THE COMMERCIAL USE OF BROWN MALLET

(Eucalyptus astringens)

Report prepared by V Paton, 1988

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1. DESCRIPTION

1.1 The Species

It is believed that the name "mallet" derives from the aboriginal word maalok, meaning a type of eucalypt that comes up in thickets and produces a dome-shaped canopy (1). The term mallet may be applied to the following species of eucalypt:

Eucalyptus astringens	Brown mallet
Eucalyptus gardneri	Blue mallet
Eucalyptus falcata	Silver or white mallet
Eucalyptus spathulata	Swamp mallet
Eucalyptus sargentii	Salt River mallet (2)

Mallets have three growth forms (3).

(a) trees with single, more or less straight boles from 1.8 m - 6 m in length and total co-dominant height for brown mallet 18 m; silver mallet 10.5 m; blue mallet 9 m; and swamp mallet 9 m.

(b) trees with very short boles and several erect and fairly straight branches.

(c) mallee form characterised by trees or shrubs of a low height growth (1.8 m - 3.6 m) with a large woody rootstock and several slender stems. A characteristic of the mallee form is its ability to coppice from woody rootstock after fire, whereas the tree forms are killed by fire (4).

Brown mallet most frequently grows in forms (a) and (b); silver mallet in forms (a) and (c); and blue mallet in all three forms.

It is the brown mallet which will be the focus of this history since it has properties which have prompted interest in its exploitation and cultivation.

The Latin name for brown mallet is *Eucalyptus astringens*. *Astringens* means binding or constrictive and refers to the bark which has astringent properties.

The following botanical description of brown mallet is taken from Boland *et al.* (1984:390):

Bark: Basically smooth throughout, with small curled flakes of older bark in patches, mainly near the base, brown and grey or slightly bronze-coloured.

Leaves: Seedling - opposite for about 3 pairs then alternate, petiolate, ovate 4-6 x 2-4.3 cm, green or greyish green, con-colorous. Juvenile - alternate, petiolate, ovate, 7-10 x 4-6 cm, green or greyish green, con-colorous. Intermediate - alternate, petiolate, broad-lanceolate, 11-14 x 2-3.5 cm, glossy green, con-colorous. Adult - alternate, petiolate, lanceolate, 7-11 x 1.2-2 cm, glossy green, con-colorous.

Inflorescences: Simple, axillary, 7-flowered; peduncles flattened, often down-curved, 1.5-2.5 cm long; pedicels 0.2-0.8 cm long; buds 1.3-2 x 0.5-0.7 cm; hypanthia cylindrical or campanulate; opercula horn-shaped, constricted in the centre, rounded or bluntly pointed, $1^1/_2$-2 times the length of the base. Flowers October - November.

Wood: Heartwood light red-brown to dark grey-brown, with reddish streaks, of fine texture and straight of interlocked grain, very hard, strong and very tough, moderately durable, density about 995 kg/m^3, used for tool handles, mining timber, farm purposes and fuel. The bark has a high tannin content (40% or more).

Distinctive Features: A tree with bark shed to ground level often with small, scattered curling patches persisting; without ligno-tubers; pith of branchlets glandular; inflorescences 7-flowered; opercula horn-shaped, up to double the length of the base; fruits campanulate, with exserted valves.

1.2 Site Data

Mallet is particularly fire sensitive and it is said that a mallet tree dies if a billy is boiled near by. The statement may be an exaggeration but it serves to underline the extreme fire sensitivity of mallet. Natural stands of mallet develop their own form of fire protection in that they tend to form a dense canopy which screens sunlight from the forest floor (5). Undergrowth is thus very sparse and is further discouraged by the astringent quality of the litter cover (6). The extent to which an area is protected from fire is a significant determinant of mallet distribution (7).

Distribution of mallet is also affected by rainfall. Mallet is generally found in the south-west area of the state, between the 635 mm and 381 mm isohyets. This area is characterised by hot, dry summers between October and April and mild winters with occasional frosts (8).

Soil type also indicates where mallet will grow successfully. Mallet soils should be seen in the context of the extensive plateau (the New Plateau) of which they form a part. This plateau has an elevation above sea level of from 183 to 367 m. On it stand remnants of an older plateau from 9 to 30.5 m and occasionally 61 m higher. These remnants are in the form of extended hills, mesas and buttes and are in many cases flanked by low escarpments known locally as "breakaways". The surface of the old plateau consists mainly of laterite capping, laterite gravel and leached sands - soils acid in reaction. The soils of the New Plateau are loams derived from underlying granites, diorites and greenstones. They are neutral or alkaline on the surface and it is not unusual to find them overlaying acid clays at a depth of 1.22 m or more (9).

The mallet country around Dryandra can be described in terms of three main topographical features: plateaus, slopes and flats (10).

(a) Plateau

The plateau terminates in a laterite breakaway which falls for a distance of 2.44 m to 3 m. On the top of the plateau for a distance of 100 to 200 m from the lip of the breakaway, there is a laterite cap with pockets of gravely sand. This area carries stunted powderbark wandoo and occasional jarrah or marri, with a dense undergrowth of *Dryandra nobilis* and other wood shrubs. In the deeper gravel soils, further in on the plateau, there are mallee and lower dense woody shrubs.

(b) Slope

Brown mallet grows on steep slopes at the foot of the breakaway, on pinkish friable clay loam and gravel. It may grow along with powderbark wandoo lower down the slope. As the slope is descended, the gravel content of the soil decreases. Wandoo is found in this area. Between the wandoo slope and the flat proper, there may be a strip of stunted wandoo about 152.4 mm in diameter. This generally indicates a subsoil of coffee rock or granite at shallow depth. The undergrowth is dense Champion Bay Poison and white myrtle.

(c) Flat

Where the basins exceed 400 to 800 m across from lip to lip, the slopes taper off into the wandoo flat or open savannah - type forest with larger wandoo of some commercial value. The floor is relatively clean and carries low scrub and York Road poison. The soils are brown or grey sandy loams with clay at a fairly shallow depth. Some small pockets of red loam from disritic rocks carry jam and york gum and occasional wandoo. However, it is more usual to find these areas cleared for agriculture. Where there are exposures of the parent granite rock or small areas of sand overlying the rock, wandoo and jam give way to sheoak.

2. THE EARLY EXPLOITATION OF MALLET

Mallet bark was first exported from Western Australia in 1903. Its value in that year was 859 pounds. By 1905 the value of the 20,700 tons of bark exported during the year had risen to 14,087 pounds. In 1905 Dr Johannes Passler delivered a lecture in Frankfurt to the General Meeting of the Central Association of the German Leather Industry. Copies of that lecture were subsequently made available in English (11). The lecture concerned the tanning potential of mallet bark, based on tests and trials carried out with this bark at the German Institute of Investigation for the Leather Industry. The composition of mallet bark was found to be as follows (12):

Tanning substance	42.0%	variation	35.0 - 42.0%
Non tanning	7.0%		5.0 - 10.0%
Non-soluble	36.5%		
Water	14.5%		

Dr Passler drew the conclusion "that we have in Malletto Bark a tanning agent which in regard to tanning property, equals those hitherto known as the richest tanning substances such as *Dividivi algarobilla* (Mangrove bark), and in other respects it varies from them most favourably."

By virtue of the high ratio of tanning to non-tanning substances, and also the fact that the extract does not form insoluble materials on long-standing, the bark was sought after by those countries which had only tanning sources containing an unfavourably low tannin/non tannin ratio. By blending, the deficiency of carbohydrate (5.2% of the tannin) in mallet was overcome and their own tannins improved (13).

Another advantage of mallet bark lay in the fact that the tannic substances dissolve easily in water at ordinary temperature. Furthermore, mallet bark was the cheapest tanning agent at the time, with the exception of Mangrove bark (14).

The only unfavourable quality of mallet bark for tanning purposes was its colour. Although original mallet extract has a favourable colour (approx. 5 units of red; 14 units of yellow), the light-coloured leather produced takes on a decided reddish tint when exposed to sunlight. This colour does not affect wearing properties, but as it is not favoured by leather buyers, suitable blending is practised to minimise it (15).

Dr Passler assessed the mallet situation in the following terms (16):

> "All this points to the fact that in Mallet bark we have a tanning agent which, owing to its qualities, deserves the highest consideration and which may be expected to obtain a permanent footing in our Industry. In some branches it has already established itself for regular use which proves that the trial stage in these branches have been passed and have produced satisfactory results. Now the question arises whether the demand which is bound to increase can be met permanently and in satisfactory quantities even if the restrictions imposed by the Western Australian Government are observed strictly. After the first reckless exploitation of this bark - and even if provision is made for afforestation of denuded districts.

> From information imparted by Dr Diels (from the Royal Botanical Museum at Berlin, and who had conducted scientific work in Australia) it may be taken for granted that the supply of this bark is not so enormous as, for example, the supplies of Quebracho wood in South America. Thus it is more than probable that after the lapse of comparatively few years this Australian source of supply of a tanning material will be exhausted. If after practical use of this bark it really permanently establishes itself and so far there seems little reason to doubt this result, it is advisable to draw the attention of our colonial Magnates and settlers to this material in order to get them to plant this tree in suitable localities similar to the mimosa tree - also a native of Australia which has been planted for a number of years in South Africa for tanning purposes, i.e. the species *Mimosa Acacia mollissima.*" ? Ac mearnsii ?

The question of supply was not only of concern to the German importers of mallet bark. It also concerned the West Australian Government such that in a letter to the Inspector of Lands, dated 29.10.1904, the Under Secretary of Lands, R. Cecil Clifton, wrote that the Minister for Lands had issued instructions that Land Inspectors "shall pay particular attention, and report fully, when inspecting land, on the existence of any patches of mallet timber, with the view to making Reserves, when a sufficient quantity exists to warrant such a recommendation being made" (17). Once land had been reserved, regulation of bark cutting was possible.

The concern was for the perpetuity of what promised to be a profitable industry from a tree growing on some of the poorest soil in the state. The land was unsuitable for agriculture and due to the presence of poison plants was also unsuitable for pasture (18). F.T. Wake for the firm Greenwood and Wake wrote to MLA Harper "the land on which the mallet grows is absolutely useless to the Selector although it is fast being alienated from the crown and destroyed by ringing whereas if this land was reserved it would be a perpetual source of revenue to the State" (19).

The difficulty in reserving mallet areas lay in the fact that mallet grows in widely scattered localities, often in patches comprising only a few acres in extent (20). The Minister for Lands, Mr Drew, wrote to the Premier "It would never do to close up from selection any large area of the South-Western Division" (21). It was important that land with agricultural and pastoral potential be used as such. There was some concern when it appeared that Selectors were taking up land "merely for the mallet bark" (22). It seemed to flout the principle that settlers should concern themselves with agricultural and pastoral activities.

Meanwhile, there were regulations governing the activity of bark stripping in accordance with Section 110, sub section 5 of the Land Act 1898 (23). The licence entitled the holder to procure bark from Crown Land. Stripping on a reserve required a special permit (24). Strippers were compelled to fell any tree from which bark was to be taken. The trees had to be of a certain diameter and all the bark on limbs down to a certain size had to be collected. There was also a bark season; stripping being disallowed at other times (25).

It was common knowledge, however, that the regulations were being abused. Unlicensed strippers were taking bark without felling the tree. Bark was being stripped 5 - 6 m from the butt, that being as far as strippers were able to reach by the aid of long poles with a wide blade fixed thereto. Only about 25% of the available bark was collected, the rest wasted and the tree died and hardened. The wastage was deplored by the manager of the Perth Tannery, J.W. Read, in letters to J.M. Hopkins, Minister for Lands (26). Rangers were recommended to police the regulations (27).

Despite attempts at regulation, the heedless exploitation of the mallet for its bark continued unabated (28). In consequence, stocks of mallet bark began to be in short supply. The export of bark began to fall off until by 1913 the export earnings from mallet had fallen to the value of 6,127 pounds.

With the onset of World War I, the mallet bark export market closed as Germany had been the main buyer. Following the war, mallet bark continued to be exported to the Continent and the Eastern States of Australia but by 1934 few virgin areas remained (29). In 1925 there was the call for a policy "whereby this valuable bark may be made to show a bigger return to the State, and, by more careful exploitation, gradually be converted into an asset which will supply the needs of Australia and prevent some 40,000 pounds leaving the country yearly to purchase wattle bark from South Africa" (30).

3. PLANTING MALLET

By the mid 1920's the shortage of mallet was acute. The reasons for the shortage related to the loss of mallet bearing areas to agriculture, the damage caused by fire, and the stripping of immature trees (31). Serious efforts at mallet conservation and propagation appeared to be justified by the market demand at that time. The difficulty was that mallet existed in patches varying from a few acres to upwards of 100 acres. Their distribution would render fire protection and supervision uneconomical. It was suggested that the difficulty be overcome by planting the intervening country with mallet or some other species of economic value (32). Reservation of land for this purpose was the next step.

Settlers neighbouring reserved land were sympathetic so long as mallet thickets were to be thinned and protected from fire, and the reserve fired periodically to reduce the vermin problem (33). As long as Government Authorities took responsibility for fire and vermin control on reserved land, then settlers were content. However, the fact that both Government and settlers viewed each other as falling down in their responsibilities was evident in the correspondence filed 00411F209: Rabbits on mallet reserves - Narrogin District.

Despite this point of tension, reservation for purposes of mallet protection and propagation continued to proceed. In September 1924, Divisional Forest Officer Gray noted that sowings of mallet and golden wattle had already begun in order to obtain information for the basis of a planting programme. In addition, sample plots had been established on land 26 km west of Cuballing. Two of the seven plots were selected for thinning experiments (34).

It had been noted that mallet regenerated itself naturally in dense thickets, and, while height growth appeared to be rapid, diameter growth did not seem to be so rapid. Mallet saplings on the edge of the groups of regrowth attained a larger girth than dominant saplings of the same height within the groups, e.g. DBH of dominants in thickets = 76 mm-127 mm, DBH of edge saplings = 178 mm. Judicious thinning seemed to indicate increased diameter growth. The stage of development of regrowth at which thinning should take place was still a matter for experiment however (35). Experimental plots were to lead to full scale planting of mallet on South block in 1926 (36).

Where blocks were of sufficient extent, they were grouped together and known as mallet working circles. A Resident Overseer would be appointed to a working circle in order to attend to protection, thinning and extension by further sowings. Isolated areas carrying mallet regrowth, but which could not be grouped for convenient control by an overseer, were worked by mobile camps.

Notes concerning the organisation of protection and regeneration work on mallet reserves (August 1927) suggested that the area of a working circle contain at least 250 acres (101 ha) of established regrowth and include at least 2,000 acres (809 ha) of country suitable for sowing with mallet (31). Subdivision would provide for 50 acre (20 ha) compartments. Early work at Lol Gray and South block had concentrated on sowing operations before attention was paid to protection and thinning of existing regrowth. Work on future mallet reserves would reverse the order of existing practice. The Overseer would be employed from June to December thinning and stripping existing patches of regrowth, and from January to May making and burning permanent firebreaks around such regrowth. This work was to be associated with seed collection where directed. When all existing regrowth had been thinned and firebreaked, sowing would then proceed at a rate of 100 - 200 acres (40.5 - 81 ha) per annum.

The work of protection was to be a crucial part of the success of any mallet planting programme. Mallet is extremely susceptible to fire. Radiant heat of a fire up to 20 and 60 metres away could kill a group of mallet trees. As a consequence, it was necessary to have a good firebreak up to 20 or 30 metres from the group, and no severe fire was possible or permissible up to 60 metres from the group.

There was some suggestion that the richest bark-producing mallet in the past had grown on the rich moist flats and bottom lands. The demise of these stands was mainly attributed to the greater frequency of fires in this area, as compared with the fire frequency on the harsh ridges and slopes which are now generally considered as mallet country. If this were in fact the case, it has implications for firebreaking and for understanding the range of soil types where mallet can be grown (38).

Sowing areas of suitable soil type is the first principle of planting success.

Successful mallet planting hinges on a sound knowledge of the natural vegetation of the region and of the kind of soils indicated by that vegetation. Good mallet planting country is found wherever natural mallet occurs. It is also associated with all heavily timbered slopes of wandoo and powderbark wandoo. Mallet will grow on wandoo flats, but the trees are invariably short-boled. Stunted powerbark wandoo or stunted wandoo slopes are unsuitable for brown mallet regeneration (39). Details of the artificial regeneration programme are outlined in Appendix 1.

During the 1930's the annual rate of sowing was 1,000 - 1,500 acres (405 - 810 ha) (40). The vigorous sowing programme exceeded former estimates because labour became readily available by way of the unemployment relief scheme which operated during the Depression years.

The massive planting programme was not followed up with the thinning that was considered necessary to maintain the forest as a viable economic proposition. There was simply no money to pay the numbers of men who would be required for the implementation of such a thinning programme. Appendix 2 elaborates on the issue of thinning schedules.

4. THE USE OF MALLET

4.1 Tannin

The vegetable extract known as tannin has its principle use in the tanning of hides for leather. A subsidiary use is the tanning of fishing nets. Myrtan (a tannin produced from wandoo) was exported to Denmark after World War II for this purpose.

Tannin is also used in boilers to prevent the scale-forming salts from compacting together on the heating surfaces. The salts remain suspended in the water as a sludge which is periodically removed by blowing off the boiler.

The oil drilling industry also has a use for tannin. It is an ingredient in specially prepared muds which are used when drilling for oil As bores were sunk deeper and deeper, down to 4,600 m on occasions, it became necessary to make up muds using bentonite, a mineral earth of volcanic origin. These muds thicken when unstirred but become fluid when stirred. Bentonite is useful when boring stops or for changing drills. Instead of detritus, which has been bored off, sinking to the bottom of the bore and jamming the drill, the bentonite thickens while stationary and holds the detritus suspended *in situ* along the column. On recommencing boring the detritus becomes fluid again. Nevertheless, the bentonite mud has considerable viscosity even in its fluid state. Tannin can reduce this viscosity.

World wide, the major vegetable tannins are (41):

Wattle	South Africa, Australia
Quebracho	South America
Cutch or mangrove	Malaya
Chestnut	France, Corsica, Yugoslavia, Italy, U.S.A.
Myrobolans	India
Valonia	Turkey, Syria
Myrtan	wandoo from Australia

In 1950, two of the main sources of the world's tannin viz. Quebracho and Chestnut, appeared to be approaching exhaustion. The future market for local tannin-bearing material seemed to hold good prospects. The mood of the time was optimistic:

"With the State's present requirements equivalent to about 1,600 tons (1,626 tonnes) of bark per year, allowing for increased population and increasing industrialisation of the country the aim should be at not less than four times that quantity for local tanning alone. With its use in synthetics tannin may be still further demanded, e.g. pressed board with tannin-formaldehyde bonding. Enquiries from overseas for the material indicate that there are potential markets outside of Australia for it" (42).

The optimism was reflected in the interest shown in tannin-bearing potential of a variety of local trees (43). Mallet held out the greatest potential. The tannin content of the bark was high, regeneration from seed was relatively easy and it could be grown on land unsuitable for agriculture.

In the early 1950's, bark production could not always meet the demand from buyers like Rosenstamm, Henry Wills, Joyce and Watkins, W.A. Tanners and Fellmongers, and Pearse Brothers (44). To meet local demand, the Forests Department itself began stripping operations in 1952. Bark was stripped and tied in bundles 1 m long; each bundle weighing about 22.5 kg. The bark had to be heaped up on poles off the ground and not removed until inspected by an officer of the Forests Department, and authority to remove it given in writing (45).

After 1957, the Forests Department supplied its bark chipped and bagged from its chipping plant at Dryandra. The plant was set up to provide gainful summer employment for the work-force who were employed in the maintenance and protection of the plantations. It was also set up as a measure to save on the costs of production. Bark in a chipped and bagged condition would then be disposed of by public tender (46).

The following table of mallet bark produced between 1953 and 1965 shows that there was a rapid fall-off after 1959 (47).

	Supplied by Forests Dept. (tonnes)	Obtained Under License From Crown Land (tonnes)	Obtained From Private Property (tonnes)	Total From All Sources (tonnes)
1953	50	153	1,049	1,252
1954	79	61	653	793
1955	55	101	108	858
1956	170	138	1,032	1,340
1957	151	143	735	1,029
1958	181	46	630	857
1959	233	78	743	984
1960	148	20	343	511
1961	189	9	377	575
1962	129	9	59	197
1963	100	14	207	324
1964	136	Nil	188	324
1965	87	Nil	212	299

Early indications of this fall-off were becoming evident in 1956 when the shortage of the world's vegetable tannins became a surplus. Large stands of Quebracho had been discovered and there was the prospect of South Africa's wattle plantations coming into production between 1960 and 1965 (48). The price offered for mallet bark fell in consequence.

Labour for bark stripping was by now in short supply. Other agricultural pursuits had opened up and bark stripping was no longer an attractive option (49). After the stripper had paid for the costs of the operations, he was left with very little, if any, margin of profit.

Bark strippers were also having to cope with the new measure whereby buyers set their prices at the point of seaport delivery. Strippers in the Narrogin district thus found themselves disadvantaged in comparison with strippers in areas closer to the point of delivery (50).

This situation was aggravated by rising royalty costs. These were designed to compensate for the loss entailed in low market prices and rising costs of production (51). Labour was asking a higher price. The cost of stripping had also risen because plantation trees were found to have thinner bark than the natural stands (52). More time and effort was therefore involved in harvesting the bark.

A radio broadcast by Mr Hillis of the CSIRO in 1959 (53) went some way towards interesting farmers in bark stripping but the tide had already turned against the industry. In 1958 the Forests Department found that it was producing more bark than it could dispose of locally. Local buyers were not prepared to pay the asking price (54). They were having difficulties with shipping. The price of shipping freight had risen and there were wharf stoppages to deal with. Rail charges had also risen and so had the cost of wages (55).

In 1961 Industrial Extracts closed its Boddington factory (56). In 1962 the biggest bark buyer, Rosenstamm, closed down (57). It was reported that reduced demand for leather was behind the closure. Competition from synthetics was seen to be the cause. The President of the W.A. Tanners' Association was quick to respond, however (58). All three of the remaining tanneries in W.A. had increased production to cope with the demand for leather. Despite increased use of synthetics, people continued to recognise leather as "still the best for foot comfort and health."

The malaise in the tannin industry was, however, much more pervasive than increased competition from synthetic products. By 1968 Henry Wills had closed down its operation in bark (59) and in 1971 the last of Australia's tannin producers ended operations (60).

4.2 Timber

Mallet plantations were established to provide tannin extract. It was never considered that mallet size and quality would support an economic timber industry - excepting possibly for handle manufacture, for fence posts and firewood.

As long as there was a market for tan bark, bark production rather than timber production was given priority and protection. Following the cessation of bark sales it was clear that any commercial future of the mallet forest would rest largely with utilisation of mallet timber in the limited spheres mentioned already (61). It was felt that "without more or less complete utilisation of the wood, either poles from thinnings or larger dimension from natural stands, the wastage of this valuable timber would be too great to warrant the exploitation of the stands we have for bark production alone" (62). It became necessary to insert into mallet stripping permits a clause insisting on felling of trees at ground level instead of axe-handle height. This would leave the bole of the tree unsplit and suitable for milling (63).

The timber of brown mallet has qualities which make it ideal for use as tool handles. The timber is pale brown, straight-grained and very strong. Shear and cleavage strength are high. Shrinkage is very low for its density. Shock resistance is very little inferior to hickory and in static binding it has about the same strength as Queensland spotted gum and is more than 30% stronger than hickory (64).

There were difficulties, however, in the establishment of any sort of mallet timber industry (65). There was the problem of supply of timber. The comparatively young age and small size of most of the mallet trees meant that timber suitable for sawn logs was in short supply (66). There was, however, a ready supply of firewood and mining timber in sizes from 25 mm crown upwards (67).

While bark was still being collected, the timber industry had to link with the stripping operations. Frequently there was a "conflict of interest in the two markets which would preclude their joint operation" (68). Tool handle logs must be processed within 48 hours of cutting and so are obtained in small quantities continuously throughout the year. Mallet bark can only be stripped in winter when the bark is loose. At any other time of the year bark cannot be removed except by machine and if bark is removed from fence posts by machine, damage to the sapwood zone will reduce the efficiency of their impregnation with preservative and consequently, in the long term, their market value (69).

There could be no guarantee of the supply of wood while bark operations were ongoing. By the 1970's, however, the bark industry had fallen away. Assessment of mallet volume in terms of handle and fence post output became an important concern to the Forests Department and the industries concerned (70).

Mallet timber has been considered as useful for various purposes. It provided firing sticks and lagging to the mining industry (71) and Boy Scout staves (72). It was also considered for use as spools or spindles for the winding-on of man-made fibres (73), picking sticks in textile looms (74), low Voltage Circuit Breakers (75), walking sticks (76), sheep hurdles (77), craypots (78), cant hook handles (79), skewers and dowelling (80), hockey sticks (81), skis (82) and archery bows (83). More recently the timber has been used to meet the needs of the Colonial Drum Stick Company in its manufacture of musical instruments (84).

The most enduring uses of mallet in the timber industry have, however, been for fence posts and tool handles.

4.3 Fence Posts

The timber of mallet is particularly susceptible to termite attack. Tests on fence post preservation were jointly undertaken by the Forests Department and the Department of Agriculture in 1930-1. Eight years after treatment, the superiority of creosote and oil was apparent. The method was to fill petrol drums with the preservative solution to a depth of 46 cm; heat to 210 degrees Fahrenheit. and stand the posts in the solution. As liquid was absorbed, more was poured in. After 21 years the creosote-treated posts were still in good condition (85).

Creosote is a bulk distillate of coal tar oil, a compound with over 150 chemicals. In 1971 it was considered that creosote was not viable for use on a commercial scale.
Copper-Chrome-Arsenic (C.C.A.) was seen to be clean to handle and left the post dry within a very short time (86). 'Celcure' C.C.A. treated mallet fence posts were displayed at the Narrogin Agricultural Show by Mr W. Beacham (87). They were favourably received. The demand was there. Old fences were no longer suitable in situations where more farmers were converting from agriculture to beef. Whereas paddocks had been hundreds of hectares in area, they now required smaller 16 hectare paddocks. New fences were needed for "back-scratching" cattle. Fence posts needed to be higher: 1.8 m instead of 1.67 or 1.75 m.

The problem was that there was no money for the fencing that everyone agreed needed to be done. Not until farm economics improved would it be feasible to sell a useful quantity of treated posts. To prepare for that time, it was proposed to treat a sample batch of about 1,500 with Celcure C.C.A. in the Department's Forests Production plant and have these scattered about the district in prominent fences in lots of about 100 (88). Notions of proper fence treatment at this time emphasised the importance of stapling fence wire and not boring holes in the treated posts. It was felt that the whole principle of treated fence posts pre-supposed that the outer coat of preservative be kept intact.

In 1976, Dryandra Wood Products began producing fence posts and strainers at Cuballing. Their method of treatment involved 'cooking' the green posts in creosote for about 6 hours in virtually a sap displacement technique. In order to conserve heat in steel vats, they were sunk into the ground and the earth wall around the excavation was lined with plastic. This ensured that the fill between the vats and the plastic was dry. The company had also purchased a driller which could bore up to 8 holes in a fence post if so desired (89). The notion of proper fence treatment had changed.

The company began by using thinnings from Bald Rock and Montague Blocks. They had the assurance that their supplies could be met for 5 years to 50,000 pieces per year (90). The following table shows the company's output 1976-82 (91).

	Fence Posts and Rails	Strainers and struts
1976 - 77	33,391	1,288
1977 - 78	12,222	364
1978 - 79	29,220	1,768
1980 - 81	31,530	1,994
1981 - 82	50,657	2,805

In 1981 the company applied to be permitted 100,000 pieces instead of the 60,000 it had been allowed (92). In 1986, it was using only about 20% of its permitted timber take (93).

4.4 Tool Handles

In the early 1940's, the Forests Department began to think about setting up a saw mill and wood turning plant in mallet country. The possibility of Departmental conversion to handles was considered in order to provide part-time work for employees. While plans for this eventuality were going ahead, an application was received from Mr Cohen of Midland Junction who was seeking supplies of mallet timber for the manufacture of tool handles.

Between 1942 and 1944 Mr Cohen received 124 tons of timber supplied by the Forests Department. This was made into 18,400 graded handles and graded: firsts 30%, seconds 40%, thirds 30% (94). The Forests Department was concerned that quality control should take priority. Chalk markings of grade were therefore replaced by brands stamped onto the handles. This was to ensure the good name of mallet as an axe handle timber (95).

The Cohen axe-handle business went into eclipse after 1944 but during the early 1950's there was a revival of interest in mallet timber for tool handles. Tests were proving its suitability for this purpose (96).

In 1967, Mr Arthur Hunter established his tool handle business in Narrogin. In 1971, Mr Hunter sought assurance of timber supply over the next 10 years. He saw his production rising from 33,000 handles per annum in 1971 to about 120,000 handles in 1976 and continuing at this annual rate thereafter. The Forest Department was able to give this assurance. The plan was to arrange for 3 trial areas of about 2 acres each within the pre 1942 plantation areas (97). Within these areas, crop trees would be marked for retention at the rate of 100, 200 and 400 stems per acre - the balance of the crop would then be made available for tool handle timber cutting. Following the tool handle cut, the area would be cut for fence posts and then firewood, so that there would be complete utilisation of all marketable produce, less the crop trees (98).

In 1981, it was noted that Mr Hunter had been permitted to take 820 tonnes of mallet per year. Since June 1974, he had taken an average of 224 tonnes per year or about 27% of his permissible intake (99).

5. THE POST-PLANTING PERIOD

The sowing of mallet for commercial use ended in 1955. Since 1955, the main purpose for establishing mallet plantations, namely, the production of bark for tannin, has been lost. The commercial use of mallet timber remains on a relatively small scale. Despite this loss of a major commercial purpose for the plantations, the value of the area for conservation of flora and fauna, scientific purposes and recreation has been recognised by forest managers. The importance of the Dryandra Forest (State Forests 51 and 53) as an area where these values are given priority becomes evident when related to the areas of similar forest destroyed by the agricultural industry over the same period.

6. NOTES AND REFERENCES

NOTE: File numbers refer to CALM departmental files.

Information within files is located either by file page number or the date of the correspondence.

1. Boland *et al.* 1984:390.

2. *Eucalyptus sargentii* is more generally known as Salt River Gum.

3. Cooper 1962:7.

4. It has been suggested that the mallee forms are probably different species now and not true mallet (Personal communication, Ken Atkins).

5. Hunter 1970:3.

6. Personal communication Ken Atkins. Transcript of talk with Arthur Hunter.

7. This point was stressed by Dick Perry (see transcript). Mr Perry's oral history was also recorded in July 1982 by Helen Bradbury and is now housed in the Battye Library in Perth.

8. Hunter 1970:3.

9. Brockway and Hillis 1955:32.

10. The description of soil type and vegetation characteristic of plateaus, slopes and flats is taken from a paper prepared by John Currie for the Lions Club of Narrogin.

11. 005125F1551:43-59

12. Soluble non-tanning substances include sugars, starches and other carbohydrates, nitrogenous compounds and inorganic salts. By fermentation, some of these substances give rise to acids (e.g. lactic and acetic) which are essential in order to neutralise and remove any lime that may be present in the untanned hide, and to assist enlargement of the surface of the hide and cause plumping or swelling of fibres to facilitate penetration of the tannins. Also non tannins give a certain amount of firmness to the leather. (Cooper 1962:11).

13. Cooper 1962:11.

14. 005125F1551:48

15. Brockway and Hillis 1955:40.

16. 005125F1551:57-8

17. *ibid*:29.10.1904.

18. *ibid*
"There is a Timber Reserve of 92 acres [Reserve 10847] which joins my homestead, the mallet bark has been stripped, and there seems no use for it now as a reserve. It is full of poison and a death trap for any stock that may get out of my paddocks, and I would be glad if you will throw it open for selection and advise me when you are doing so, or clear the poison." (Letter from Mr T M Hallet, 25.6.1919).

19. *ibid*:16.10.1903.

20. *ibid*:03.11.1903.

21. *ibid*:06.09.1904.

22. *ibid*:30.07.1904.

23. 276/04:25.08.1904.

24. *ibid*:23.06.1904.

25. *ibid*:The details of the regulations were subject to minor changes. See 26.06.1905, 28.09.1905, 12.01.1905.

26. *ibid*:03.08.1904, 10.08.1904.

27. *ibid*:16.08.1904.

28. 005125F1551:22.04.1907.
010683F2910:13.07.1908.

29. In 1934 bark went to:

Eastern States	1,355	tons
Netherlands	528	tons
Germany	160	tons
Belgium	52	tons (Langlands 1937:10).

30. *The Australian Forestry Journal* 1925:211.

31. 008751F2301:72.

32. *ibid*:7,72.

33. 011426F3003:11.

34. 008751F2301:5-6.

35. *ibid*:7.

36. The scattered areas of land west of Cuballing were the 'blocks' which would later make up the Dryandra State Forest.

37. 008671F2304:1-4.

38. 008751F2301:83-4.

39. Cooper 1962:19.

40. 011416F3001:31.08.1934.
1408/33:31.08.1934, 24.08.1937
By the 1950's it was difficult to find sufficient labour prepared to work in the mallet forest. See 010778F2910:28.05.1954.

41. Cooper 1962:49.

42. 008751F2301:153.

43. 005281F1560:26.06.1953, 18.10.1953, 21.07.1955, 05.09.1955
GE/2:13.07.1954, 07.09.1954
Cooper 1962:59
Brockway and Hillis 1955:31.

44. 010778F2910:76.

45. 219/60:152.

46. 003056F0909:15.

47. *ibid.*

48. 005332F1560:125

49. 219/60:11.04.1960.

50. 004910F1458:65.

51. Cooper 1962:27.

52. 184/57:24.06.1961.

53. GE/2:3.

54. 005304F1551:18.12.1963, 23.03.1961, 05.12.1960.

55. 184/57:18.02.1961.

56. Cooper 1962:55.

57. *The West Australian* 10.02.1962.

58. *ibid*:13.02.1962.

59. 004889F1458:09.09.1968.

60. 005419F1560:17.12.1982.

61. 005449F1531:36, 54, 55.

62. 219/60:137
005332F1560:149.

63. 003637F1101:18.05.1956.
005448F1531:11.03.1943.

64. Langlands 1937:19-20.

65. 003056F0909:18.11.1965

66. 183/57:29.10.1957.
613/42:06.04.1967.
005341F1331:22.06.1964.

67. 005449F1531:29.12.1953.

68. 005332F1560:165.
See also 005449F1531:29.12.1953.

69. 005332F1560:08.11.1973.

70. *ibid*:07.12.1973.
005449F1531:129-31.

71. 005349F1503:1-164.
005350F1503:5, 13-14.

72. 296/33.

73. 004060F1112:27.02.1976.

74. 613/42:11.09.1942.

75. 005448F1504:159.

76. 613/42:22.02.1952.

77. *ibid*:13.02.1946.

78. *ibid*:23.07.1946.

79. 183/57:04.09.1957.

80. 10/9:06.12.1957.

81. Personal communication, Des Muir.

82. 613/42:23.07.1946.

83. *ibid*:10.08.1953, 03.06.1958.

84. 005450F1531.

85. GE/2:13.07.1954.

86. 10/9:10.03.1971.

87. *ibid*:26.10.1971.

88. 005342F1591:11.12.1971, 08.03.1971.

89. 004060F1112:*The Countryman* 24.06.1976.

90. 005449F1531:21.10.1975.

91. 004060F1112:134.

92. *ibid*:105.

93. *ibid*.

94. Mr Cohen's production of first grade handles was not sufficient to make the venture economically viable. This is the view of Arthur Hunter (see transcript).

95. 005448F15:101.

96. 613/42:13.12.1945, 24.06.1953, 05.08.1953.
10/9:21.04.1972.

97. Arthur Hunter doubts whether this plan was ever carried out. He has no knowledge of it.

98. 10/9:08.03.1971.

99. 005449F1531:16.07.1981.

100. The age at which viable seed is produced from mallet is not known conclusively. Suggestions range through 5 years (008751F2301), 6 - 8 years (Cooper 1962:29) to 12 - 15 years (002066F0806).

101. Experiments to determine the most suitable manure or mixture of manures to improve the rate of growth were begun in 1935 but no clear results were obtained (1315/35). The best seed bed remains an ash bed. The mineral salts in the ash allow for rapid growth in the early years; the ash beds retain moisture during the early stages of growth; burning reduces scrub competition and sterilises the soil, so aiding germination (Cooper 1962:31).

102. The recommended distance was soon to change to 2 m x 2 m. See also 190/32:19.11.1937 and Cooper 1962:31.

103. 011466F3003:102.

104. 18.13.1:3.

105. 005342F1591:1.

106. Brockway and Hillis 1955:36.

107 005419F1560:43-8.
003046F0935:1-121.
008770F2301:22.
002963F0909:22-47.

108. 002963F0909:13.01.1959.

109. 00875F2301:90.

110. 003056F0909:16.

111. 003046F0935:1-121.

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8. APPENDICES

APPENDIX 1

GLOSSARY OF PLANT NAMES

Champion Bay Poison	*Gastrolobium oxylobiodes*
Hickory	*Carya sp.*
Jam (Raspberry Jam)	*Acacia acuminata*
Jarrah	*Eucalyptus marginata*
Marri	*Eucalyptus calophylla*
Powerbark Wandoo	*Eucalyptus accedens*
Queensland Spotted Gum	*Eucalyptus maculata*
Sheoak	*Casuarina fraserana*
Wandoo	*Eucalyptus wandoo*
White Myrtle	*Hypocalymma angustifolia*
York Gum	*Eucalyptus loxophleba*
York Road Poison	*Gastrolobium calycinum*

APPENDIX 2

(Quoted from File 002066F0806)

ARTIFICIAL REGENERATION OF BROWN MALLET

(Eucalyptus astringens)

GENERAL

A number of years of experimentation and commercial regeneration of brown mallet by the Forests Department in the Narrogin District has proved conclusively that the regeneration of this species is very easy and cheap.

Although it is found that mallet can be established on a large number of soil types, the farmer is primarily interested in its establishment on areas considered unsuitable for cropping or grass growing. The ideal type is the rough mallet breakaway and the adjacent slopes. However, its satisfactory establishment is also possible on the gravelly slopes carrying tall powderbark or wandoo. Where the wandoo or powderbark is stunted results are seldom satisfactory. York gum, jam and sheoak country is not generally suitable for mallet regeneration. There are considerable areas of suitable mallet land, privately held along the Great Southern Railway.

Regeneration by burning under seed trees is not recommended, as the method is not always certain, owing to the destruction of seed by the fire, and the resulting crop is confined to patches of excessively dense stands separated by more or less unstocked areas. The method outlined below, that of "Spot sowing" seeds, is very cheap and should result in up to 95% germination and survival.

COLLECTION OF SEED

The trees from which seed is to be collected should be carefully selected, large, well-formed, well-grown, mature trees ensuring seed which will give the best results in plantation (100).

All branches carrying mature seed vessels (gum nuts) are lopped and spread out on a tent fly or other suitable sheet, which is staked out on the ground in such a way that the corners are elevated 18" (46 cm) to 2 ft (61 cm) above ground level, forming a large shallow basin in which the seeds and chaff collect. Coarse Hessian is useless, since the seeds are very small, and would be lost. A 12 ft (3.7 m) x 14 ft (4 m) sheet made from superphosphate, bags would be ideal if tent flys are not available.

If a large amount of seed is required, several such sheets should be used to save time.

The branches are thrown loosely on the sheets to provide for free circulation of air, and a pole may be rigged up, say 3 ft (1 m) above the sheet, on which other branches may be leaned.

Two or three days of bright sunlight opens the seed vessels and the seed and chaff falls out on the sheet. The branches are now thrown off, after being well shaken to remove all the seed, and the residue left on the sheet is sieved to remove twigs, leaves and seed vessels that may become broken off; the seed and chaff remains. It is practically impossible to remove the chaff from the seed, nor is it necessary.

The handiest sieve for this job is made by cutting a petrol tin in halves lengthways, and replacing the bottom of the container thus formed with zinc gauze. The perforations of this material are most suited for the work, and are preferable to punching holes in the tin, as the latter method results in uneven perforations which are either too large or too small. Fly wire is not suitable, as the material in the sieve clogs between the cross wire strands. If zinc gauze is not available, small holes $^{1}/_{12}$th to $^{1}/_{10}$th inch (2 to 2.5 mm) in diameter punched in the bottom of the tin will serve.

Seed can be collected during the months from November until March.

REGENERATION

It must be realised that to obtain the best results mallet seed must be sown on ash beds (101). The ash left after the burn plays a very important part in securing rapid development in early years.

The correct method of procedure is:-

1. The area to be regenerated is "chopped down" no grubbing or ploughing is necessary. It is also advisable to slash all tall scrub, say everything over 3 ft (1 m). This ensures a good even ash bed over the whole area.

2. After a summer on the felled area, it is burned up at the opening of the burning season with as fierce a fire as possible. It may be as well, at this juncture, to sound a note of warning with regard to the burning operations. Every precaution should be taken to prevent the escape of the burning-off fire. The area to be burned will be in a highly inflammable condition, with all the trees down, and all the very tall scrub slashed and dry, and the resulting fire is liable to be dangerously fierce, and will escape if adequate breaks are not provided.

3. The sowing is started immediately after the burned area has cooled down, and must be completed not later than the end of May, or the first week in June.

4. Method of Sowing

   At intervals of approximately 5 ft (1.5 m) in lines 4 ft (1.2 m) apart, "spots" are cultivated with a light garden hoe with a shortened handle (102). The "spot" is a circular cultivated area, approximately 1 ft (30.5 cm) in diameter, and 4" (10.2 cm) deep. The soil is merely loosened and stirred up, not excavated and refilled, as this would tend to place all the ash at the bottom of a hole filled on top with raw soil, which is a condition to be avoided.

The earth is firmed down with the foot, leaving a saucer-shaped depression to retain moisture; the saucer should not be too deep or the seeds will be smothered with wash from the burned area; an inch deep at the centre is ample.

A small pinch of seeds (3 - 4 seeds) is scattered over the spot, not deposited in one heap, and a light dusting of earth is kicked over the seeds.

The absolute necessity of sowing on an ash bed must be realised by any one attempting to regenerate brownmallet; even if it means deviating somewhat from the regular spacing; patches of ash must be followed up in the sowing. No spot should be prepared in the centre of a heap of ashes, but seeds may be sown on the edge of the heap left by burned logs, but it must be thoroughly understood that, if there has not been a good complete burn resulting in a good ash bed over the area, the germination and subsequent growth of seedlings will not be satisfactory.

5. Quantity of Seed

For a spacing of 5 ft x 4 ft (1.5 m x 1.2 m) from three quarters to one pound of seed is required per acre, and a tent fly well filled with good seed-laden branches may yield up to 4 pounds (1.8 kg) of seed, but this, of course, will vary with the amount of seed vessels on the branches.

6. Future Treatment

After sowing no further attention is necessary until the plantation is 3 years old, when it will need sucker-bashing to liberate the young mallets from the competition of the suckers. At the same time the firebreaks around the plantation will need attention to ensure that no fire gets in while the based suckers are in an inflammable condition.

After this first sucker-bashing, which must not be delayed beyond $3^1/_2$ years nor carried out before the plantation is 3 years old, further treatment will vary with each individual plantation, and must be decided upon after inspection of the condition of the stand.

A final note of warning: Just as the absolute necessity of a good burn in the felled area has been stressed, so also must be stressed the absolute necessity of keeping fire out of the established plantation. Brown mallet is exceptionally fire sensitive, and the radiant heat of a big fire up to two chains away is liable to kill, or seriously damage even fairly old trees. Good breaks must be provided around the plantation, and these must be kept in order until the stand is in such a condition that is is no longer in danger from fire, and that will not be until it is nearly ready to strip.

Advice on any particular problem arising is always available from officers of the Department in the District.

APPENDIX 3

ROTATION AND THINNING

The schedule of rotation and thinning is dependent on the purpose for which the mallet is required. Its implementation is further dependent on a sound knowledge of the growth rate of mallet. The following table of figures was drawn up in 1952 and is based on measurements of trees from Dongolocking. the figures in brackets are from mallet stands at Dryandra (103).

Age (Years)	DBH (cm)
5 (15)	20.0
15 (20)	25.0
18 (25)	30.5
37 ($32^1/_2$)	38.0

Thinning prescriptions based on crown room (104) were not sufficiently heavy to ensure sustained vigorous growth. The semi-arid nature of the area meant that thinning should be based on empirical stem spacing that was estimated to ensure adequate moisture to sustain growth. The following schedule was established in 1964 (105):

Codominant Height of Stand (metres)	No. of Trees/Acre (0.4 ha)	Average Spacing (metres)
6	300	3.6
9	140	4.0
12	180	4.6
15	140	5.0

While bark yield was the major concern, it was necessary to collect data which related to bark thickness to density of the stand (106).

Even though various thinning experiments (107) were conducted there was still the call for more data covering the effect of spacing on bark thickness. "There is a firmly held conviction that widely spaced trees have thick bark but there appears to be nothing in the way of accurate measurements to support this" (108).

The following 35 year rotation schedule was proposed in 1938 (109):

Age	Trees per Acre (0.4ha)	Volume Timber (cu.m)	Bark (kg)	Thinnings Trees	Yield Timber	Bark
10	1,000	-	-	300	-	-
15	700	20	2,538	200	204	1,640
20	500	30	4,309	200	480	3,830
25	300	58	7,360	100	691	5,452
30	200	90	11,498	100	1,597	12,776
35	100	86	11,059	-	-	-
					Final Cut	

It was subject to adjustment depending on the relative importance of bark and timber. For example, in 1965 it was noted that unless sales of firing sticks were to be made, thinning would seldom be carried out on trees which were below a height of 9 m (110). In 1974, the objectives of thinning were re-orientated towards providing only for the immediate demands of the tool handle industry. This would involve careful selection and relatively frequent light thinning on about a 5 year cycle of stands of marketable size. It would also involve thinning stands of non-commercial size in order to release selected crop trees. This thinning programme would be accompanied by the establishment of thinning, spacing and treatment demonstration plots (111). Collecting information about thinning was still a priority.

APPENDIX 4

ANNUAL MALLET PLANTINGS 1926 - 1956 (From File 008770F2301)

1926 - 27	159 hectares
1928	47 hectares
1929	67 hectares
1930	112 hectares
1931	140 hectares
1932	394 hectares
1933	599 hectares
1934	610 hectares
1935	512 hectares
1936	630 hectares
1937	597 hectares
1938	599 hectares
1939	282 hectares
1940	356 hectares
1941	627 hectares
1942	528 hectares
1943	54 hectares
1944	364 hectares
1945	136 hectares
1946	12 hectares
1947	Nil
1948	112 hectares
1949	87 hectares
1950	121 hectares
1951	127 hectares
1952	8 hectares
1953	2.4 hectares
1954	67 hectares
1955	22 hectares
1956	Nil

9. MAPS AND ILLUSTRATIONS