10. Growth Modelling Components of the AFFFM

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When developing the AFFFM, a conscious decision was made at an early stage to populate the model with as much data as possible. By doing so it was felt that the model would be more useful to a wider range of users. A module was developed which contains information about potential growth rates, harvest ages and log prices for a number of suitable timber species for the Atherton Tableland, the Darling Downs and the New England Tableland regions of eastern Australia. Data on the potential growth rate, harvest age and product mixtures for tree species suitable for plantations on the New England Tablelands and Darling Downs were generated using the Plantgro program. Users of the model from these areas can choose to load the appropriate values for the various species by specifying the location and soil type of the planned plantation. Data on the potential growth rate, harvest age and timber price for 31 species of cabinet timbers in Far North Queensland were also included. These data were obtained from a previous survey of forestry experts undertaken by Herbohn *et al*. (1999). This chapter outlines the process through which growth data used in the AFFFM were collected.

10.1 Plantgro Estimate for Darling Downs and New England Tablelands

The Plantgro program (Hackett 1991a) was selected for predicting tree performance under a variety of conditions. Plantgro was originally developed at CSIRO Division of Water and Land Resources (Hackett 1988, 1991b) and later marketed commercially under licence by Iris Media Software Division, Brisbane (MSDOS Version 2.0, Iris Media 1994) and over 500 copies of the software were sold worldwide. The appeal of Plantgro to its users is its predictive power, ease of use and especially its relevance to a wide range of problems to which it provides practical solutions (e.g. see Davidson 1996, Hidayat 1996). Its strength lies in the core program that can be applied without modification in any country or locality. The soil, climate and plant files are the components that vary and can be supplied from an existing library of files, or compiled to suit the task at hand. For this project, a beta copy of Plantgro Version 3.0 for Windows supplied by Clive Hackett was used.

Plantgro uses information on 12 important soil factors, including pH, nitrogen and phosphorus levels, and 11 climate factors including monthly maximum and minimum temperature, precipitation evaporation and solar radiation. The core program includes a simple water-balance modelling subroutine, as well as light and temperature modelling subroutines. A valuable attribute is the ‘fuzziness’ in the relationships which are used to determine Limitation Ratings (LR) on a 0 to 9 scale, where 0 limitation indicates ideal growing conditions, 8 indicates highly unsuitable conditions, and 9 means the plant will probably die rapidly (Suitability Rating or SR is the opposite of LR, for example LR0=SR9, LR9=SR0, meaning at SR9 the plant will be growing optimally, while at SR0 it will probably die rapidly). Individual factors are combined into an overall rating (the Greatest Limitation Rating, GLR) using Liebig’s Law of the Minimum, where the most limiting factor determines the level of plant (tree) performance (Davidson 1996). For this project, since trees as long-lived perennial plants were under consideration, GLRs were obtained on a monthly basis across a calendar year, and averaged for the 12 months to obtain an Annual Greatest Limitation Rating (AGLR), except in the case where at least one month delivered a GLR of 8 or 9, for which the AGLR was automatically set at 8 or 9 respectively. Examples of Plantgro tree, climate and soil files can be found in Booth (1996, pp. 86-91).

Development of tree files

The first step was to choose the tree species to be included in the system. Initially, a somewhat dated survey by CARE was available of people in the timber industry who were asked to rank species that they preferred for processing or planting on the Northern Tablelands. It was difficult to judge how much weight should be given to these survey results. New England Blackbutt and the several Stringybark species seemed reasonable candidates. Brush Box and Tallowwood were suggested but these are not Tableland species. *Pinus radiata* (an exotic) should have scored higher given that it is likely to be the only possibility west of the New England Highway east of the Cypress Pine country. Cypress Pine itself is unlikely to be a candidate for planting, though natural stands on private lands are in need of better management for timber production.

State Forests of New South Wales (SFNSW) records of species and provenance trials of eucalypts over a wide geographic range and elevations from 15 m to 1100 m above sea level were examined. About 64 species are represented in these trials. Data are readily available for those trials established from 1961-1991 (Johnson and Stanton 1993). Unfortunately, there were only two trial sites at altitude of relevance to the present project. In December 1972, a 'High Altitude Eucalypt Trial' (G18005) was established in Mt. Boss State Forest in stands of eight different species planted in 1969. In 1990, at age 21 years, *Eucalyptus delegatensis* and *E. regnans* had failed completely, while *E. laevopinea* and *E. fastigata* had a low survival rate, both 39%. *E. campanulata* and *E. saligna* had higher survival rates, or 86% and 76% respectively, but somewhat slower diameter growth than *E. obliqua* (61% survival). 'Mila Routine Site Tablelands Species Trial' (SEL1301 (R32281), Bondi State Forest, is one of seven small replicated trials near Bombala. The Mila trial is on 'routine' ex-pasture, with granite parent rock. *E. nitens*, *E. viminalis* and *E. globulus* ssp *globulus* were the best after one year.

Most other SFNSW data come from only two eucalypt species, *E. pilularis* and *E. grandis*, neither of which are candidates for the Tablelands and Downs localities in this project, but these data do provide some insights into growth performance of eucalypts generally with respect to different site qualities. There is no information on planted *Callitris glaucophylla* since this species is not generally planted, having rather prolific natural regeneration which requires careful management.

Given the generally poor nutrient status of unfertilised Australian soils, it is desirable that some nitrogen fixing species be included in the list, either to be used alone or planted in mixtures with the eucalypts. Chief amongst these are the acacias.

Information from Kristen Williams of the Queensland Department of Natural Resources and Mines (NRM) reveals that there are some species from South East Queensland, which are common with species of the Northern Tablelands, NSW. These include *Corymbia maculata*, *E. microcorys*, *Lophostemon confertus*, *E. crebra*, *E. sideroxylon* and *E. saligna*. The additional species to be included for South East Queensland and estimates of their potential growth rates were decided upon in December 2000 by an expert panel of Kristen Williams, Paul Ryan and John Davidson, taking into account additional opinions from Queensland foresters and others with some knowledge of species performance.

E. saligna was chosen as the pilot species for development the biological part of the project. *E. grandis* (Coffs Harbour high altitude provenance) was included as a check species since a tested plant file was already available, although it would be unsuitable at most localities on the Northern Tablelands and Darling Downs.

The species which have been included are:

Acacia mearnsii (Black Wattle)	*E. laevopinea* (Silvertop Stringybark)
Acacia melanoxylon (Blackwood)	*E. macroryncha* (Red Stringy Bark)
Corymbia maculata (Spotted Gum)	*E. nitens* (Shining Gum, Silvertop)
Corymbia variegata (Spotted Gum) (Qld)	*E. saligna* (Sydney Blue Gum)
Eucalyptus andrewsii (New England Blackbutt)	*E. viminalis* (Ribbon Gum)
E. argophloia (White Gum) (Qld)	*E. youmanii* (Youman's Stringy Bark)
E. caliginosa (White Stringybark)	*Pinus radiata* (Radiata Pine)
E. grandis (Flooded Gum) (Coffs Hbr high)	

Methods of creating Plantgro tree files and assigning yield information to Plantgro LRs were described in detail by Davidson (1996), including ways of using existing published information such as that provided in Webb *et al.* (1984), Brown *et al.* (1989), Booth and Pryor (1991) and Eldridge *et al.* (1994).

Climate files developed for the modelling

Climate files corresponding to the following locations have been compiled in the system. No advantage was found in having a finer grid of locations for the target areas at this stage.

Armidale	Barraba	Baradine	Bingara
Bundarra	Collarenebri	Dalby	Deepwater
Glenn Innes	Goondiwindi	Gunnedah	Guyra
Inverell	Ipswich	Killarney	Moree
Mungindi	Narrabri	Quirindi	Stanthorpe
Tamworth	Tenterfield	Texas	Toowoomba
Walcha	Wallangarra	Warialda	Warwick

Soil files developed for the modelling

Forty-eight soil files have been prepared and included. Thirty-one have general soil names based on soil texture. The other 17 have the names corresponding to soil orders and suborders of the Australian Soil Classification (as in Isbell 1996). The latter have average properties of such orders and suborders where found on the Northern Tablelands of NSW and in South East Queensland (Table 10.1). These soil files were originally drafted by Warwick McDonald, a visiting American soil scientis, in the CSIRO Division of Water and Land Resources, Canberra, in the mid-1990s. Median data were compiled from the CSIRO soil profile database. For this project the soil files were modified to reflect soils in the target areas that had been fertilised with nitrogen, phosphorus and potassium and cultivated to the extent allowed by the quantities and costing of these activities in the financial model. That is, the limitations caused by generally low values of these nutrients, and heavy texture, in most of these natural soils was reduced artificially by cultivation and application of fertiliser. All Available Water Capacities and Drainable Water Capacities were estimated. Infiltration depths are approximate, because they are difficult to validate with existing data.

10.2 Identifying the Soil Type at a Forestry Site

To use Plantgro, it is necessary to be able to identify the soil type at a chosen planting site. This section provides a practical guide on how to classify the soil type. Basically, three steps are involved:

1. From the menu of locations, choose the location nearest the proposed tree planting location. This will load the corresponding climate file.

2. Examine the soil on an exposed face such as in a road cutting, quarry, trench or pit, or in a hole dug with an auger. Such an exposure is called a *profile*. A soil profile is normally examined to a depth of 1-2 m or down to bedrock if shallow. There are two ways to enter the soil menu, namely, by determining the dominant soil texture in the profile as described below, or by seeking professional help to classify the soil into its Australian Soil Classification Order and Sub-order and choosing this from the menu.

Table 10.1. Soils and their coding in Plantgro soil files

Soil Name	Depth (cm)	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Clay-heavy	200	Very sticky, gleying common	4	70	35	200	7.2	0	0	50	150	0	2	2	0	12	12	8	8	0
Clay-heavy	65	Very sticky, gleying common	4	70	35	65	7.2	0	0	10	55	0	2	2	0	12	12	8	8	0
Clay-light	200	Black/brown, sticky when wet, some gley	5	70	35	200	7.2	0	7	50	150	0	4	4	0	17	17	13	13	0
Clay-light	50	Black/brown, sticky when wet, some gley	5	70	35	50	7.2	0	7	20	30	0	4	4	0	17	17	13	13	0
Clay-medium	10	Black/brown, some gleying, sticky	5	40	20	10	6.5	0	0	7	3	0	3	3	0	15	15	13	13	0
Clay-medium	200	Black/brown, some gleying, sticky	5	40	20	200	6.5	0	7	50	150	50	3	3	7	15	15	13	13	40
Clay-medium	60	Black/brown, some gleying, sticky	5	40	20	60	6.5	0	7	20	40	50	3	3	7	15	15	13	13	40
Clay-swelling	200	Black, cracks when dry	3	70	35	200	7.2	0	0	50	150	0	1	1	0	12	12	8	8	0
Clay-swelling	75	Black, no structure, cracks when dry	3	70	35	75	7.2	0	0	30	45	0	1	1	0	12	12	8	8	0
Gravelly/stoney	100	Red/orange, gritty	6	10	8	100	5.5	0	7	46	60	50	6	6	7	4	4	40	40	40
Gravelly/stoney	50	Red, gravel and stones visible	6	10	8	50	5.5	0	7	0	50	30	0	6	7	0	4	0	40	0
Loam	200	Brown/grey, gritty	6	40	20	200	5.5	0	15	50	150	75	4	4	6	16	16	16	16	40
Loam	50	Brown/grey, gritty	6	40	20	50	5.5	0	15	20	30	75	4	4	6	16	16	16	16	40
Loam+clay (Clay loam)	100	Dark grey, some red/brown	5	40	20	100	5.5	0	0	20	80	0	4	4	0	17	17	13	13	0
Loam+clay (Clay loam)	200	Dark brown, some gleying	5	40	20	200	6.5	0	0	50	150	0	4	4	0	17	17	13	13	0
Loam+sand (Sandy loam)	200	Loam with a high proportion of sand	6	40	20	200	6.0	0	7	50	150	75	4	4	6	13	13	18	18	40
Loam+sand (Sandy loam)	75	Dark brown loam with a high proportion of sand	6	60	30	75	6.0	0	7	20	55	75	4	4	6	13	13	18	18	40
Peat (Organic)	100	Undecomposed organic matter in profile	6	5	3	100	3.5	0	0	50	50	0	8	2	0	12	5	8	1	0
Peat (Organic)	60	Dark brown, undecomposed roots	6	5	3	60	4.5	0	0	30	30	0	8	2	0	12	5	8	2	0
Rocky	35	Young soil, large particle size	6	5	3	35	5.5	0	7	10	25	50	7	7	7	2	2	40	40	0
Rocky	75	Young soil, large particle size	6	5	3	75	4.5	0	7	30	45	50	7	7	7	2	2	40	40	40
Sand+clay (Clayey sand)	200	Clay gives some structure	6	10	8	200	5.5	0	7	50	150	50	4	4	7	13	13	16	16	40
Sand+clay (Clayey sand)	75	Clay gives some structure	6	30	20	75	5.5	0	7	20	55	50	4	4	7	13	13	16	16	40
Sand+loam (Loamy sand)	100	Predominantly sand with some silt	6	60	30	100	5.5	0	7	30	70	50	4	4	7	9	9	22	22	40
Sand+loam (Loamy sand)	75	Predominantly sand with some silt	6	40	20	75	6.5	0	7	20	55	75	4	4	7	9	9	22	22	40
Sand – compacted	200	No plasticity, feels dry and gritty	6	1	1	200	5.5	2	7	50	150	100	5	5	7	7	7	25	25	40

Sand – compacted	50	Structureless, feels dry and gritty	6	1	1	50	6.5	2	7	30	20	100	5	5	7	7	7	25	25	40
Sand – loose	200	Low organic matter, little structure	6	1	1	200	5.5	0	7	50	150	75	5	5	4	4	4	35	35	22
Sand – loose	50	Low organic matter, little structure	6	1	1	50	7.2	0	7	20	30	75	5	5	4	4	4	35	35	22
Silt	100	Alluvial, often found on stream banks	3	10	8	100	5.5	0	7	20	80	0	3	3	0	15	15	14	14	0
Silt	200	Alluvial, often found on stream banks	3	10	8	200	5.5	0	7	50	150	0	3	3	0	15	15	14	14	0
AACH	100	Red Chromosols (Red Earths)	5.5	16.9	3.2	100	6.3	0	1	17	76	30	4	3	5	3	11	5	15	7
AADE	116	Red Dermosols (Red Podzolics)	5.5	9.7	2.2	116	5.9	0	5	18	95	32	3	3	4	3	12	4	15	8
AAFE	150	Red Ferrosols (Kraznozems)	4.5	11.4	2.7	150	5.8	0	2	15	13	20	3	3	3	3	15	13	16	4
AAKA	160	Red Kandosols (Red Earths)	5.5	12.7	1.2	160	6.2	0	1	14	134	55	4	4	5	2	18	4	31	15
ABCH	100	Brown Chromosols (Non-calcic Brown Soils)	4.5	15.5	2.3	100	6.1	0	1	18	63	20	5	2	5	2	8	6	12	6
ABDE	115	Brown Dermosols (Prairie Soils)	5.5	8.8	1.3	115	5.6	0	5	20	89	30	3	3	5	3	11	3	12	6
ABFE	107	Brown Ferrosols (Chocolate Soils)	5.5	29.5	2.9	107	5.7	0	3	10	97	155	3	3	3	3	10	2	11	5
ABKA	110	Brown Kandosols (Brown Earths)	5.5	10.6	1.3	110	5.9	0	2	20	84	53	4	4	5	3	11	6	16	8
ABSO	99	Brown Sodosols (Solodised Solonetz)	4.5	25.3	3	99	6.2	0	0	15	75	30	5	2	5	2	9	5	12	6
ABVE	121	Brown Vertosols (Brown Clays)	4.5	8.4	5.3	121	8.0	0	0	10	110	30	2	2	4	1	16	1	17	6
ACCH	122	Yellow Chromosols (Yellow Podzolics)	5	12.2	1.8	122	6.3	0	0	18	75	38	5	2	5	2	8	6	12	8
ACSO	122	Yellow Sodosols (Yellow Podzolics)	5	14.3	1.5	122	6.4	0	0	11	99	31	5	2	5	1	10	4	15	9
ADSO	121	Grey Sodosols (Solodised Solonetz)	5	14.6	2.1	121	6.3	0	0	16	96	30	5	2	5	2	12	5	15	7
ADVE	175	Grey Vertosols (Grey Clays)	4.5	16.7	6.3	175	7.8	0	0	10	158	43	2	2	4	1	18	1	19	7
AEVE	137	Black Vertosols (Black Earths)	4	17	7.4	137	7.1	0	1	10	127	26	2	2	5	1	15	1	15	7
DTHY	110	Oxyaquic Hydrosols (Non-gleyed Organic Soils)	4	4.8	3.7	110	5.5	0	0	10	90	65	4	4	5	2	10	3	20	20
EDHY	140	Redoxic Hydrosols (Mottled, Gleyed Organic Soils)	3	6.8	1.6	140	5.5	0	0	20	112	45	4	3	5	3	12	5	16	8

Column Headings: 1: Aeration (Class, 1-6 nil to good); 2: Base saturation (% of Cation Exchange Capacity); 3: Cation Exchange Capacity (meq./100gm soil); 4: Depth overall (cm); 5: pH; 6: Salinity (dS/m); 7: Slope (degrees); 8: Depth A Layer (cm); 9: Depth B Layer (cm); 10: Depth I (Infiltration) Layer (cm); 11: Texture A Layer (Class, 1-8); 12: Texture B Layer (Class, 1-8); 13: Texture I Layer (Class, 1-8); 14: Available Water Capacity A Layer (%) (Plant available water – cm/m); 15: Available Water Capacity B Layer (%) (Plant available water – cm/m); 16: Drainable Water Capacity A Layer (%) (cm/m); 17: Drainable Water Capacity B Layer (%) (cm/m); 18: Drainable Water Capacity I Layer (%) (cm/m).

Soil texture can be determined in the field by the farmer, by following a number of simple steps. First break off a piece of soil, crush it and work it with a little water in the hand until all the lumps are broken and the mixture is moist without being sticky. Soil texture is placed into one of several classes, namely sand, loam, clay and intermediate classes. The classification of texture is made from the feel of moist soil between the fingers and thumb and the palm of the hand. The following is a guide as to how to classify soil texture:

Sand – does not cohere (hang together), and is coarse to the touch
Loamy sand – cohesion just perceptible; a cast can just bear handling without breaking up
Sandy loam – coheres, yet is easily friable; individual sand grains can be felt
Loam – both friable and coherent; sand grains cannot be felt in a moist sample
Sandy clay loam – like a clay loam, but sand grains can be felt
Clay loam – somewhat friable, but also somewhat plastic, rolls out into a ribbon between the palms of the hands while a loam breaks up
Sandy clay – like a clay, but sand grains can be felt
Clay – tough and plastic, rolls out into a ribbon between the palms of the hands, the ribbon can be bent into a circle without breaking up.

These classes approximately correspond to farmers' normal usage. 'Loam', however does not imply rich in humus in the sense gardeners use the word. The terms 'light' and 'heavy' represent the sandy and clayey ends of the series respectively; they have nothing to do with specific gravity or weight of the soil (clay actually weighs less than an equivalent volume of sand), but do refer to the ease or difficulty of digging or cultivating sandy or clayey soils. The above list refers to texture after any gravel or stone has been set aside. This may have to be included in the description (e.g. *gravelly loam*). Some soils with a smooth feel when moist are called *silty*, e.g. *silty loam*, *silty clay loam*. Clay is divided into *light*, *medium* and *heavy* (or *swelling*).

The importance of soil depth for tree growth is reflected in the ability to choose shallow and deep phases of the same soil from the menu. The simulation could be run with both shallow and deep choices from the menu to determine whether the depth of soil is really a limiting factor in a particular case.

3. Choose the species from the menu. Since the same SR from two or more species can represent more or less timber production, depending on their relative growth rates, the simulation should be run several times in order to determine the best species for wood production at the proposed planting site.

10.3 Estimates of Tree Growth Rates in North Queensland

Extensive experience has been gained in recent years in the growing of rainforest and eucalypt species through the Community Rainforest Reforestation Program (CRRP) that has operated in the Wet Tropics of North Queensland since 1993. A Delphi survey was used by Herbohn *et al*. (1999) to collect estimates from forestry experts of the growth rates of a number of species commonly grown in the CRRP. This was done primarily to provide estimates of growth and harvest age to be incorporated in the Australian Cabinet Timbers Financial Model (ACTFM) and which has now been subsumed into the AFFFM. The following sections outline how the growth estimates for the north Queensland species were obtained and draws heavily from Herbohn *et al*. (1999)

The Delphi survey procedure

The Delphi method was employed to provide estimates of (a) mean annual increment or MAI (m^3/ha/year) and (b) time to harvest (years) of 31 species. Harvest age and MAI are the two key biological variables needed to estimate yield and harvest scheduling parameters for use in financial models. Species have been selected on the basis that they were (a) listed in Russell *et al*. (1993) and planted under the CRRP, or (b) they are among the most common species planted under the CRRP. Species included are predominantly those which occur naturally in North Queensland (mostly rainforest species along with a number of eucalypts common to the area but not occurring in rainforest), as well as a limited number of native species found in sub-tropical Australia and one exotic species.

Opinions were obtained from 13 individuals with extensive experience in growing of Australian tropical and sub-tropical rainforest species for either timber production or restoration. Individuals generally had either extensive field experience or had undertaken research involving native rainforest and tropical eucalypt species. Participants included representatives of the Queensland Department of Primary Industries (Forestry), Queensland Department of Natural Resources and Mines, CSIRO, The University of Queensland, James Cook University of North Queensland, Griffith University and Southern Cross University.

Participants were provided with a table listing the 31 selected species and asked to provide estimates of their 'best guess' of optimal rotation period (years) for each species along with estimates of 'shortest time to harvest' and 'longest time to harvest'. Estimates were also requested for the 'best guess' for expected yield (m^3/ha/year) along with estimates of 'highest yield expected' and 'lowest expected yield', based on the 'best guess' rotation period. In this section, participants were asked to assume that the trees would be planted on relatively fertile basaltic soils near Atherton, that average annual rainfall would be between 1500 - 2000 mm, the initial planting density would be around 660 stems per hectare (sph) and suitable thinning regimes would be applied. Where available, estimates of rotation time and average growth rate from Russell *et al*. (1993) were provided. The questionnaire also contained a section on favoured planting regimes and mixtures of species, the effects of mixed species plantings on yields of individual species, and the likely differences in potential yields between plantation managed by farmers as opposed to professional foresters. A copy of the survey form distributed to participants is available on request.

Survey forms were distributed to participants followed by a visit by one of the research team. Responses for the estimates of growth rates and harvest ages of the 31 selected species were then collated and averages calculated. A summary table including the group averages was prepared and distributed to participants along with their original estimates. Participants were invited to review their original estimates of growth rates and harvest ages in light of the group averages and to provide any appropriate revisions or comments. Few revisions were received in this second survey round, after which the Delphi process was terminated.

Performance estimates obtained in the Delphi survey

Estimates of harvest ages and MAI provided by forestry experts are summarised in Table 10.2. Expected growth rates of most rainforest species are modest compared to those for eucalypts. Eucalypt species accounted for seven of the 10 fastest growth rates of species listed. This is not surprising given the high growth rates recorded for a number of eucalypt species in plantations elsewhere in Australia and overseas (e.g. Goodwin and Candy 1986, Pohjonen and Pukkala 1988, West and Mattay 1993, Moore *et al*. 1996).

The estimates of potential growth rates and harvest ages of eucalypt and rainforest cabinet timber species produced in the current study represent the best available at present. These estimates must however be treated with some degree of caution. While the Delphi method is useful for assembling and quantifying expert opinion, it does have some limitations. The Delphi method was chosen for this study because of a lack of reliable growth data associated with the performance of many of these species under plantation conditions. It is difficult to assess the reliability of estimates of growth and harvest age obtained from application of this method. Of the 31 species included, extensive growth data based on past performance are available only for Hoop Pine (*Araucaria cunninghamii*) and, to a lesser extent, some of the eucalypt species. There is close agreement between the MAI estimates of Hoop Pine provided by experts in this study, estimates provided by Russell *et al*. (1993) and actual volumes reported for mature hoop pine plantations (aged over 50 years) on the Atherton Tablelands reported by Gnan (1992). There is less experience of performance under commercial production for the other species.

The closeness of the estimates for Hoop Pine lends some support to the reliability of estimates for other species. There is however no such external check available to assess the reliability of performance estimates of other species, and caution needs to be exercised in the use of these. This is particularly relevant for those estimates based on the views of a small number of respondents and who provided widely divergent estimates (as indicated by large standard errors). Furthermore, there can be considerable differences between potential productivity and realised (harvestable) production. For example, *E. grandis* is highly susceptible to wood borer which can render the stem virtually unsaleable for sawlogs.

Table 10.2. Estimated average growth rates (MAI) and harvest ages of timber species grown under the Community Rainforest Reforestation Program in North Queensland

Species	MAI (m^3/ha/year)		n	Harvest age (years)		n
Eucalyptus grandis	20.8	(5.7)	6	31	(1.1)	11
Acacia mangium	20.7	(2.3)	7	24	(2.2)	9
Araucaria cunninghamii	20.5	(3.7)	10	44	(1.4)	12
Eucalyptus camaldulensis	18.8	(2.1)	5	28	(0.9)	8
Elaeocarpus angustifolius	18.4	(4.0)	7	34	(2.2)	13
Eucalyptus cloeziana	17.4	(1.6)	9	35	(2.8)	11
Eucalyptus pellita	16.5	(2.2)	6	31	(2.7)	9
Eucalyptus citriodora	16.3	(2.3)	5	32	(1.6)	10
Eucalyptus tereticornis	16.2	(2.6)	7	32	(1.8)	9
Eucalyptus cloeziana (poles)	16.1	(1.7)	4	26	(2.2)	10
Eucalyptus microcorys	15.8	(3.3)	4	31	(1.5)	9
Agathis robusta	16.0	(5.0)	9	46	(2.1)	13
Melia azedarach	13.7	(4.1)	6	31	(3.7)	9
Flindersia brayleyana	13.5	(4.0)	6	43	(3.6)	10
Acacia melanoxylon	12.3	(3.0)	5	30	(2.4)	10
Eucalyptus drepanophylla	11.0	(1.3)	5	44	(7.6)	9
Cedrela odorata	10.4	(0.7)	6	38	(2.1)	10
Flindersia bourjotiana	10.3	(3.8)	4	53	(4.8)	6
Flindersia pimenteliana	9.0	(5.0)	3	55	(5.6)	6
Toona ciliata (australis)	8.9	(3.4)	4	49	(4.7)	8
Blepharocarya involucrigera	8.7	(2.1)	4	48	(3.4)	7
Gmelina fasciculiflora	8.6	(3.6)	3	54	(4.9)	6
Flindersia schottiana	8.5	(3.5)	4	48	(3.4)	9
Grevillea robusta	8.2	(0.8)	6	35	(1.7)	10
Flindersia ifflaiana	8.0	(4.5)	3	57	(5.6)	6
Cardwellia sublimis	7.6	(3.2)	4	58	(4.5)	8
Paraserianthes toona	7.1	(2.1)	2	55	(11.8)	6
Castanospermum australe	5.6	(1.2)	5	67	(7.1)	9
Ceratopetalum apetalum	5.0	--	1	113	(20.3)	3
Endiandra palmerstonii	4.5	(2.5)	2	156	(63.6)	5
Beilschmiedia bancroftii	2.9	(1.9)	2	102	(18.0)	5
Flindersia australis	--	--	0	58	(6.3)	4

Note: 'n' represents the number of participants providing estimates for each parameter. Standard errors are reported in parentheses.

10.4 Summary

This chapter has documented the process involved in the development of growth estimates of a range of species which have been included in the AFFFM as default data. Growth estimates for species suitable for the Darling Downs and New England Tableland areas were obtained using the Plantgro program. Users of the model from these areas can choose to load the appropriate values for the various species by specifying the location and soil type of the planned plantation. Data on the potential growth rate, harvest age and timber price for 31 species of cabinet timbers in Far North Queensland obtained by Delphi survey have also been included in the AFFFM.

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