foresta.

April 10, 2005.
Locate office of INFOR, Huérfanos 554, Santiago Centro.
Contact from Patricio Rojas to confirm meeting times for next day.

April 11, 2005.
AM: Meeting with David Campos, Chief of Central North Region, INFOR.
Introduction to Forestry in Chile, and INFOR programs provided by David Campos.
Leave for North Central Region with Patricio Rojas.
Visit Longotoma species introduction trial of eucalypts and casuarinas.
Visit pilot plantation of *Eucalyptus sideroxylon*.
PM: Visit Caracas farm, Los Villos, meet with landholder Eduardo Collante, tour plantations of *Artiplex nummularia, Acacia saligna, Eucalyptus globulus*, and a *E. cladocalyx* provinance trial.
Visit Agua Amarilla farm, inspect *plantings of E. globulus and Atriplex nummularia, and trial plantings of E. cladocalyx and E.* sideroxylon.
Visit Cavilolén nursery, producing *E. globulus, A. saligna, A. nummularia* and native species.
Visit Valle de Ilta trial site, provenance-progeny trial of *E. cladocalyx.* A collaboration between INFOR, ALTRIG (supplied pollen for hybrid work), and CSIRO (supplied open pollinated seed for progeny trial).
Travel Illapel

April 12, 2005.
AM. Meeting with CONAF province head, Marcelo Cerda and staff, Illapel.
Attend presentation of overview of CONAF work in the region, focussing on land use and socio-political basis for revegetation in the region. Discussion of operational proceedures and interaction between government agencies.
Inspect trial plots of *A. saligna* at Mincha Sur community. Discuss technical prescriptions and plantation management with CONAF staff.
Inspect species introduction trial with *A. saligna, A. cyclops, E. cladocalyx* and local species.
PM: Visit Las Cardas Experimental Farm, operated by the University of Chile. Meet with farm manager Claudia Torres, tour nursery areas for *Acacia saligna*, plant production areas for jojoba, fig, capparis and pomegranate. Inspect trial plantings of *A. saligna* and discuss site preparation prescriptions with contractor.
Travel La Serena

April 13, 2005.
AM. Meeting with Waldo Canto, head of CONAF Region 4, at CONAF office in La Serena.
Travel to INIA Intihuasi Research Station office, La Serena, and meet with INIA Director Mr. Alfonso Osorio Ulloa.
Meet with Principal Researcher Raul Meneses.

Present PowerPoint material on Search, mallee and *A. saligna* taxonomy to audience of CONAF, INIA and university people.
Meet with Jorge Carrasco Contreras, Director of School of Agronomy, Del Mar University, La Serena.
Travel Tongoy.
PM. Inspect plantings on El Tangue community, including *A. saligna, A. nummularia, E. globulus, E. diversicolour* and mixed species trials.

April 14, 2005.
AM. Inspect (Australian and Chile land race) provenance trial of *A. saligna*
Inspect silviculture trial of *A. saligna*.
Tour and identify long established eucalypt species around the community.
Inspect cross-pollination work for hybrid production with eucalypts.
Inspect site preparation and planting stock for INFOR trial of palm species.
PM. Travel Santiago.

April 15, 2005.
AM. Meeting and report of field observations to David Campos, INFOR office.
Work in INFOR library to access research publications on *A. saligna*.
PM. Visit INIA research facility La Platina, 15km south of Santiago.
Meeting with Patricio Hinrichson, biochemist responsible for the genetic analysis *of A. saligna* in Chile.
Meeting with Gabriel Selles Van Schouwen, subdirector of research and development for the La Platina research station.
Continue work in INFOR library.

April 18, 2005
AM. Meeting with David Campos, discuss program for remaining time in Chile.
Meeting with Susana Benedetti, Forester, in charge of projects for INFOR.
PM. Meeting with Professor Gloria Montenegro, and Assistant Professor Miguel Gomez, School of Botany, Faculty of Science, University of Chile.

April 19, 2005.
AM. Present PowerPoint material on Search, mallee and *A. saligna* taxonomy to audience of CONAF, INIA and university people at INFOR.
Meeting with Germain Ortiz, economist for INFOR.
PM. Meeting with Carloz Muñoz Schick, agronomist in charge of genetics at INIA La Platina Research facility, and Carlos Magni, forester and geneticist with Department of Silviculture, University of Chile.

April 20, 2005
AM: Meeting with Patricio Rojas to discuss and draft proposals for research work in Chile for further development of *Acacia saligna*.
Meeting with David Campos to discuss research directions and timing of funding for trial work in Chile.
PM: Work at INFOR on draft report for CALM.

Appendix

Draft ideas for research, prepared by P. Rojas and W. O'Sullivan after discussion in Santiago.

Potential research on *Acacia saligna* for the semi-arid zones.

- Assessment of genetic composition and origin of the Chilean land race, through comparison with data from the Australian forms.
- Determination of genetic correlation to favourable traits, as a precursor to development of a multiple purpose crops.
- Development of a tree breeding strategy for a multi-purpose tree crop (e.g. for fodder and biomass) through seedling or clonal material.
- Introduction into Chile of multiple family collections of provenances showing most promise (for example Murchinson River).
- Assessment of variation in biomass production between forms and individuals.
- Development of silvicultural prescriptions (for example: spacing trials, response to water, site preparation, coppice management, evaluation of provenance x site interaction).
- Evaluation of the protein, digestibility, tannin content and palatability of Australian and Chilean forms.
- Evaluation of yield of *Acacia saligna* as a component in mixed species forage regimes, under different site conditions.
- Exploration of the potential of seed production from *Acacia saligna* as a cash crop and food supplement, especially for small landholders.
- Evaluation of accumulation of soil nitrogen in *Acacia saligna* plantations.
- Evaluation of carbon sequestration by *Acacia saligna* plantations.

Sample technical proposal for a research project : Genetic assessment of *Acacia saligna,* as the basis for a breeding program for a multipurpose tree crop for the semi-arid zone of Chile.

There is evidence to suggest that the Chilean *Acacia saligna* land race is highly variable and composed of more than one variant or subspecies. This morphological and genetic variability may be affecting the palatability, as well as its use for other commercial and industrial products.

Therefore it is necessary to investigate the origin and the genetic composition of the Chilean land race. Once determined, it will allow the commencement of a breeding program for a multipurpose tree crop. An initial phase of this work would ideally see the introduction of family collections from each of the nominated forms in Western Australia, ensuring that such collections include material from those provenances showing best performance in Chile to date. The genetic assessment of multiple traits of progenies will support the establishment of, for example, clonal seed orchards and mother stock plants for seedling and cutting commercial production.

Potential research topics on mallee eucalypts in Chile

- Re assessment of old provenance and species introduction trials and experimental plantations in the semiarid zone of Chile containing mallee species (e.g. CONAF El Tangue).
- Assessment of results of similar projects developed in Chile (e.g., "Cidere Bío-Bío"program for the extraction of oil from *E. globulus* leaves) to learn from these experiences.
- Comparative analysis of bioclimatic regions between WA and Chile IV Region, for potentially suitable mallee species.
- Determination of use, and selection of mallee species for commercial purposes.
- Introduction of quality germplasm from WA for use in the semiarid region of Chile (seeds, pollen, vegetative material).
- Nursery trials of the mallee species selected.
- Plantations of species/provenances for trial on different sites.
- Assessment of silvicultural prescriptions for plantation development (spacing and layout trials, fertilizer trials and site preparations trials).

Sample technical proposal for a research Project : Species and provenances introduction of mallee eucalypts for the semiarid region of Chile.

The establishment of commercial tree crops for the semi arid zone needs to be preceded by the development of a new concept in forestry for Chile. Australian experience shows that multiple products can be produced from short-cycle coppice crops, grown in alley farming systems.

In Western Australia, mallee eucalypts are grown in belts of trees, up to ten rows wide, to gain hydrologic control in the landscape, and produce multiple products. These species are adapted to arid conditions, and have root systems able to access soil moisture. Sufficient growth to allow harvest is usually achieved after 4-5 years, with subsequent harvests at an interval as short as two years.

This trial proposes the introduction of a range of mallee eucalypt species to explore the potential of this group of plants.

Appendix

Curriculum Vitae

Patricio Rojas Vergara

Antecedentes Personales

Fecha Nacimiento	7 de Diciembre de 1954
Edad	49 años
Estado civil	Casado, 3 hijas
Idiomas	Inglés y portugués
RUT	7.202.766-3
Domicilio	Llano Subercaseaux 3229. Departamento 401. Santiago
Fono	02-5540466. Celular (9)0078973.
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Domicilio comercial	**BIOTEKNICA LTDA.** Agustinas 751. Oficina 44. 8 Piso. Fono 6390727.
Email	bioteknica@latinmail.com

Estudios Básicos y Medios

1966-1971. Secundarios. **Instituto Zambrano, Hermanos de la Salle.**

1972-1977. **Universitarios.** Ingeniero Forestal, Facultad de Ciencias Forestales, Universidad de Chile.

Estudios de Postgrado

1982	Curso de Silvicultura en zonas templado-frías. INIA. Pontevedra. Galicia. España.
1982	Análisis de Sistemas, ECOM -Universidades Chilenas
88	Congreso Brasileño de Biotecnología Forestal, Belo Horizonte
1988-1989	Maestría en Ciencias Forestales, Escuela Superior de Agricultura Luis de Queiroz, Universidad de Sao Paulo. Brasil.
1988	Diseños estadísticos para ensayos genéticos, U. de Sao Paulo.
1991	Curso corto de mejoramiento genético. University of Florida. Estados Unidos.
1994	Planificación Estratégica, Consultora. Anguita. Santiago.
1996-1997	Diplomado en Gestión de Empresas, Universidad Adolfo Ibáñez.
1996-1997	Diplomado en Administración de Empresas, Universidad de Concepción.
2001-2003	Programa de Doctorado. Higher Degree by Research. Plant Science Department University of Tasmania. Australia.

Becas

- **Embajada de España.** Dirección de Asuntos Exteriores. Curso de Silvicultura en zonas templado-frías. INIA. Pontevedra. Galicia. Octubre de 1982.

- **International Development Resarch Center (IDRC). Canadá.** Financiamiento programa de Maestría en Genética Forestal de E***ucalyptus***. Universidad de Sao Paulo. Brasil (2 años).

- **International Post Research Scholarship. Australia.** Financiamiento programa de Doctorado en Genética de *Eucalyptus*. University of Tasmania (2001)

Empleos

1978-1979. Contrato con INFOR para desarrollar proyectos de silvicultura relacionado con especies y procedencias de zonas áridas y semiáridas. El proyecto fue financiado por CONAF y las Naciones Unidas (PNUD).

1979-1983. Investigador del Departamento de Silvicultura de INFOR. Principales tópicos de investigación: ensayos de introducción de especies y procedencias de especies del género ***Pinus y Eucalyptus***.

1984. **Jefe de proyecto** de la actividad CONAF/PNUD/FAO/CHI76003 "Evaluación de ensayos de introducción de especies en la zona árida y semiárida de Chile".-

1985-1987. Jefe de Proyecto "Manejo silvicultural de especies del género *Eucalyptus*" financiado por **INFOR/CORFO** y compañías forestales. La principal responsabilidad fue planificar e implementar técnicas silviculturales aplicadas a especies de rápido crecimiento del género ***Eucalyptus : E. globulas, E. nitens, E. regnans and E. delegatensis.***

1990. **Jefe de Proyecto del programa de mejoramiento genético de INFOR.** Las principales actividades desarrolladas incluyeron la producción de plantas y el establecimiento de ensayos de progenies de ***E.. globulus y E. nitens.***

1990-1994. Profesor Asistente de la **Universidad de Concepción. Facultad de Ciencias Forestales.** Se diseñó el curso de mejoramiento genético forestal.

1994. **Gerente Técnico de CONAF.** Planificación estratégica de la nueva institucionalidad del Servicio Forestal del Estado. Participación Congreso Mundial sobre desarrollo sustentable. Nueva Delhi. India. Participación seminario "Perspectivas del cultivo del ***Eucalyptus*** en Chile". Tokio-Japón. Visita a Mito Station Centro de biotecnología y genética forestal.

1990-1997. Jefe del programa "Fibre Yield Improvement Program (FYIP) del grupo Santa Fe (Shell Forestry). El plan maestro consideró el mejoramiento del rendimiento y la calidad de la pulpa de las plantaciones de ***Eucatyptus*** de la empresa Forestal y Agrícola Monteaguila. Los principales trabajos desarrollados fueron : Producir plantas en vivero correspondientes a familias de polinización abierta para la plantación de ensayos de progenies (1) Diseñar y plantar 70 ensayos genéticos de terreno como : especies y procedencias, ensayos de híbridos, ensayos clonales, plantación de huertos semilleros de plantas de semillas y clonales (de injertos). (2) Cosechar semilla para los requerimientos del vivero incluyendo las, áreas productoras de semillas **(APS)** y huertos semilleros (HSS & HSC). (3) Cosecha de semilla en rodales comerciales de ***E globulus*** y ***E. nitens*** para venta. (4) Desarrollar un programa de estudios en tecnología de la madera incluyendo mediciones directas e indirectas de las propiedades físicas y químicas de la madera. Relación con la planta industrial de Santa Fe. (5) Iniciar un programa de investigación de biología reproductiva de ***E. globulus*** y ***E. nitens.*** Las principales actividades incluyeron fonología, procesamiento de polen y almacenamiento en laboratorio, polinización controlada en terreno. Los principales híbridos sintetizados fueron : ***E. nitens*** x E. ***globulus,*** E. ***nitens*** x ***E. camaldulensis,*** E. ***nitens*** x E. ***viminalis.*** (7) Promover intercambio genético (polen y semillas) con otras compañías extranjeras como FOSA(Uruguay), SAPPI & HLH(Sudáfrica), RIOCELL (Brasil) (8) Manejar un presupuesto anual de U$ 300.000 (9) Colectar, manejar y procesar una base de datos de diferentes

ensayos genéticos llamada GENETICA. (10) Usar la información genética generada (valores de mejora genética) para la depuración genética de ensayos de progenies y huertos semilleros (de semillas y clonales). (11) Entregar información al programa clonal para la liberación de clones operacionales a terreno.

1998-2002 **División Genética BIOFOREST S.A. Proyecto Genes de *Eucalyptus*.** Programa de Cruzamientos Operacionales de ***Eucalyptus globulus*** con Bosques Arauco S.A. Meta : 30 Kgs. de semilla de polinización artificial. **Proyecto Biología reproductiva y protocolos de hibridación de *Eucalyptus* (FONTEC N° 99-1754).** Cooperativa de Mejoramiento Genético-CRC University of Tasmania. Desarrollo de Híbridos experimentales de *E. globulus x E. gunnii, E. globulus x E. viminalis, E. globulus x E. nitens.* **Proyecto "Desarrollo e implementación de herramientas moleculares para la caracterización de material genético forestal". FDI-INIA-BIOFOREST-CMGF. 2001-2004** (Etapa de formulación del proyecto y aprobación de CORFO del proyecto).

2003-2004 **Gerente de BIOTEKNICA Ltda.** Comercialización de productos y servicios de biotecnología forestal. Representante de Arianda Pty. Ltd. Victoria, Australia. Consultor de INFOR y CONAF.

Giras y Seminarios

1986 **Visita a las principales compañías forestales de Brasil, Marzo 1986.** Visita a Klabin, Champion Cellulose, Aracruz e IPEF (Instituto Forestal Brasilero - Sao Paulo)

1991 **Meeting "Intensive Forestry. The role of Eucalyptus" in Durban, Southafrica, 1991.** Visita a compañías forestales SAPPI, HLH, ICPF.

1991 **Universidad de Florida, USA. 1991.** Entrenamiento corto en el paquete estadístico SAS.

1992 **IUFRO Meeting "Eucalyptus productivity. Principles of species introduction" in Pontevedra, Spain October, 1992.** Visita a las principales organizaciones de investigación forestal en España: Galicia, Navarra y Servicio Forestal de Barcelona (Cataluña).

1992 **Visita técnica a programas de mejoramiento genético forestal de empresas del sur de Brasil, 1992.** Klabin do Parana and Riocell.

1992 **IUFRO meeting "Resolving tropical forest resources concern through gene conservation, tree improvement and domestication of new species.** Cartagena, Colombia. 1992.

1992 **Pre-conference tour en Venezuela (Carton de Venezuela) y Colombia (Cartón de Colombia). SMURFITT.**

1994 **Workshop in New Delhi , India. Sustainable Forestry. Julio 1994**

1994 **Visita Oxford University.** Oxford, Gran Bretaña.

1994 **Seminario de Eucalyptus en Tokio, Japan. Organizado y financiado por Mitsubishi. Septiembre, 1994.** Visita al Centro de Biotecnología Forestal (Mito Biotechnological Forest Research Center)

1995 **CRCTHF-IIUFRO meeting "Eucalyptus plantations: Improving Fibre Yield and Quality". Conference in Hobart, Australia 19-24 February 1995.** Visita a los bosques nativos de *Eucalyptus* en Australia, incluyendo la distribución natural de *E.* **globulus** *y* E. ***nitens*** con investigadores del CSLRO. El recorrido incluyó los estados de New South Wales, Central Victoria and Tasmania.

2001-2003 **University of Tasmania, Plant Sciences. Hobart, Australia. (Febrero-Junio 2001).** Desarrollo del programa de doctorado. Estadía. Tema de tesis : Propagación de líneas híbridas F_1 de ***E. globulus***.

Algunas Publicaciones Técnicas

1979. **CONAF/PNUD/FAO/CRI-761003.** Una metodología para el establecimiento y análsis de ensayos de introducción de especies y procedencias.

1979. **Informe Técnico INFOR 86.** Supervivencia y crecimiento de especies del género ***Eucalyptus*** y ***Pinus*** probados en la zona costera de la región del Maule. **Chile Forestal. Junio, 1980.** Nuevas especies para la reforestación en Chile.

1980. **Informe Técnico INFOR 89.** Especies de ***Eucalyptus***, una alternativa de forestación en la 8va. región.

1980. **Informe Técnico 93.** Crecimiento de ***Eucalyptus*** y ***Pinus.***

1980. **IUFRO meeting "Fast growing species". Sao Paulo-Brasil.** Algunos antecedentes acerca de la introducción de especies del género ***Eucalyptus*** en la zona centro-sur de Chile".

1992. **IUFRO meeting "Eucalyptus productivity. Principies of species introduction" Pontevedra, España, Octubre.** Crecimiento y productividad de 4 especies de ***Eucalyptus*** en la zona centro-sur de Chile.

1993 Simposio CORFO/INFOR en Pucon. Noviembre,. **Primeros resultados de floración y producción de semillas de *E.* nitens. Primeros resultados de hibridación de *Encalyptus.***

1997 **Fibre Yield Improvement program of *E. globulus.* Santa Fe. Chile.** IUFRO Conference in Silviculture and Improvement of *Eucalyptus.* Bahía-Salvador. Brasil.

2004. **Híbridos de *Eucalyptus* de interés potencial para Chile.** Chile Forestal (en prensa).

Consultorías

GRUPO ARAUCO .

1987. Eucaliptos de interés económico para las compañías del Grupo Arauco : Forestal Celco, Arauco y Forestal Pedro de Valdivia. El

trabajo incluyó una revisión bibliográfica de aspectos de silvicultura intensiva para especies de rápido crecimiento.

FORESTAL ANCHILE. 1990. Silvicultura de especies de rápido crecimiento de ***Eucalyptus.***

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FORESTAL EL ALAMO. 1998. Preparación del proyecto FONTEC-CORFO "Desarrollo de la propagación comercial de clones de ***Populus, Eucalyptus*** y otras especies. **(Aprobado).**

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INFOR. 2004. **PROYECTO FDI/CORFO 9652.** Desarrollo de plantaciones forestales económicamente rentables con individuos resistentes al déficit hídrico y de alta productividad, en las zonas áridas y semiáridas de la IV Región Programa de hibridación de *Eucalyptus* spp.

Referencias Laborales

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3. **Dr. Claudio Balocchi.** Bioforest-Arauco. Email : cbalocchi@arauco.cl

Santiago, Jueves, 28 de Julio de 2005

Appendix

Dear Wayne :

We are at the moment preparing and submitting a research project for CORFO Grant related with ***Acacia saligna*** tree improvement program and multipurpose industrial uses (for next 5 years and probably starting by 2006). Deadline for presentation is July,20.

INFOR is interested to sign a joint research collaboration with your organization in the following topics so it would be nice if you can confirm the interest of CALM to go on with this :

a) to receive from CALM technical assistance on genetic test designs and seed orchards for different industrial uses (fodder, tannins, MDF and others).
b) to have regular consultancies visits/technical reports of a CALM researcher to Chile (every 2 years).
c) to provide native genetic material/information for a molecular analysis of ***Acacia saligna*** oriented to determine the genetic origin of the Chilean land race.
d) to supply improved genetic material of ***Acacia saligna*** (o.p. or control pollinated seedlings from CSO or clones)
e) to develop joint technical papers
f) to collaborate in a technical tour for INFOR research staff to visit ***Acacia saligna*** experiences (silvicultural, genetic and industrial uses).
g) to develop a joint research work on ***A. saligna*** industrial uses in a second phase.
h) to organize an international congress to be held in La Serena on 2010 about ***Acacia saligna*** experiences in Chile and abroad.

I am very interested to know in which activities your organization can participate and what is the estimated cost involved on this. It would be also nice if you can give your comments on these activities. We will be very grateful if your organization can confirm your interest on a joint research work INFOR/CALM and send to us the information required by the next week if feasible.

My best regards.

INNOVACIÓN PRODUCTIVA Y TECNOLÓGICA DE *Acacia saligna* PARA RENTABILIZAR Y DESARROLLAR NEGOCIOS EN LA IV REGION

1 ENTIDAD POSTULANTE Y ENTIDADES VINCULADAS

INFOR: EJECUTOR
INIA: COOEJECUTORA

Asociados

- CONAF
- INDAP
- ASOCIACION DE COMUNIDADES DEL LIMARI
- HACIENDA TALINAY
- HACIENDA HUENTELAUQUEN
- PROPIETARIOS PARTICULARES
- CEZA U. DE CHILE
- HACIENDA EL TANGUE

Subcontratos

- CEAZA (harina)
- CALM/Australia. Conservation and Land Management.
- U. de Chile – U. de Cordoba España (Bono carbono)

2 USUARIOS-BENEFICIARIOS

1 PYMES/INDUSTRIAS. Apoyar el desarrollo de nuevos productos industriales Pellets, fruto, harinas, heno, forraje, tableros, venta de bonos de carbono, taninos, entre otros) derivados del cultivo de *A. saligna* para diferentes sectores de la economía presentes en la IV REGIÓN, (Hacienda Caracas, Hacienda El Tangue, Hacienda Huetelauquen, Hacienda Talinay entre otras).

2 COMUNIDADES RURALES. Contribuir al desarrollo de la actividad productiva rural de la IV Región de Coquimbo, de manera de apoyar la transformación de la economía local, pasando de un estado de subsistencia a un estado de mayor competitividad. Beneficiar las comunidades rurales, pequeños propietarios, empresas agropecuarias y microempresarios de la industria láctea y de la carne (Comunidad Agricola de Cuz-Cuz, Asociacion de Comunidades del Limari, Comunidad Agricola Higueritas Unidas, entre otras).

3 ORGANISMOS PÚBLICOS Y SERVICIOS. También se verán beneficiados organismos estatales relacionados con el tema (CONAF, INFOR, INIA e INDAP) y otros agentes, como consultores y prestadores de servicios.

3 OBJETIVO GENERAL

- Fomentar el establecimiento de plantaciones comerciales de *Acacia saligna*, a través de su mejoramiento genético para incrementar la biomasa total, de manera de dar lugar a su utilización en nuevos negocios tecnológicos que hagan sustentable y rentable dichas plantaciones en la Región de Coquimbo.

4 OBJETIVOS ESPECÍFICOS

ETAPA I: Mejoramiento de la Productividad en Plantaciones de *Acacia saligna*

1 Diseñar e implementar estrategias de corto y mediano plazo para suministrar material genético mejorado de Acacia saligna a los agricultores de la IV Región para aumentar la productividad de las plantaciones comerciales.

2 Establecer las bases para el desarrollo de negocios tecnológicos que impliquen la utilización integral de las plantaciones de *Acacia saligna* basandose en la producción de fruto, forraje y madera.

3 Desarrollar protocolos de manejo silvícola para optimizar los resultados biométricos y los retornos económicos de las plantaciones de Acacia saligna mejoradas .

ETAPA II: Prefactibilidad Economica e Insdustrial de nuevos productos de *Acacia saligna*

4 Elaborar estrategias comerciales para los productos derivados de los negocios tecnológicos y promoverlos en el mercado nacional e internacional.

5 Diseñar e implementar un paquete de transferencia tecnológico. con especial énfasis en la aplicación del Mecanismo de Desarrollo Limpio, como instrumento para fomentar y mejorar la rentabilidad de las plantaciones de Acacia saligna.

5 ESTADO DEL ARTE

Acacia saligna se ha transformado en una de las especies arbóreas de mayor interés productivo para la IV Región del país, debido a su adaptación a una gran variedad de condiciones ambientales adversas (salinidad, escasa precipitación) con resultados favorables de supervivencia, adaptación y crecimiento.

Con el desarrollo de proyectos impulsados por CORFO (INFOR, 1998, proyecto FDI) y los incentivos estatales a la forestación con la especie, la superficie plantada pasó de 290 ha, en el año 1999, a más de 5.000 ha, en el año 2004, tornándose en la especie mayor plantada en el período actual.

Sin embargo existen dudas respecto del origen del material genético introducido desde Australia, ya que existen al menos 5 variedades con diferentes características de adaptación, crecimiento y producción dentro de las razas locales presentes en la IV región.

De esta forma existen variaciones importante en la producción de forraje y otros usos del recurso, por lo cual resulta esencial identificar el material genético (semillas) usadas actualmente en los programas de reforestación en la IV Región.

Por otra parte, recientes investigaciones desarrolladas por CALM (Conservation and Land Management-Western Australia) han prospectado nuevos usos industriales para la especie entre los que se incluyen la producción de taninos, tableros MDF y de harina comestible a partir de las semillas. Los tableros MDF presentan un potencial de mercado creciente y en el país se han establecido corrientes de negocios a partir de ellos.

Adicionalmente, la especie es una forrajera que aporta nitrógeno al suelo, mejorando sus propiedades nutricionales para su uso sustentable en la IV Región. Entre los negocios en perspectiva se encuentra además la venta de bonos de carbono y la producción de miel.

6 MÉRITO TECNOLÓGICO

- Plantas genéticamente mejoradas de *Acacia saligna*, las cuales no existen actualmente en el país. Implementación de un programa de mejoramiento genético que apunta al desarrollo de características descables:
  - Características de interés
  - Producción de biomasa por unidad hidrica utilizable: Resistencia a la sequía – Calidad forrajera.
  - Subcaracterísticas de palatabilidad, contenido de proteína cruda, digestibilidad (selección de individuos con menor contenido de taninos, etc). Estas apuntan al

mercado de la carne bobina, caprina (híbridos boers, FDI-CORFO), producción de quesos (productos regionales, identidad REGIONAL).

- Desarrollo de prefactibilidad productiva industrial de nuevos productos. Diversificar productos y servicios a partir de la biomasa de las plantaciones actuales y futuras de *Acacia saligna* en la IV Región. El desarrollo tecnológico apunta a los siguientes objetivos :

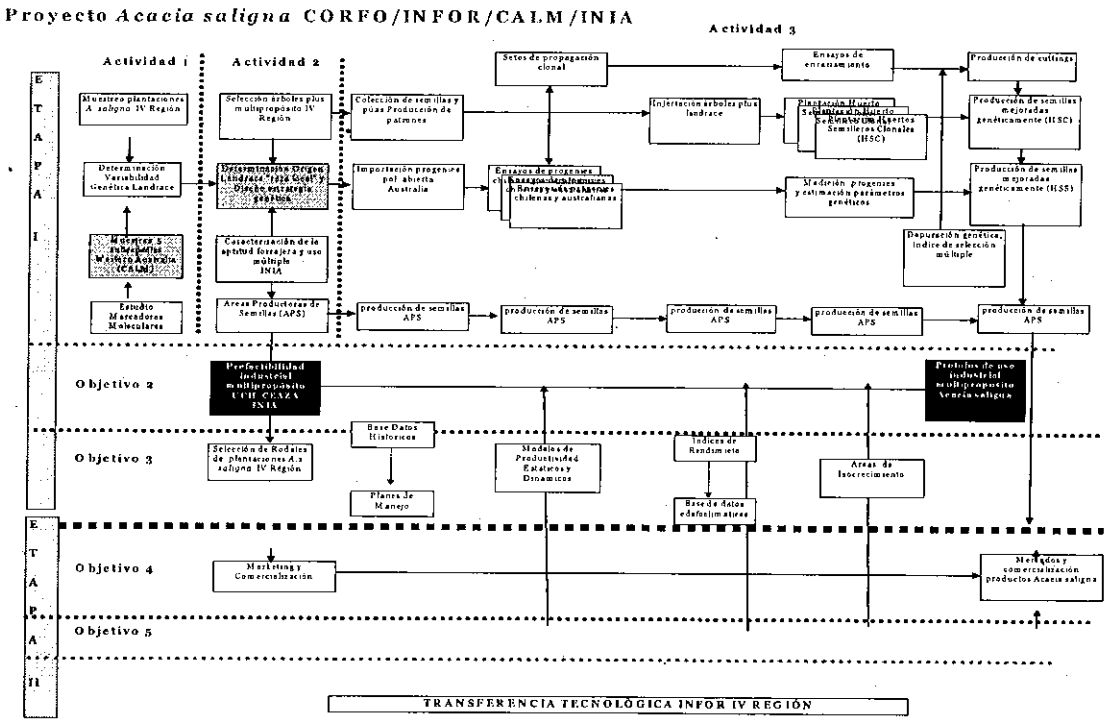
  - Tableros MDF, estudios desarrollados por CALM (proyecto Search) determinaron que las propiedades físicas, químicas y mecánicas de la madera de la especie la hacen adecuada para la fabricación de tableros MDF.

  - Taninos, la corteza de los árboles de esta especie fue usada en Sudáfrica como insumo de la industria del curtiembre antes de la plantación de *Acacia mearnsii* con este propósito. Selección de aquella raza local que presente mayor contenido de tanino y que no sea apta para forraje

  - Elaboración de harina a partir de semillas de *Acacia saligna* y otras especies del genero que puedan ser usadas como insumo en la industria del pan, en mezcla con otras harinas o para alimento de animales (maseotas)y forraje.

  - Bonos de carbono. Venta de bonos de carbono de las plantaciones actuales y proyección de la demanda en nuevas plantaciones.

- METODOLOGIA



Objetivo 1:

- Diseñar e implementar estrategias de corto y mediano plazo para suministrar material genético mejorado de *Acacia saligna* a los agricultores de la IV región para aumentar la productividad de las plantaciones comerciales.
    - Actividad 1: Analizar el origen genético de la raza local chilena de *Acacia saligna* para determinar su variabilidad en cuanto a la productividad forrajera y de la biomasa en la región.
    - Actividad 2: Establecer una estrategia que incremente el potencial genético de *Acacia saligna* a partir de la propagación sexual (semillas mejoradas genéticamente) y vegetativa (propagación por estacas de clones selectos) para aumentar la productividad de las plantaciones comerciales en las zonas áridas y semiáridas.
    - Actividad 3 : Establecer Huertos semilleros y clonales para la producción de material genético mejorado de *Acacia saligna* en la zonas áridas y semiáridas con individuos superiores seleccionados en función de su adaptabilidad, producción de biomasa y valor forrajero.
- Objetivo 2: Establecer las bases para el desarrollo de negocios tecnológicos que impliquen la utilización integral de las plantaciones de acacia saligna basado en la producción de fruto, forraje y madera
    - Actividad: Estudio de prefactibilidad industrial para la producción de tableros MDF, taninos, harina.
- Objetivo 3: Desarrollar protocolos de manejo silvícola para optimizar los resultados biométricos y los retornos económicos de las plantaciones de Acacia saligna mejoradas.
    - Actividad 1: Establecer pautas de establecimiento , cuidados culturales, espaciamiento , entre otros según los productos a generar.
    - Actividad 2: Generar modelos biometricos para predecir volumen de biomasa total y parcial (fruto, follaje y madera) en plantaciones de *Acacia saligna.*
- Objetivo 4: Elaborar estrategias comerciales para los productos derivados de los negocios tecnológicos y promoverlos en el mercado nacional e internacional .
    - Pruebas experimentales de productos, testeo en el mercado, difusion y promoción.

Objetivo : Diseñar e implementar un paquete de transferencia tecnológico. con especial énfasis en la aplicación del Mecanismo de Desarrollo Limpio, como instrumento para fomentar y mejorar la rentabilidad de las plantaciones de Acacia saligna

Actividades: Construcción del balance de carbono, diseño y evaluación de un proyecto MDL, Implementar tablas de costos de forestacion apropiadas para la región.

Chapter 5
Chile's forest products markets—a plantation success story[1]

Highlights

- Since the 1950s when Chile introduced large commercial plantations of radiata pine and eucalyptus, which span over 2 million hectares today, dependency on the native hardwoods has decreased dramatically.
- Roundwood production from plantation radiata pine is expected to double to 37 million m^3 in 15 years. With log exports being minor, 41% of harvest in 2001 was processed into sawnwood, 31% into pulp and the balance used for structural and non-structural panels.
- Eucalyptus is increasing increasingly upgraded into solid wood applications rather than its traditional uses for firewood and pulp.
- Approximately 75% of the production of primary (pulp, paper, panels and sawnwood) and secondary products (engineered wood products, doors, windows, interior finish items and furniture and furniture components) is exported, mainly to the United States, followed by Japan and China, respectively.
- Over the last decade, wood products exports, worth $2.2 billion, have more than doubled, mainly as a result of the six-fold increase in value of further-processed wood products exports.
- Forest products exports constitute 13% of Chile's total exports today by value.
- Imports of wood products into Chile are already significant, at almost $540 million in 2001, and with expectations for continued GDP per capita growth, imports of paper, millwork and furniture are expected to increase.
- All of the plantation forests in Chile are privately owned, and with high industry concentration.
- There is a growing trend for Chilean forest product companies to invest their capital in other Latin American countries, including plantations, manufacturing facilities, and sales offices.
- Over 50% of Chile's plantation forests are managed with an environmental management system complying with ISO 14001, with the area growing steadily.

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[1] By: Mr. David Cartwright, Forestry Consultant and Special Advisor to the Canadian Council of Forest Industries, 1200-555 Burrard Street, Vancouver, British Columbia, Canada, V7X 1S7, telephone +1 604 891 1270, fax +1 604 687 4930, E-mail: dcartwright44@hotmail.com; and Dr. Christopher Gaston, Group Leader, Markets & Economics, Forintek Canada Corp., 2665 East Mall, Vancouver, British Columbia, Canada, V6T 1W5, telephone +1 604 224 3221, fax + 1 604 222 5690, E-mail: gaston@van.forintek.ca. The authors wish to acknowledge the help of both the Instituto Forestal and the Corporación Chilena de la Madera for background and statistical information in support of this Chapter.

Secretariat introduction

Chile's rapidly expanding forest products trade is influencing markets within the UNECE region, as well as competing for market share in some of the same export markets. Despite growing domestic consumption, with softwood and hardwood plantation-grown wood that will double in volume in the next 15 years, Chile will become an even greater player in world markets. Chile is not he only country in the southern hemisphere to benefit from fast-growing plantations, as more countries' forest resources are based on planted stock. However, Chile has capitalized on its raw material by simultaneously developing a forest products industry to manufacture both primary and further-processed products

This chapter is one of a continuing series of special chapters in the *Review* that features a country's wood products markets, either a trading partner or a competitor, from outside the UNECE region. The *Forest Products Annual Market Review, 1999-2000* featured a similar chapter on New Zealand's forest products markets.

The secretariat would like to express sincere appreciation to Mr. David Cartwright, Forestry Consultant and Special Advisor to the Canadian Council of Forest Industries and Dr. Christopher Gaston, Group Leader, Markets & Economics, Forintek Canada Corporation, for this insightful chapter on Chile's forest products sector. Dr. Gaston is the Leader of the new UNECE and FAO Team of Specialists on Forest Products Markets and Marketing.

5.1 Introduction

Chile's forest industry has experienced dynamic development during the past thirty years. In 1974, a re-activated Government-led programme provided incentives that resulted in the establishment of two million hectares of plantation forests, primarily radiata pine and eucalyptus. An integrated industrial infrastructure has been developed to process the raw material resulting from these plantations, developing Chile into a significant exporter of a wide range of wood products to numerous markets around the globe. Chile is a true success story in fibre production, processing both primary and secondary wood products of generally high quality. The Chilean forest industry has established a highly successful worldwide marketing network, and is starting to make investments in processing facilities outside of the country. With the 2001 plantation production of roughly 25 million m^3 of roundwood, and expectations for this to nearly double in the next two decades, Chile is positioned to be an even greater global supplier of forest products.

At the same time, economic growth and the prosperity of the Chilean population poises them to become significant importers of wood products. While to date this has been dominated by paper, there are growing opportunities for imports of solid wood products, especially for interior finish of principal and recreational housing.

5.2 General economic developments

The population of Chile is nearing 15 million people, 28% of which are 14 years of age or younger. The population growth rate is 1.2% and life expectancy at birth is 75.5 years. The literacy rate for the total population 15 years and older is 95.2%.

During the 1991 to 1997 period the growth in real GDP averaged more than 7% annually but dropped to 3% in 2001. It is forecast to increase slightly in 2002 to 3.3%. The export of goods and services in 2001 experienced a 7.1% growth rate in real terms, slightly below the previous year's rate of 7.5%. In 2002 the forecast is for a 4.2% growth rate (Central Bank of Chile, 2002). In 2000, at $10,100, Chile had a respectable purchase power parity adjusted per capita GDP (compared, for example with $6,700 for Costa Rica, $6,500 for Brazil, $2,900 for Ecuador, and $23,400 for Germany) (United States Central Intelligence Agency, 2001).

The annual rate of inflation dropped from 6% in 1997 to 2.6% in 2001. It is forecast to remain low in 2002. During most of the 1990s Chile's unemployment rate remained low averaging about 7%. In February 2002 the unemployment rate had climbed to 9.3% countrywide, and to 13.3% in the Santiago metropolitan region, a reflection of the downturn in the construction sector. This is due in part to depressed global commodity prices and the slowdowns in the Asian economies.

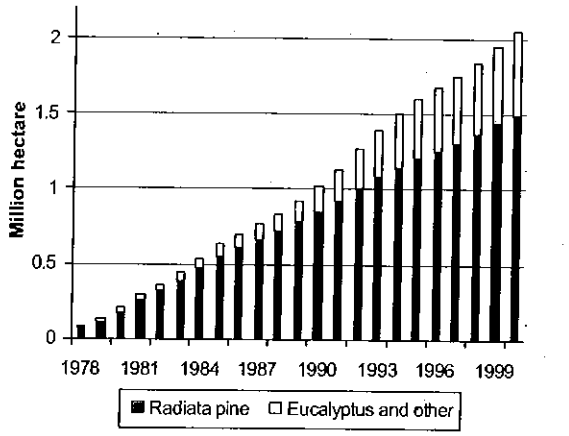
5.3 Forest resources

Chile's temperate forests remained almost intact until the arrival of the Europeans over 450 years ago. The uncontrolled use of fire to clear land for agricultural uses and the harvesting of the more valuable native softwoods and hardwoods have reduced the original forest cover by 44%. Fibre use until quite recently has primarily been for firewood and for sawnwood manufacture for use in construction, shipping and mining.

Today Chile has 15.6 million hectares of forest cover (approximately one fifth of the county's total area), with native forests representing 85.9% (13.4 million hectares) and plantation forests accounting for 13.5% (2.1 million hectares). There is an additional

GRAPH 5.3.1

Cumulative plantation area in Chile, 1978-2000



Source: Instituto Forestal, 2001.

14.1 million hectares of scrub forestlands that are Government-owned and protected (*Instituto Forestal*).

The dependency on the natural hardwoods decreased dramatically with the introduction of plantation forests in the mid-1900s, utilizing introduced species, primarily radiata pine and eucalyptus. In the mid-1970s, this trend toward plantation forestry accelerated through government subsidized planting programmes (graph 5.3.1). This peaked in 1992, with over 130,000 hectares planted that year. To date, Chile has over 2 million hectares of plantation forests exist. Plantation subsidies have been curtailed significantly. No subsidies exist for processing of wood products.

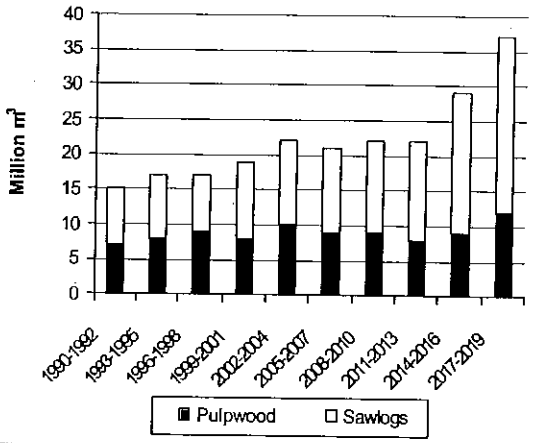
Radiata pine has been the preferred plantation species primarily due to its fast growth rate, averaging 24 m^3/hectare/year (*Instituto Forestal*). It also tends to grow straight and tall with well-spaced, small-sized branches. This species currently represents over 75% of the area planted. Based on established plantation inventories, age classes and annual increments, radiata pine timber production is forecast to increase substantially from an annual harvest of 18.8 million m^3 today to an estimated harvest of 36.9 million m^3 in 2018 (graph 5.3.2) (*Instituto Forestal*). There is, however, a growing interest in faster growing species of eucalyptus that could begin to lessen the dependence on radiata pine. The eucalyptus wood is expected to be used for both high quality, short fibre pulp and wood-based products.

Industrial log consumption has experienced a five-fold increase during the past 25 years, from less than 5 million m^3 in 1976, to over 25 million m^3 today. Plantation forests account for 85% of this supply, with native forests supplying only 15% of the industrial log harvest. Approximately 41% of the industrial log production is processed by the sawmilling sector with 31% destined to the pulp mills, mainly in the form of undersized roundwood resulting from thinning operations. The balance is primarily used for structural and non-structural wood-based panels.

It is of interest to note that an additional 10 million m^3 of wood, equivalent to 40% of the roundwood production, is extracted annually from the forests for use as firewood. The preference is for certain hardwoods from native forests. This often uncontrolled extraction of firewood can cause significant degradation to the mature as well as second growth native forests.

GRAPH 5.3.2

Past, present and projected radiata pine roundwood production, 1990-2020



Source: Instituto Forestal, 2002.

5.4 Institutional framework for forest and wood industries

The majority of the plantation resources in Chile are privately owned. Large owners (six in total, each holding in excess of 5,000 hectares of plantation forests) account for 51% of the total acreage of plantation forests. Medium-sized owners, each holding between 1,000 and 5,000 hectares, represent 15% of the plantation forests (1,100 firms), with the balance owned by small operators (5,400 firms). Native forests are largely owned by the Government and are either very strictly managed for use or totally protected. However, almost 20% of the native forests are owned privately, and managed under strict harvesting guidelines.

Chilean forest policies are implemented through various institutions. The principal public institution is the Corporación Nacional Forestal (CONAF) and its role is to encourage the growth and development of

productive forestry activities while protecting and conserving the forests and the forest environment. The Instituto Forestal's (INFOR) objective is to develop the forest industry by providing factual statistical and analytical information about resources, industrial activities, products and markets. The Comisión Nacional del Medio Ambiente (CONAMA) is responsible for environmental issues and the development of a comprehensive national environmental law. The Corporación Chilena de la Madera (CORMA) is the Chilean wood corporation that represents the private sector forest product producers.

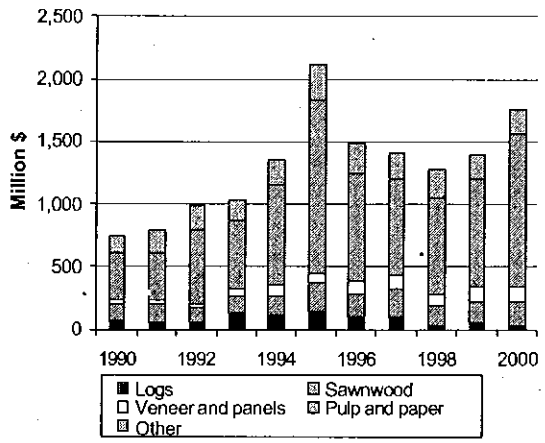
A rising interest in, and concern for, the protection of the environment has resulted in increased controls over the harvesting of native forests. This has delayed implementation of some industrial projects, including chipping and sawmilling operations, reliant on the native hardwood species and has slowed the establishment of plantation forests using introduced species that replace native species.

5.5 Wood industry - production and consumption

Chile's forest industry produces a wide range of wood products, primarily from their radiata pine and eucalyptus plantations, for both export and domestic markets (graphs 5.5.1 and 5.5.2). The sawmilling sector is characterized by the existence of a large number of small sawmills, many owners and wide spatial distribution. However, there is a high concentration of milling capacity in the hands of a few companies. The principal companies are Aserraderos Arauco S.A., Aserraderos Mininco S.A., Andinos S.A. and Forestal

GRAPH 5.5.1

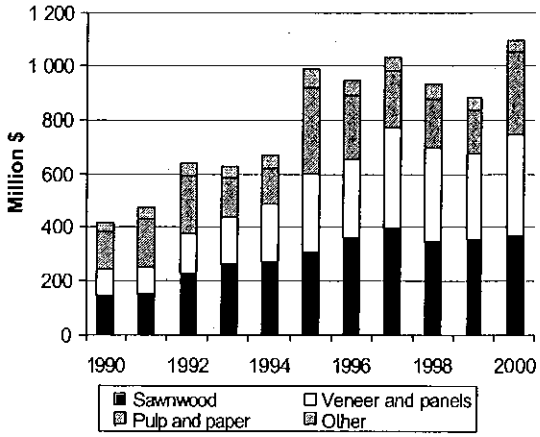
Chilean production of primary forest products for export markets, 1990-2000



Source: Instituto Forestal, 2001.

GRAPH 5.5.2

Chilean production of primary forest products for domestic use, 1990-2000



Source: Instituto Forestal, 2001.

Copihue. It should be noted that there is a low level of foreign investment in both Chile's plantation resources and its processing facilities.

The veneer and plywood industry has undergone significant growth during the past decade as plants have been modernized, facilities have been expanded and new investment made in this sector. Current capacity is 50% particle board, 35% fibreboard (primarily MDF), 10% plywood and 5% veneer production.

Wood chips are produced for the domestic and export market. Most chipping facilities are attached to sawmills processing radiata pine logs and account for 48% of total chip production. Native species account for 39%, with eucalyptus representing the balance, or 13% of total production. About $135 million of chips are exported annually.

The pulp and paper industry is well developed and produces chemical and mechanical pulp, newsprint and other papers (printing, sanitary, facial, corrugated cardboard and cardboard). Six companies account for 87% of installed capacity of approximately three million tons per annum.

In addition to these primary processors there is a well-established secondary manufacturing industrial base that produces a wide range of value-added products. These range from the basic kiln-dried, finger-joined blanks to moldings, doors, windows, and numerous items of furniture. Growth in the production of such value-added products has far outstripped the growth in primary wood products (see section 5.6).

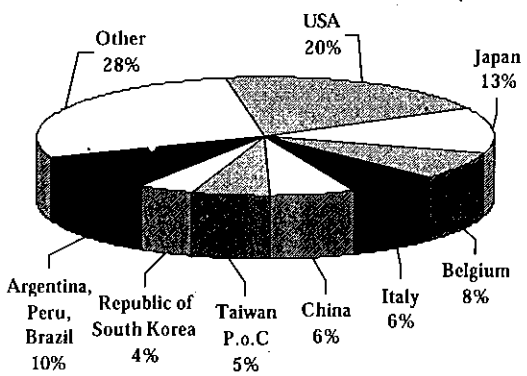
5.6 Trade of wood and wood products

5.6.1 *Wood product exports*

The growth of Chile's forest industry over the past three decades has depended on the development of foreign markets (graph 5.6.1). Since 1990 the value of forest product exports has more than doubled, reaching $2,200 million in 2001, representing 13% of the country's total exports (graph 5.6.2). The value of forest products exports peaked in 1995 at $2,369 million due largely to the high world prices for wood pulp, particularly during the third quarter of that year. Non-wood forest products exports have also doubled; these include herbs, edible nuts, bark, mushrooms, extracts and essential oils, bamboo poles and charcoal.

GRAPH 5.6.1

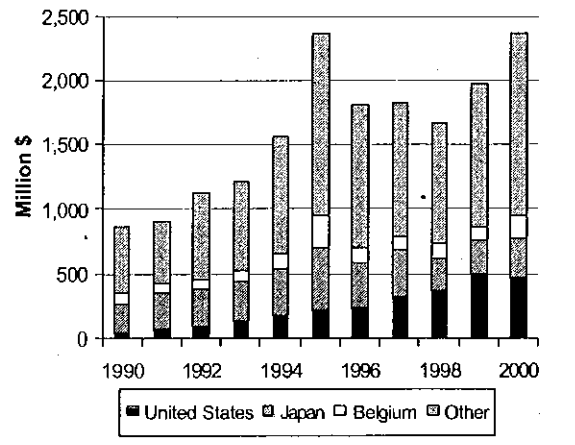
Chilean forest products export destination, 2000



Source: Instituto Forestal, 2002.

GRAPH 5.6.2

Chilean forest products exports by destination, 1990-2000

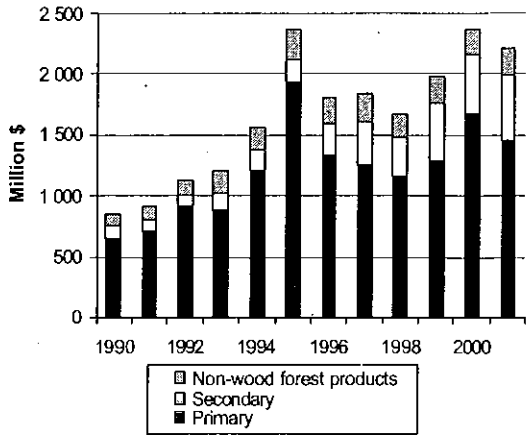


Source: Instituto Forestal, 2002.

While primary wood products account for the largest percentage of the value of exports, the volume and value of secondary value-added wood products is steadily increasing as a percentage of the total. During the past eleven years the value of primary wood product exports has doubled while that of value-added wood products has grown six-fold (graph 5.6.3).

GRAPH 5.6.3

Chilean exports of forest products, 1990-2001



Note: Other is non-wood forest products.
Source: Instituto Forestal, 2002.

Also during the past eleven years the number of exporters, products exported and countries exported to have all experienced moderate growth. The value of exports has, on the other hand, more than doubled (table 5.6.1). Pulp is the largest export item, representing roughly 40% of all wood product exports. The balance includes sawnwood and a wide variety of further-processed products.

TABLE 5.6.1

Diversification of forest product exports and exporters, 1991, 1996 and 2001

	1991	*1996*	*2001*
Value of exports (million $)	913	1 808	2 206
Number of exporters	670	942	968
Number of products exported	385	420	407
Number of countries exported to	76	89	98

Source: Instituto Forestal, 2002.

The United States remains the principal destination for Chile's wood exports, accounting in 2001 for 23.2% of the value of total wood product exports. Japan and China with 12.5% and 10.9%, respectively, follow in importance.

It is important to note that there is a significant difference in terms of the wood products that each of the four principal importing countries purchase (table 5.6.2). The United States imports primarily value-added radiata pine wood products, namely moldings, planed wood, and doors and doorframes. The principal product exported to Japan is eucalyptus wood chips, while China imports primarily softwood pulp. Exports to Mexico have experienced a significant increase in the last three years, primarily plywood, sawnwood, planed wood and multi-layered paperboard.

5.6.2 Wood products imports

Imports of wood products in 2001 totalled $536 million. 73% of imports were paper, followed by solid wood and manufactured wood products at 13% (table 5.6.3).

TABLE 5.6.2

Wood products exported to the principal markets, 2001
(Million $)

Country and imported product	*2001*	*%*
United States		
Solid wood moldings	127.4	24.9
Planed wood	62.3	12.2
Door jambs	46.4	9.1
Wood furniture	41.9	8.2
MDF moldings	39.1	7.6
Other	195.0	38.0
Total	**512.0**	100.0
Japan		
Eucalyptus wood chips	148.1	53.9
Sawnwood	48.4	17.6
Bleached pulp	37.5	13.7
MDF panels	6.0	2.2
Other	34.5	12.6
Total	**274.7**	100.0
China		
Bleached pulp	176.8	73.4
Raw pulp	57.6	23.9
Sawnwood	3.5	1.5
Planed wood	2.3	0.9
Other	0.9	0.3
Total	**241.0**	100.0
Mexico		
Plywood	17.1	18.1
Sawnwood	16.9	17.9
Planed wood	15.0	15.9
Paperboard	10.3	10.8
Other	35.3	37.3
Total	**94.6**	100.0

Source: Instituto Forestal, 2002.

The relationship between the value of imports and the value of exports of wood products has changed during the past decade. In 1990 for each dollar of wood products imported, Chile exported $6.9. In 2001 this had decreased to $4.1. The trend is more noticeable in the value-added sector, particularly wood furniture. In 1990 for each dollar imported, $11.8 were exported. This has dropped to $2 in 2001 reflecting increase purchasing power in the country and generally depressed global prices for forest products (graph 5.6.4).

5.7 Certified forest products

Some progress has been made to develop a national standard of sustainable forest management, primarily for the native hardwood forests. Efforts have been compatible with both the Forest Stewardship Council and Sustainable Forestry Initiative programme.

Commencing five years ago a few Chilean forest companies, reacting to market conditions, began the process that would result in the certification of their plantation forests. As of January 2002, nine forest companies and two wood-processing firms have obtained ISO 14001 certification. Slightly over one million hectares have been certified. By the end of 2002 it is forecast that an additional four companies will have secured certification on an additional 51 thousand hectares of plantations. This will represent approximately 60% of the country's plantation forests.

At this time five companies have obtained chain of custody certification and the right to use eco-labels on their products. FSC is at this time the preferred chain of custody certification.

During the past ten years a few foreign citizens and companies have purchased significant parcels of native forestlands located in the southern regions of the country. One investor has assembled a block that covers an area of over 360,000 hectares that spans the width of the country. It is the owner's professed desire to retain this area in its pristine condition and prohibit any form of farming, road construction, installation of electricity generating plants or other forms of development on the land that he controls or the adjacent waters.

TABLE 5.6.3

Wood products imports, 1990 – 2001

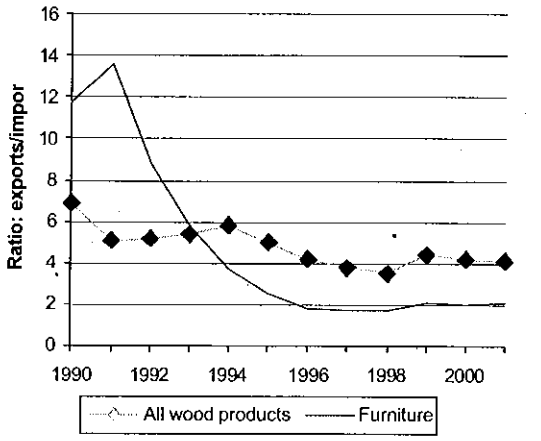
(Million $)

Year	*Paper and paperboard products*	*Wood and wood products*	*Cork and cork products*	*Furniture and furniture parts*	*Cellulose*	*Total*
1990	109.2	6.4	5.3	1.0	2.7	124.7
1991	161.9	7.0	7.1	1.6	2.3	180.1
1992	196.1	10.0	10.0	2.7	0.8	220.0
1993	194.9	17.0	9.8	5.3	0.7	228.3
1994	235.5	17.8	8.9	9.4	1.6	274.1
1995	407.3	27.5	12.3	13.3	9.5	471.3
1996	342.0	36.3	17.9	21.0	3.0	422.1
1997	392.1	50.1	24.5	33.2	3.7	505.4
1998	385.1	51.6	27.5	33.7	4.6	503.9
1999	338.9	39.7	29.1	23.6	7.2	439.9
2000	411.5	56.2	29.3	25.9	17.7	542.2
2001	393.6	67.2	31.2	22.8	19.5	536.3

Source: Central Bank of Chile, 2002.

GRAPH 5.6.4

Relationship of wood product imports to exports in Chile, 1990-2001



Note: $ exported per $ imported
Source: Instituto Forestal, 2002.

5.8 Prospects for the future of the Chilean wood industry

Experimentation with fast-growing introduced hardwoods, primarily eucalyptus, has bome positive results. There is a growing trend towards the establishment of plantations that could outperform radiata pine and provide the industry with an increased volume of high quality fibre as well as saw or veneer logs within 14 years of plantation establishment.

There are two trends points worth noting, particularly among the larger forest product companies in Chile. First, the level of horizontal integration is high, from nursery operations, harvesting, log merchandizing, sawmilling, value-added manufacturing and through to marketing and sales. Second, there has been a large investment in technology in all aspects of their operations, substituting capital for increasing labour costs. Both of these trends can be expected to continue.

Another significant trend warranting observation is the investment that Chilean forest companies have made in other Latin American countries. The recent signing of various free trade agreements with Central American countries, including Costa Rica, has resulted in the establishment of offices in some of these countries to direct market Chilean wood products. The free trade agreement signed with Mexico has resulted in a strategic alliance entered into by Terranova Internacional with Maderas y Sintéticos de México (an affiliate of the Chilean company Masisa) to form Masnova de México. Masnova will market Chilean MDF products. Muebles Sur S.A., a Chilean furniture manufacturer, in 2001 opened a retail outlet in Mexico to direct market its products.

In 2001 Masisa purchased MacMillan Guadiana, a Mexican waferboard manufacturer and affiliate of Weyerhaeuser, and started up an OSB plant in Brazil. In that same year the Terranova Group purchased a large acreage of plantation forests in Brazil and Venezuela, investments that totalled approximately $40 million. Terranova has now purchased Masisa for $150 million.

The Arauco Group has a large investment portfolio in Argentina that includes MDF plants that, when

combined with their plants in Chile, gives this company an annual production capacity of over one million m^3 situating it as a significant global producer.

5.9 Conclusion

Chile has clearly proven itself to be a fibre supply success story. Through past incentives to establish impressive plantations, Chile has all but eliminated its reliance on native forests. Moreover, from resource to international markets, the Chilean wood products industry has implemented a supply chain management scheme that could be a model for any country. It can be expected that Chile will continue to grow in importance as a world wood products supplier, contributing to the global trend of an increased reliance on southern hemisphere plantations.

5.10 References

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