# PROVENANCE TRIALS OF *ACACIA HOLOSERICEA* AND *ACACIA AURICULIFORMIS*

**D.P. Gwaze**

*Forest Research Centre, Harare, Zimbabwe*

*Received May 1992*

**GWAZE, D.P. 1993. Provenance trials of *Acacia holosericea* and *Acacia auriculiformis*.** Performance of provenances of *Acacia holosericea* and *A. auriculiformis* was examined at 2.2 and 4.0 *y* after planting. Experiments to compare the provenances were conducted at two sites for both species. All provenances of both species had high survival. Provenances of both species varied significantly in height and diameter growth. Jabiru provenance of *A. holosericea* was the best performing provenance on both sites, while Mibini and Reynolds River provenances performed best for *A. auriculiformis*.

Key words: Provenance trials - *Acacia holosericea* - *Acacia auriculiformis* - Zimbabwe

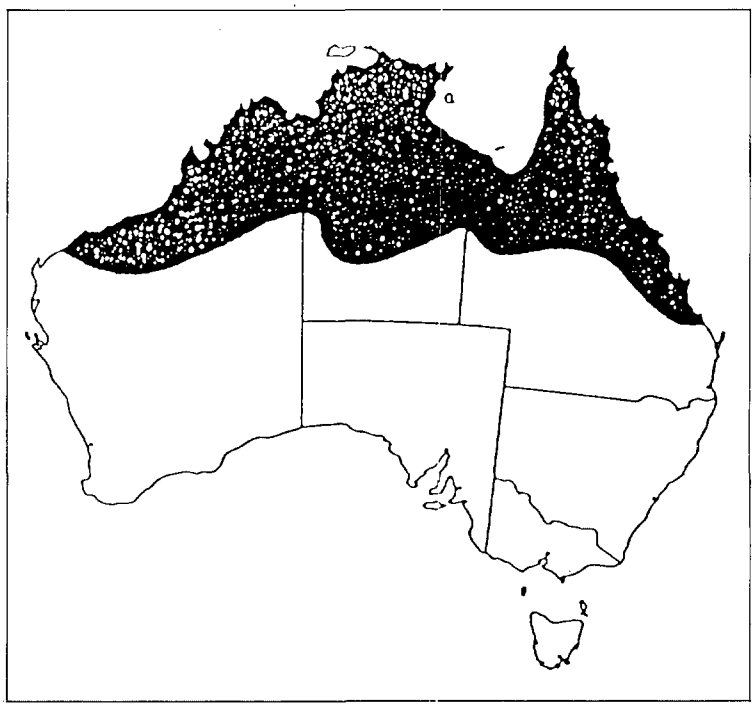
**GWAZE, D.P. 1993. Ujian provenans *Acacia holosericea* dan *Acacia auriculiformis*.** Prestasi provenans *Acacia holosericea* dan *A. auriculiformis* dikaji pada 2.2 dan 4.0 tahun selepas penanaman. Kajian perbandingan provenans dibuat pada dua tapak yang berlainan bagi kedua spesies. Semua provenans bagi kedua spesies menunjukkan kadar kemandirian yang tinggi. Provenans bagi kedua spesies berbeda dengan nyata dari segi ketinggian dan diameter pertumbuhan. Provenans Jabiru menunjukkan prestasi terbaik antara dua tapak yang dikaji bagi *A. holosericea*. Provenans Mibini dan Reynolds River pula menunjukkan prestasi terbaik bagi *A. auriculiformis*.

## Introduction

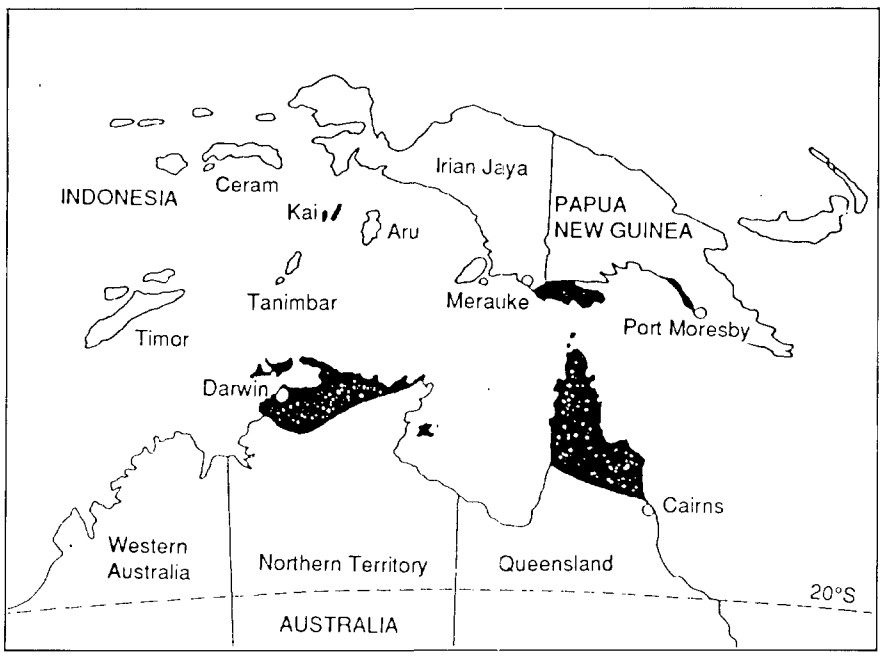
When the Rural Afforestation Project in Zimbabwe was started in 1981, only two species could be recommended for planting for fuelwood and poles in the dry areas: *Eucalyptus camaldulensis* and *Eucalyptus tereticornis*. In 1984 a project sponsored by the Australia Centre for International Agricultural Research was set up in order to expand the choice of species for planting in the rural areas. Over 100 species were tested on 10 sites around Zimbabwe.

*Acacia holosericea* and *A. auriculiformis* are of particular interest as they performed well in the species trials. They also may have the ability to fix nitrogen and so be useful in improving soil fertility in rural areas. Both species are known to be good for fuelwood (Turnbull 1986). In addition, *A. holosericea* seed is used for human food (Thomson 1989) while *A. auriculiformis* timber can also be used for furniture (Pinyopusarerk 1990).

This paper reports the performance of provenances of *A. holosericea* at 2.2 and 4.0 *y* and *A. auriculiformis* at 2.2 *y* of age at two sites each in Zimbabwe (Table 3).



**Map 1**. Natural distribution of *Acacia holosericea*




**Map 2.** Natural distribution of *Acacia auriculiformis*

## Materials and methods

### *Plant material*

The natural distributions of *A. holosericea* and *A. auriculiformis* are shown on Map 1 and Map 2 respectively. Seed collected from the natural range of the species was provided by CSIRO Tree Seed Centre, Australia.

Tables 1 and 2 show the details of the provenances used in *A. holosericea* and *A. auriculiformis* provenance trials.

Seven seedlots (seven provenances) of *A. holosericea* were included at the Kadoma trial while ten seedlots (nine provenances) were included at the Matopos trial; four provenances were included at both sites. Twenty-eight seedlots (28 provenances) of *A. auriculiformis* were included at the Kadoma trial and 18 seedlots (18 provenances) at the Kozi trial; eighteen were included at both sites. The Thailand provenances are landraces and their origin is not known.

**Table 1.** Details of *A. holosericea* provenances included in the trials at Kadoma and Matopos. QLD=Queensland, N.T=Northern Territory, W.A.=Western Australia

| CSIRO No. | Origin | Longitude | Latitude | Altitude (*m*) |
|---|---|---|---|---|
| Sou.1** | Not known | - | - | - |
| 13853 | Jabiru, N.T | 132° 50'E | 12° 50'S | 50 |
| 13879* | Mt. Molloy,QLD. | 145° 15'E | 16° 46'S | 380 |
| 13879* | Mt. Molloy,QLD. | 145° 15'E | 16° 46'S | 380 |
| 13879+ | Mt. Molloy,QLD. | 145° 15'E | 16° 46'S | 380 |
| 14413* | Cairns, QLD. | 145° 46'E | 16° 55'S | 0 |
| 14660+ | Turkey Creek,W.A. | 128° 12'E | 17° 04'S | 400 |
| 14618+ | Elliot, N.T. | 133° 31'E | 17° 30'S | 230 |
| 14632* | Wave Hill, N.T. | 138° 53'E | 17° 37'S | 300 |
| 17161 | Broome, W.A. | 122° 11'E | 17° 38'S | 12 |
| 14649 | Wolfe Creek Crater, W.A. | 127° 48'E | 19° 10'S | 360 |
| 14651* | Carranya, W.A. | 127° 46'E | 19° 14'S | 340 |
| 14118 | Tennant Creek, N.T. | 134° 11'E | 19° 39'S | 0 |

* Not included at Kadoma trial; + Not included at Matopos trial; ** Sou. 1 is not a CSIRO reference as the seed was supplied by ATPS and SOU. 1 is their reference number.

### *Measurements*

Vertical height to the highest point on the tree woody stem or branch and diameter at breast height (DBH) were measured from all trees after 2.2 and 4.0 *y* of planting for *A. holosericea* trials and 2.2 *y* for *A. auriculiformis*. Diameter was measured for every stem greater than 25 *mm* in diameter. For species with multiple stems, all stems with DBH greater than 25 *mm* were measured for diameter. Mean diameter of the multi-stemmed tree was then calculated as the quadratic average of the individual stem diameters. Quadratic average was calculated as the mean of the square root of the sum of the individual diameters squared.

**Table 2.** Details of *A. auriculiformis* provenances included in the trials at Kadoma and Kozi. QLD = Queensland, N.T = Northern Territory, W.A = Western Australia, P.N.G. = Papua New Guinea, Thai=Thailand

| CSIRO No. | Origin | Longitude | Latitude | Altitude (*m*) |
|---|---|---|---|---|
| 16106 | Mibini, P.N.G. | 141° 38'E | 08° 49'S | 40 |
| 16101/2 | Bensbach, P.N.G. | 141° 15'E | 08° 50'S | 20 |
| 16105 | Balamuk, P.N.G. | 141° 71'E | 08° 55'S | 20 |
| 16107* | Old Tonda Village, P.N.G. | 141° 33'E | 08° 55'S | 40 |
| 16103* | Balamuk to South Balamuk, P.N.G. | 141° 15'E | 09° 00'S | 10 |
| 16108 | Mari Village, P.N.G. | 141° 42'E | 09° 11'S | 5 |
| 16397 | Sai Thango to Sai Thong, Thai. | 099° 27'E | 11° 25'N | 50 |
| 16187* | Melville Island, N.T. | 130° 50'E | 11° 55'S | 1 |
| 16143 | Cooper Creek, N.T. | 133° 11'E | 12° 06'S | 40 |
| 16154* | Goomadeer Creek, N.T. | 133° 41'E | 12° 08'S | 50 |
| 16152* | Aligator River N.T. | 132° 55'E | 12° 17'S | 10 |
| 16156* | Yarunga Creek, N.T. | 134° 48'E | 12° 18'S | 50 |
| 16155* | Mann River, N.T. | 134° 08'E | 12° 22'S | 60 |
| 16147 | King Creek, N.T. | 131° 00'E | 12° 23'S | 28 |
| 16161 | Howard Springs, N.T. | 131° 03'E | 12° 27'S | 70 |
| 16297 | Nong Sanom, Thai. | 101° 15'E | 12° 35'S | 0 |
| 16163* | Elizabert River, N.T. | 133° 04'E | 12° 36'S | 40 |
| 16148 | Manton River, N.T. | 131° 07'E | 12° 50'S | 100 |
| 16137 | Piccaninny Creek, QLD. | 142° 48'E | 13° 09'S | 40 |
| 16160* | Aligator River to South Aligator River, N.T. | 132° 19'E | 13° 16'S | 40 |
| 16158 | Cerrowi to Gerowie, N.T. | 132° 15'E | 13° 19'S | 100 |
| 16162 | Reynolds River, N.T. | 130° 32'E | 13° 32'S | 150 |
| 16151 | Mary River, N.T. | 132° 08'E | 13° 36'S | 120 |
| 16149* | Douglas River, N.T. | 131° 09'E | 13° 51'S | 70 |
| 16142 | Coen River, QLD. | 143° 03'E | 13° 53'S | 170 |
| 15697 | Coen to South Coen, QLD. | 143° 16'E | 14° 07'S | 160 |
| 15985 | Mount Molly, QLD. | 145° 17'E | 16° 41'S | 380 |

* Not included at Kozi trial.

## *Description*

*A. holosericea* provenance trials were established at Kadoma and Matopos while those of *A. auriculiformis* were established at Kadoma and Kozi. These sites were choosen because of their low rainfall which is representative of majority of the rural ares. Details of the trial sites are given in Table 3.

## *Experimental design and analysis*

For the *Acacia holosericea* trial at Kadoma a randomised complete block design was used with four replications. The plot size was 16 trees with a tree spacing of 2.5 × 2.5 *m*. The plot was square and there was no buffer zone around the plots or blocks. Seven provenances were included in the trial. A randomised complete block design was used for the *A. holosericea* trial at Matopos with nine provenances replicated six times. Sixteen tree plots were also used with tree spacing of 3 × 3*m*.

**Table 3.** Details of the trial sites

| Trial site | Longitude | Latitude | Altitude (*m*) | Mean annual rainfall (*mm*) | Soil | Vegetation |
|---|---|---|---|---|---|---|
| Kadoma | 29° 55'E | 8° 18'S | 1180 | 780 | Reddish-brown clay loam soil | *Acaia*, *Terminalia*, *Combertum*, scrub vegetation |
| Kozi | 28° 55'E | 20° 50'S | 1120 | 500 | Sandy loam soil | *Brachystegia*, *Julbernardia* woodland |
| Matopos | 28° 31'E | 20° 23'S | 1380 | 600 | Sandy loam soil | *Acacia* Woodlands |

For the *A. auriculiformis* trial at Kadoma, 28 provenances were planted in a randomised complete block design with six replications. The plot size was 16 trees at a tree spacing of 3 × 3*m*. At Kozi, 18 provenances were included in the trial using the same design and spacing as at Kadoma except that the line plots of five trees were used. Line plots were used at Kozi due to poor seedling recoveries in nursery.

Analyses of variance were done on height and diameter data. The means were compared using the Least Significance Difference test.

## Results and discussion

### *A. holosericea provenance trials*

Survival of all provenance was good at both trials. The Kadoma site is a termite infested area and the good survival supports the finding of Mitchell (1989) that the species was resistant to termite attack.

At both trials the best performing provenance, in terms of height, was the Jabiru provenance (Tables 4 and 5). It was also the best performing provenance in terms of diameter at Kadoma. Jabiru provenance was found to be the only provenance that was not affected by tip die-back and did not lose foliage during the dry season. Therefore the provenance could have had a longer growing period compared to the other provenance resulting in better growth.

The results found here differ from those of the provenance trial in Niger where the Northern form (*e.g.* Jabiru) performed poorly compared to the inland provenances (Thompson 1989). The may be due to lower rainfall received at the Niger trial site.

The northern and inland forms of *A. holosericea*, identified through isozyme analysis (Thomson & Moran unpublished data), were only distinguishable using phyllode colour. The inland forms were dark green and the northern forms light green.

Stem splitting, particularly at Kadoma, was noticed in all provenances except Jabiru and the reason for this splitting is unknown.

All provenances had curly pods. Personal observations show that extraction of seed is difficult from curly pods. In Niger, the northern provenances had curly pods while the inland provenances had straight pods (Thompson 1989). All provenances produced seed quantities except Jabiru provenance which has never seeded despite the production of pods. The reason for the Jabiru provenance not seeding is unknown and it is an area that is being investigated.

**Table 4.** Survival, mean height, mean diameter, L.S.D and significance of the F-test for provenance mean height and mean diameter at four years for the *A. holosericea* trial at Kadoma

| Seedlot number | Provenance | Survival (%) | Mean height (*m*) | Mean diameter (*mm*) |
|---|---|---|---|---|
| 13853 | Jabiru, N.T. | 100 | 4.4 | 72 |
| 14649 | Wolfe Creek, W.A. | 98 | 4.2 | 60 |
| 13879 | Mt Molloy, QLD. | 98 | 3.9 | 46 |
| 14660 | Turkey Creek, W.A. | 94 | 3.8 | 44 |
| 17161 | Broome, W.A. | 100 | 3.6 | 51 |
| 14118 | Tennant Creek, N.T. | 96 | 3.4 | 40 |
| 14618 | Elliot | 96 | 3.3 | 38 |
| Mean | | 97 | 3.8 | 50 |
| L.S.D. (5%) | | | 0.6 | 15 |
| Significance of provenance effect | | | ** | ** |

** Significant at 1% probability level.

**Table 5.** Survival and mean height data, L.S.D and significance of the F-test for provenance mean height at 2.2 *y* for the *A. holosericea* trial at Matopos

| Seedlot Number | Provenance | Survival (%) | Mean height (*m*) |
|---|---|---|---|
| 13853 | Jabiru , N.T. | 98 | 1.6 |
| 13879 | Mt. Molly, QLD. | 100 | 1.1 |
| 14649 | Wolfe Creek Crater, W.A. | 98 | 1.0 |
| 14632 | Wave Hill, N.T. | 94 | 0.9 |
| 17161 | Broome, W.A. | 98 | 0.9 |
| 13879 | Mt. Molly, QLD. | 98 | 0.8 |
| 14651 | Carranya, W.A. | 86 | 0.8 |
| 14118 | Tennant Creek , N.T. | 89 | 0.8 |
| 14413 | Cairns, QLD. | 92 | 0.7 |
| Sou.1 | Not known | 92 | 0.6 |
| Mean | | 96 | 0.9 |
| L.S.D. (5%) | | | 0.3 |
| Significance of provenance effect | | | ** |

** Significant at 1% probability level.

## *A. auriculiformis provenance trials*

Most of the trees at Kozi had heights less than 1.3*m*, so DBH was excluded from analysis.

Survival of *A. auriculiformis* provenances at both trials was greater than 88% (Tables 6 and 7). Provenances varied in height growth and diameter growth but this variation was small. The best performing provenance was Mibini from Papua New Guinea (P.N.G.) with a mean height of 4.1 *m* and mean DBH of 48 *mm* at Kadoma, while the worst was also from P.N.G. (Mari Village Western province) with a mean height of 2.6 *m* and mean DBH of 22 *mm*. At Kozi the best performing provenance was Reynolds River followed by Mibini. Ganeson (1989) grew 30 provenances from Australia, P.N.G. and Thailand under glass house conditions and also found that P.N.G. provenances were the most vigorous. Pinyopusarerk (1990) also reported that the P.N.G. provenances performed better than the Thailand provenances in Thailand.

**Table 6.** Survival , mean height, mean diameter, L.S.D. and significance of the F-test for provenance mean height and mean diameter at 2.2 *y* for *A. auriculiformis* trial at Kadoma

| Seedlot number | Origin | Survival (%) | Mean height (*m*) | Mean diameter (*mm*) |
|---|---|---|---|---|
| 16106 | Mibini, P.N.G. | 100 | 4.1 | 48 |
| 15697 | Coen to South Coen, QLD. | 99 | 4.1 | 42 |
| 16137 | Piccaninny Creek, QLD. | 100 | 4.0 | 38 |
| 16156 | Yarunga Creek, N.T. | 100 | 3.9 | 42 |
| 16149 | Douglas River, N.T. | 98 | 3.9 | 43 |
| 16155 | Mann River, N.T. | 97 | 3.8 | 40 |
| 16158 | Cerrowi to Gerowie, N.T. | 100 | 3.8 | 35 |
| 16161 | Howard Springs, N.T. | 99 | 3.8 | 38 |
| 16142 | Coen River, QLD. | 98 | 3.8 | 36 |
| 16148 | Manton River, N.T. | 99 | 3.8 | 40 |
| 16154 | Goomadeer Creek, N.T. | 99 | 3.8 | 45 |
| 16160 | Aligator River, N.T. | 95 | 3.7 | 34 |
| 16162 | Reynolds River, N.T. | 98 | 3.7 | 39 |
| 16163 | Elizabeth River, N.T. | 97 | 3.7 | 35 |
| 15985 | Mount Molloy, QLD. | 99 | 3.7 | 37 |
| 16153 | Cooper Creek, N.T. | 100 | 3.7 | 37 |
| 16152 | Aligator River to East Aligator River, N.T. | 100 | 3.5 | 38 |
| 16151 | Mary River, N.T. | 98 | 3.5 | 33 |
| 16105 | Balmuk to South Balamuk, P.N.G. | 99 | 3.4 | 39 |
| 16101/2 | Bensbach, P.N.G. | 100 | 3.4 | 35 |
| 16187 | Melville Island, N.T. | 99 | 3.2 | 29 |
| 15483 | Archer River, QLD. | 100 | 3.2 | 31 |
| 16397 | Sai Thango to Sai Thong, Thailand | 100 | 3.2 | 24 |
| 16107 | Old Tonda Village, P.N.G. | 98 | 3.2 | 31 |
| 16147 | King Creek, N.T. | 99 | 3.1 | 23 |
| 16103 | Balamuk, P.N.G. | 89 | 3.0 | 27 |
| 16108 | Mari Village WP, P.N.G. | 94 | 2.8 | 22 |
| Means | | 98 | 3.5 | 35 |
| L.S.D. (5%) | | | 0.6 | 12 |
| Significance of seedlot effect | | | ** | ** |

** significant at 1% probability level.

The best and the worst prevenances were from P.N.G. while the Thailand provenances were generally poor performers. The Australian provenances varied in performance. Within Australia there was no relationship between growth performance and the state from which the seed was collected.

**Table 7**. Survival, mean height, L.S.D. and significance of the F-test for provenance mean height and mean diameter at 2.2 y for *A. auriculiformis* trial at Kozi

| Seedlot number | Origin | Survival (%) | Mean height (m) |
|---|---|---|---|
| 16162 | Reynolds River, N.T. | 100 | 2.6 |
| 16106 | Mibini, P.N.G. | 100 | 2.5 |
| 16158 | Cerrowi to Gerowei, N.T. | 100 | 2.3 |
| 15985 | Mount Molloy, QLD. | 95 | 2.3 |
| 16153 | Cooper Creek, N.T. | 97 | 2.3 |
| 16101/2 | Bensbach, P.N.G. | 100 | 2.2 |
| 16142 | Coen River, QLD | 93 | 2.1 |
| 16161 | Howard Springs, N.T. | 100 | 2.0 |
| 15697 | Coen to South Coen,QLD. | 89 | 1.9 |
| 16105 | Balamuk to South Balamuk, P.N.G. | 96 | 1.9 |
| 15483 | Archer River, QLD. | 93 | 1.8 |
| 16108 | Mari River, WP, P.N.G. | 100 | 1.7 |
| 16137 | Piccaninny Creek, QLD. | 96 | 1.7 |
| 16148 | Manton River, N.T. | 85 | 1.7 |
| 16151 | Mary River, N.T. | 96 | 1.7 |
| 16397 | Sai Thango to Sai Thong, Thailand | 96 | 1.6 |
| 16147 | King Creek, N.T. | 89 | 1.6 |
| 16297 | Nong Sanom, Thailand | 97 | 2.0 |
| Means | | 96 | 2.0 |
| L.S.D. (5%) | | | 0.6 |
| Significance of seedlot effect | | | ** |

** significant at 1% probability level.

## Conclusion

Provenances varied in growth in both species. The best performing provenance of *A. holosericea* was identified as Jabiru at both trials. In *A. auriculiformis* the best performing provenance was Mibini at Kadoma and Reynolds river at Kozi.

Seed production of *A. holosericea* should be evaluated because of its potential for human food.

Future work should examine the management requirements of these species, particularly spacing and coppicing ability.

## Acknowledgements

Thanks are due to S. Kunaka and C. Maenzanise of the Biometrics Unit for assistance in data capture and analyses and K. Crockford for his comments.

The work was funded by the Australiaan Centre for International Agricultural Research.

## References

GANESON, S.K. 1989. Provenance Variation and Salt Tolerance in *Acacia auriculiformis* A. Cunn. ex Benth. B. Sc. (Honours) thesis. Australian National University, Canberra. 100 pp.

MITCHELL, M.R. 1989. Susceptibility to termite attack of various tree species planted in Zimbabwe. Pp. 215 - 228 in Boland, D.J. (Ed.) *Trees for the Tropics: Growing Australian Multi-purpose Trees and Shrubs in Developing Countries.* ACIAR Monograph , number 10.

PINYOPUSARERK, K. 1990. *Acacia Auriculiformis*: An Annotated Bibliography. Winrock International/ACIAR. 154 pp.

THOMSON, L.A.J. 1989. Report to ACIAR on visit to Kenya and West Africa (Nigeria, Niger, Burkina Faso and Senegal), 27 March - 6 May, 1989. 50 pp. (Unpublished).

TURNBULL, J.W. 1986. *Multipurpose Australian Trees and Shrubs of Lesser Known Species for Fuelwood and Agroforestry.* ACIAR, Canberra. 316 pp.