Carngham agroforestry trial – revisited

BY TIM JACKSON

The groundbreaking Carngham agroforestry trial compared several designs combining pruned Radiata Pines and pastures. Forest, sheep and wool production were measured in each system. Re-measurement by the Victorian Department of Primary Industries has given results to 25 years.

Background

The trial was set up by the Victorian Forests Commission and Department of Agriculture in 1983. Interest in agroforestry had grown with interest in land protection and shelter for livestock, as forestry became more profitable and land availability and agricultural returns declined. A Radiata Pine (*Pinus radiata*) plantation had been planted 25km west of Ballarat (mean annual rainfall 620 mm, duplex basalt soil) in 1981 and thirty hectares was thinned to create several replicated agroforestry systems (Table 1, Fig.1). All trees except in the unpruned plantation were pruned to above 6m.

Pastures of perennial rye-grass and sub-clover were sown in all but the plantation systems and super phosphate was applied annually from 1983 to 1997. Pasture growth was measured from 1990 to 1995.

Plots were stocked with young shorn wethers during each pasture growing season from late 1984 to 1998. From 1990 stocking rates were adjusted so that liveweight gain (LWG) and wool production (WP) per head were similar in all grazed plots. Sheep were not replaced after 1998 because managing small plots from a distance was becoming awkward.

Fig.1 Four agroforestry systems in Year 25. The bottom right-hand picture shows unpruned and pruned plantation; a row in between was removed during thinning.

Final configuration	Treatment imposed in 1983	Other thinnings
60 trees/ha	100 trees ha, widely spaced (12m x 8m)	To 60 trees/ha in 1989
200 trees/ha	277 trees/ha, widely spaced (9m x 4m)	To 200 trees/ha in 1989
Belts: 200 trees/ha	277 trees/ha in belts (5 rows, 3m x 4m, N-S) with pasture alleys(33m wide) in between	To 200 trees/ha in 1989
Pruned plantation: 815 trees/ha	1650 trees/ha, plantation (3m x2 m)	To 1020 trees/ha in 1988 and to 815 trees/ha in 2002
Unpruned plantation: 1090 trees/ha	1650 trees/ha, plantation (3m x 2m)	To 1350 trees/ha in 1989 and to 1090 trees/ha in 2002
Open pasture	Open pasture (no trees)	

Table 1 Agroforestry systems at Carngham (plantation initially est. 1981 at 1650 trees/ha)

Results

Higher tree stockings produced taller trees in mid-rotation (Fig.2), but height growth later slowed in the plantation systems. Height differences at 25 years were not great. Tree diameter was greater under lower stockings (Fig.3), though there was little difference between 60 trees/ha and 200 trees/ha until after 1996.

Stem volumes/tree at year 25 (Fig.4) were correspondingly greater under lower tree stockings. At 60 trees/ha, 68% of total stem volume was in the pruned 6m butt-logs, compared to 60% in other systems. Higher stockings were more productive in terms of stem volume/ha (Fig.5), but agricultural production (pasture, wool and liveweight) was greater at lower tree stockings (Fig. 6 and 7).

Wide spacing produced greater diameters and stem volume than the belt system at the same overall stocking of 200 trees/ha. However the belt system was more agriculturally productive; widely spaced trees had more impact on livestock-carrying capacity.

Tree height differed little among the 5 rows of the belts, but trees in edge rows had greater diameter and stem volume. Trees in the middle row had 37% mortality under strong competition, which reduced overall stocking to 185 trees/ha.

Wool production/ha, liveweight gain/ha, and therefore livestock-carrying capacity, declined over time in all agroforestry systems (Fig. 6 and 7). By year 25, pasture remained only in the open pasture, under 60 trees/ha (carrying capacity 35% of open pasture) and a little between the belts (strips 10-15m wide in the central alleys).

Discussion

Choosing an appropriate agroforestry system clearly involves trade-offs between agricultural production and wood production, and between log quality and total wood volume.

More work is needed to evaluate the costs and returns of the systems tested at Carngham. Overall profitability depends on many factors in the forest component, such as establishment costs, pruning costs, rotation length, wood volume and log qualities. It also depends on factors in the agricultural component, including stocking rates, wool

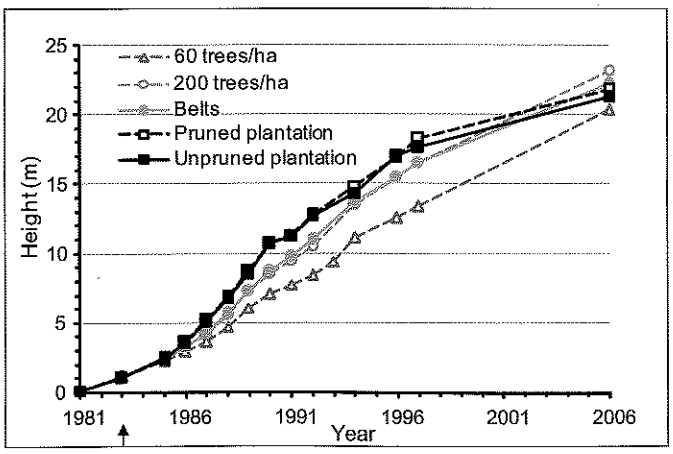

Figure 2 Tree height over time

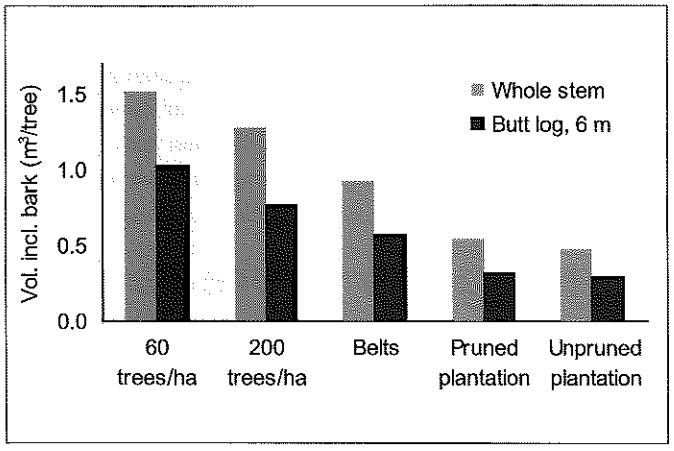

Figure 4 Stem volume per tree at Year 25

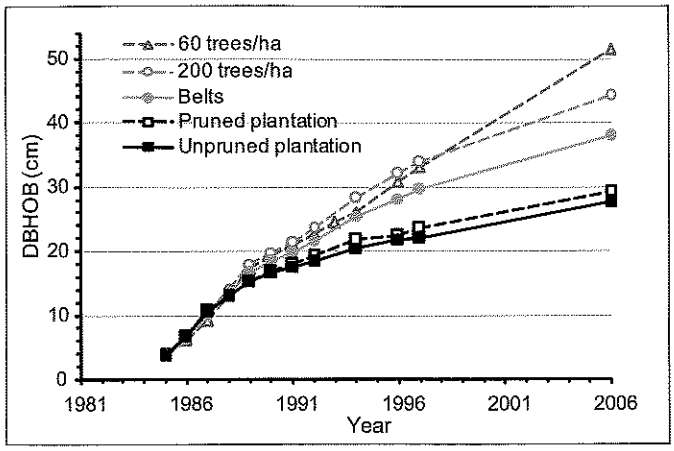

Figure 3 Tree diameter over time

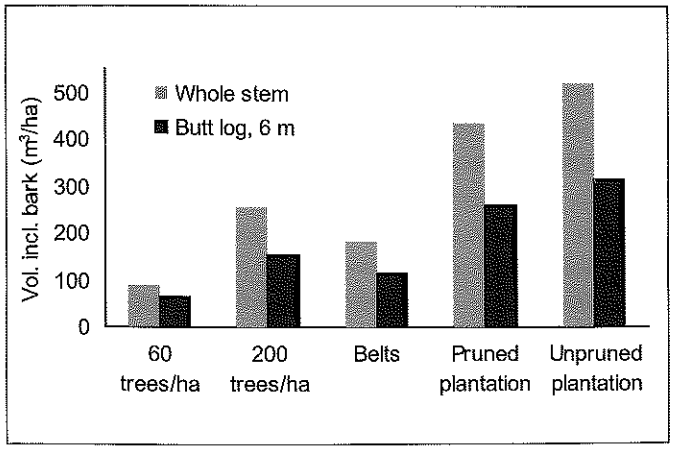

Figure 5 Stem volume per hectare at Year 25

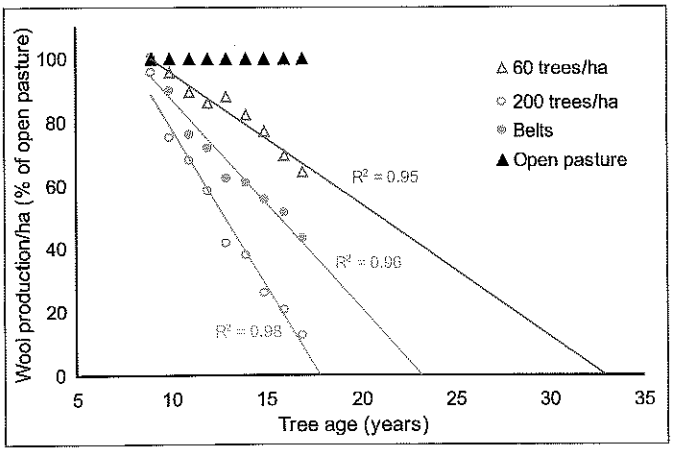

Figure 6 Relative wool production, years 9 to 17

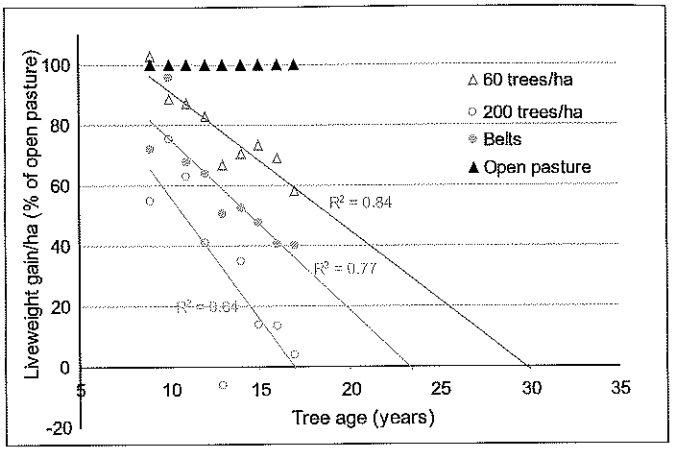

Figure 7 Relative liveweight gain of wethers, years 5 to 17

production and liveweight gain, which change over time as competition from trees increase. Varying wood, wool and sheep prices also have a major bearing on profit.

Large, pruned butt-logs yielding high proportions of clearwood are probably necessary to make widely spaced agroforestry systems worthwhile. Pruning in highly stocked plantations is unlikely to be worthwhile because limited diameter growth will not allow sufficient clearwood production.

Belt systems have several advantages over equally stocked, widely spaced systems, despite lesser wood production. These include:

- greater agricultural productivity,
- easier to fit trees into a cropping system,
- easier to fence and protect trees from livestock (necessary in the first few years),
- smaller branches and easier pruning.

Agroforestry belts of 2 to 4 rows are better than 5-row belts for low rainfall areas. Two-row belts result in more uniform competition and log size. Four-row systems may be more productive in higher rainfall zones, though inner trees will still grow less than edge trees. Wider belts mean smaller branches and easier pruning.

People establishing narrow belts or widely spaced trees for sawlog production must use good genetic stock to ensure acceptable tree form. There has been much genetic improvement in pines since planting at Carngham in 1981.

The Carngham belt system had trees planted on 33% of land (immediate planting area). Simply increasing the distance between belts from 33m to 138m or 288m would give 10% or 5% of land under trees. Such systems allow agricultural production throughout the forest rotation and can be more easily established on farms.

Arranging belts in a grid or network can provide shelter from winds of all directions and is advisable in landscapes where shelter is important.

All agroforestry systems used at Carngham provide useful shelter once the trees have reached a certain size, even only 60 trees/ha.

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Farming the future report

The role of government in assisting Australian farmers to adapt to the impacts of climate change. House of Representatives Standing Committee on Primary Industries and Resources. March 2010

Growing trees on farms as part of an integrated farm plan has potential to diversify farm income and provide other benefits such as shelter for stock, enhanced biodiversity and carbon sequestration. Consequently, the forestry sector's role as a complementary land use can help reduce farm reliance on drought assistance and provide alternative income sources in dealing with the longer term impacts of climate change.

Committee conclusions

Farm forestry provides a real opportunity for farmers to diversify income while improving the environmental sustainability of their properties within the context of existing production mixes. It is not about the wholesale replacement of agriculture by forestry with all its attendant social, economic and environmental consequences. Farm forestry also provides for emissions offsets through the storage of carbon in trees, and, potentially, the creation of income through carbon credits.

During the course of the inquiry, the Committee had the opportunity to inspect sites related to all three of the above programs and was impressed by them all. They had in common a desire to see forestry incorporated into the existing farm enterprise rather than simply bolted on, and all showed sensitivity for the ecological impacts of forestry in the landscape. None was a case of simply changing land use for commercial return regardless of the environmental, economic or social consequences. The key difference between them was the level of ownership, responsibility and direct involvement in the forestry enterprise by the farmer. All three provide models for future action.

The recently released report includes a dedicated section on forests on farms which reports on three projects visited by the committee.

The full report is available at
http://www.aph.gov.au/house/committee/pir/australianfarmers/report/Final%20Report.pdf