Management of Mopane in Southern Africa

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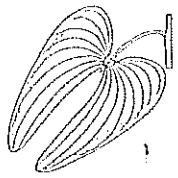
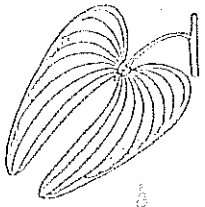
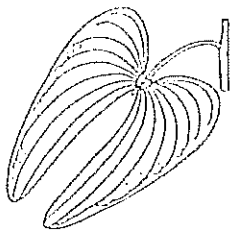




CHAPTER SIX

PROSPECTS FOR THE SUSTAINED UTILIZATION OF MOPANE (*COLOPHOSPERMUM MOPANE*) FOR CHARCOAL PRODUCTION IN THE VENETIA LIMPOPO NATURE RESERVE, SOUTH AFRICA.



Peter Cunningham [a]

ABSTRACT

The ecological feasibility of the sustained utilization of *Colophospermum mopane* (mopane) for charcoal and firewood production was investigated in three vegetation types including mopane woodlands in the Venetia Limpopo Nature Reserve (VLNR), South Africa. Highest densities of mopane are found in mopane woodlands on Oakleaf (OaB), Valsrivier (VaA and VaB), Dundee (Du) and Swartland (SwB) soils. Oldest average ages per tree and highest weights per hectare were also found in mopane woodlands. A strategy of harvesting between 25 - 50 % of mopane trees should be economically and ecologically viable. Harvesting levels of 25 - 50 % would yield mean weights of between about 3,700 kg/ha and 7,400 kg/ha of wood with charcoal potential.

Keywords: *Colophospermum mopane*, mopane woodlands, density, charcoal production

INTRODUCTION

Colophospermum mopane (Kirk ex Benth.) Kirk ex J. Léonard, commonly known as mopane, forms a widespread woodland throughout southern Africa. This is a largely unexploited resource in many areas. Mopane distribution is limited to south-central Africa (Fig. A) with the trans-continental extension including countries such as South Africa, Namibia, Angola, Botswana, Zimbabwe, Zambia, Malawi and Moçambique (Obermeijer 1933, Coates Palgrave 1956, Palmer and Pitman 1961, Von Breitenbach 1965, De Winter *et al.* 1966, Kromhout 1967, Louw 1970, Palmer and Pitman 1972, Coates Palgrave 1983, Gertenbach 1987). It has good burning properties which makes it important for firewood and charcoal utilization (Codd 1951, Coates Palgrave 1956, Palmer and Pitman 1961, Von Breitenbach 1965, De Winter *et al.* 1966, Palmer and Pitman 1972, Ayensu 1980, Coates Palgrave 1983, Prior and Cutler 1992). It may be possible to provide a sustained yield of mopane for charcoal production. The aim of this paper is to determine the association of soil type with mopane and to determine growth rates and yields in various mopane-dominated vegetation types within the Venetia Limpopo Nature Reserve. This may allow mopane to be utilized for charcoal production on a sustainable basis.

METHODS

Study area

The Venetia Limpopo Nature Reserve (VLNR) is situated in the north-western corner of South Africa (Northern Province) close to the confluence of the Limpopo and Shashe rivers (Fig. 6.1). The 36,000 ha reserve belongs to De Beers Consolidated Mines. This is a semi-arid region with a mean annual rainfall in summer of 384 mm. High summer temperatures of greater than 40 °C are frequently registered and frost seldom occurs. The area is generally classified as mopane woodland with three main mopane vegetation types occurring on the reserve (Fig. 6.2). These

Figure 6.1: Location of Venetia Limpopo Nature Reserve

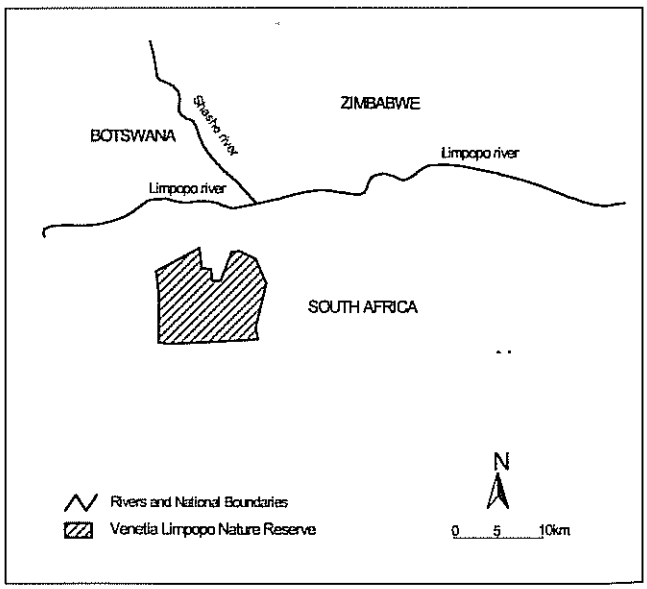


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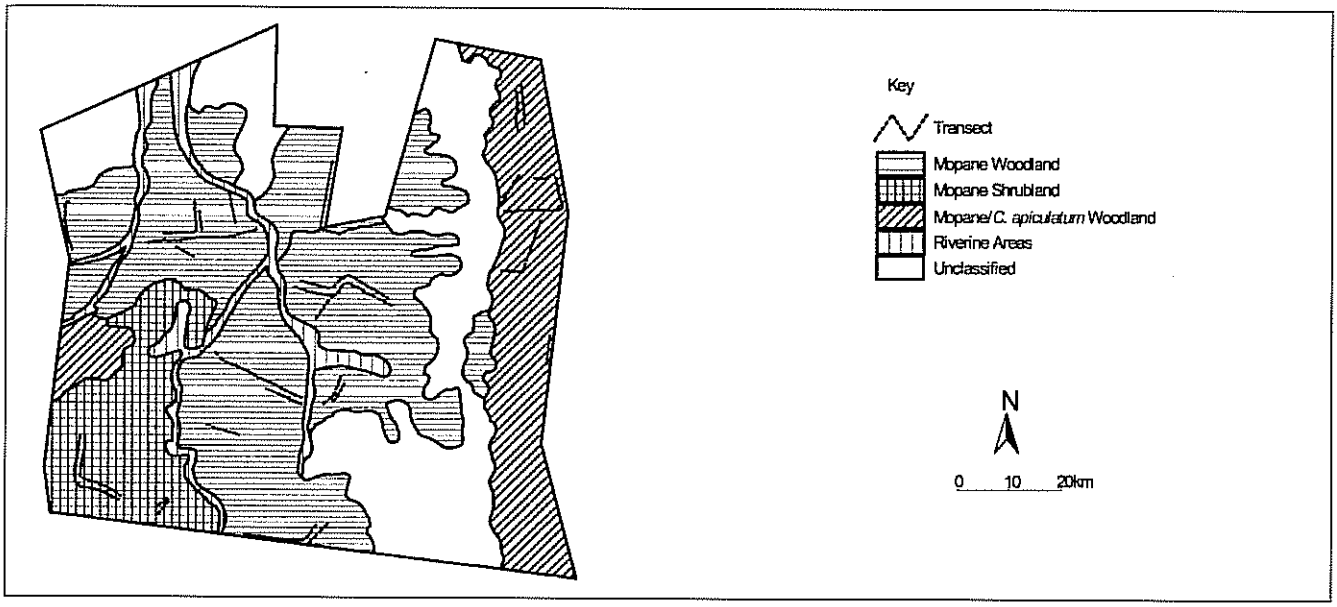
Figure 6.2: Vegetation types of Venetia Limpopo Nature Reserve (VLNR) (after O'Connor 1991)



are mopane woodland, mopane and *Combretum apiculatum* open woodland and mopane shrubland.

Field methods

Soil maps of the area were used to determine associations between soil type and vegetation type. The correlation between mopane performance and selected physical properties was examined using simple, multiple and stepwise regression analysis. One-way and multifactorial analysis of variance were also used to analyze the effects of vegetation type and soil type on the following dependent variables; density, height, circumference, senility, age, growth rate and biomass.

Two hundred sampling plots, each 10 m x 10 m in size, were placed 300 m apart in the three vegetation types (Fig. 6.2). The following was determined for each tree in each plot; the number of mopane and other trees present, height (m) and circumference of each stem (cm), number of stems per tree, senility criterion (% canopy dead) and browse damage caused by elephant *(Loxodonta africana)* and eland *(Taurotragus oryx)*. Two hundred random sample trees were harvested (one in each plot) and the following was determined for each tree; total wood weight (leaves included), charcoal weight (leaves and stems with circumference less than seven centimetres discarded), age (ring counts) and growth rate (mean circumference / age).

Estimating yields

A preliminary harvesting model was developed using a Quattro Pro spreadsheet and optimizer functions. Circumference data were placed into one centimetre classes from 3 - 30 cm and into two centimetres classes from 30 - 72 cm. The number of stems in each class was calculated and entered into the harvesting model. A five-year harvesting interval was implemented up to 60 years. The dependent variables (initial population, trees to be harvested, trees remaining after harvesting, yield and promotion proportion) were calculated for all circumference classes. Average mopane woodland growth rate (0.59 cm/yr) was used to determine promotion between circumference classes. The assumptions made for the model were that populations of harvestable stems (circumference) would decrease over time, that harvestable yields would decrease over time and that promotion from one circumference class to another would increase initially due to initial promotions and then decrease with time. The optimizer facility of Quattro Pro was used to determine best harvesting rate over time (60 years).

RESULTS

Estimated mopane densities (trees/ha) for the three vegetation types including mopane, as well as comparable data from other areas in southern Africa, are presented in Table 6.1. In the VLNR the density of mopane was greatest in the mopane woodland. There was a considerable difference in density between mopane woodland and the other two vegetation types. Other tree species make up a small portion of the species present in a monospecific stand of mopane woodland. Mopane woodland had the lowest density of "other" tree species present compared to mopane shrubland and mopane / C. *apiculatum* open woodland (Table 6.1).

Results for VLNR do not differentiate between shrub and tree components of mopane. If the shrub component is also taken into consideration, there appears to be little difference between the range of densities in Klaserie Private Nature Reserve, Kruger National Park, Sengwa Wildlife Research Area and those on VLNR. Results indicate a negative correlation between density and circumference for mopane. Mean circumference of mopane decreases with an increase in density. Intra-specific competition for resources is suggested for this trend.

Research results comparing the different vegetation types for VLNR are presented in Table 6.2. The growth rate is

Table 6.1: ***Colophospermum mopane*** **density estimations for Venetia Limpopo Nature Reserve and other areas in southern Africa.**

Regions	Trees / ha	Trees / km²	Other species / ha
mopane woodland [1]VLNR	2,289 ± 72		* 187 (8.2%)
mopane shrubland [1]VLNR	830 ± 68		* 147 (17.7%)
mopane *C. apiculatum* woodland [1]VLNR	727 ± 44		* 300 (41.3%)
[2]Klaserie Private Nature Reserve RSA	475 - 2,833		
[3]Kruger N P (RSA)	369 - 1,757		
[4]Etosha N P (Namibia)	189 - 381		
[5]SLNP (Zambia)		1,500 - 1,900	
[6]S/E Zimbabwe	150 - 380		
[7]Sengwa Wildlife Research Area (Zimbabwe)			
Trees:	542 - 581		
Shrubs:	2,181 - 4,730		
[8]TULI (Zimbabwe)	3,896		

* other species per ha (%): Trees other than mopane as a percentage of total number of trees.

Sources: [1]Cunningham 1996, [2]Scholes 1990, [3]Van Rooyen *et al.* 1981, [4]Nott and Stander 1991, [5]Lewis 1991, [6]Kelly and Walker 1976, [7]Guy 1981, [8]Dye and Spear 1982.

Table 6.2: **Results comparing the different vegetation types for VLNR.**

Variable	mopane woodland	mopane shrubland	*C. mopane / C. apiculatum* open woodland
N (Plots)	126	30	44
Mean height (m)	2.3 ± 0.06	1.4 ± 0.11	2.6 ± 0.11
Circumference (cm)	14.2 ± 0.43	13.9 ± 1.27	16.6 ± 0.72
Growth rate (cm/yr)	0.59 ± 0.02	0.56 ± 0.04	0.71 ± 0.03
Average age (yr)	25 ± 1	21 ± 2	20 ± 1
Total weight per tree (kg)	10.4 ± 0.96	6.1 ± 1.52	11.9 ± 2.24
Charcoal weight per tree (kg)	6.5 ± 0.73	3.9 ± 1.25	7.8 ± 1.62
Tree weight per hectare (kg/ha)	23,668	4,939	8,651
Charcoal weight per hectare (kg/ha)	14,787	3,237	5,624

Table 6.3: **The number of plots in each soil family per vegetation type at VLNR**

	Du	S/R	HuA	HuB	SwA	SwB	VaA	VaB	OaB
mopane woodland	5	0	0	0	0	10	11	13	87
mopane shrubland	0	4	0	0	12	0	14	0	0
mopane / *C. apiculatum*	0	0	43	1	0	0	0	0	0

Du - Dundee soils; S/R - Shallow and Rocky soils; HuA & HuB - Hutton soils; SwA & SwB Swartland soils; VaA & VaB - Valsrivier soils; OaB - Oakleaf soils

slightly faster in mopane woodland than in mopane shrubland while the oldest trees on average occur in the mopane woodland areas. Although the mean total weight per tree is less than that in the mixed mopane / *C. apiculatum* open woodland, the mean total weight per hectare is virtually three times as high in the mopane woodland than in the mopane / *C. apiculatum* mixed open woodland (Table 6.2).

There is strong association between different soil types and vegetation types (Table 6.3). Mopane woodland is mainly associated with Oakleaf (OaB) soils while mopane shrubland is associated with Valsrivier (VaA) and Swartland (SwA) soils. The mopane / *C. apiculatum* mixed open woodland is associated with Hutton (HuA) soils. Oakleaf soils are red / brown, deep alluvial, sandy loam soils compared to Valsrivier and Swartland soils which are shallow, sandy loam or sandy clay with loam topsoil on dense clay. Hutton soils are red, deep, sandy and well drained.

Highest mopane densities are found on Oakleaf (OaB, 2,329 ± 88 trees/ha), Valsrivier (VaA, 1,312 ± 174 trees/ha and VaB, 2,615 ± 160 trees/ha), Dundee (Du, 2,020 ± 215 trees/ha) and Swartland (SwB, 1,920 ± 272 trees/ha) soils. Each of these soils support mopane woodland, although the Valsrivier (VaA) family, also supports mopane shrubland (Table 6.3).

DISCUSSION

An optimum harvesting rate of 25 % every five years would ensure the best harvestable yields for up to 60 years. There would be a long-term decrease in mopane wood from 8 tons/ha initially to 1.5 tons/ha after 60 years. According to the Council for Scientific and Industrial Research (CSIR), the Gaylard charcoal retort could yield 30 % charcoal from wood with moisture content of 20 % and a carbon content of 80 %. This would be approximately 350 kg/ha of charcoal when harvesting 25 % of the available wood with a circumference greater than 13 cm. At the local going price of R2/kg for mopane charcoal, this would mean R700/ ha (R300 profit/ ha). The land price for the same area is R350/ha, while the yield from game ranching is currently R12/ha/year. It can be seen that charcoal from mopane could be an extra source of income for areas with a marginal farming potential.

Benefits and reasons for thinning mopane

Fallen leaves provide food for grazers during the late dry season. Mopane is also a preferred browse for elephants. Mopane is excellent firewood and provides a good quality charcoal. Leaf flush occurs earlier in spring in areas thinned through harvesting than in areas not thinned (Smit and Swart 1991). This is the time of the year when browsers need the new leaves the most as most other species have not yet started to flush. Discarded browse and twigs not suitable for charcoal purposes could be mulched and utilized as animal fodder. It could also be left on the soil to prevent erosion and to establish a grass seed pool.

Leaves from the harvesting of mopane could be used to grow domesticated mopane worms. In South Africa the retail price was on average R3.20 per 30 g in 1993 (Brandon 1993). According to an estimate by the South African Bureau of Standards, annual sales in 1982 through agricultural co-operative markets amounted to about 40,000 bags containing 40 kg each (Dreyer and Wehmeyer 1982). According to the CSIR the average weight per dry caterpillar is 5.8 g and that has a 10 % protein value (Brandon 1993); 100 g will provide a person with their daily allowance of calcium, phosphate, riboflavin and food iron.

Thinning mopane improves visibility of animals for ecotourism benefits. Mopane also competes with grass, which is important for grazers. The best grass growth has been obtained by thinning by 50 - 75 % (Chapter four).

CONCLUSIONS

Mopane is resistant to a wide spectrum of environmental stresses and is an important source of browse for animals, source of food for humans (mopane worms) and provides firewood and charcoal production. This suggests that this species plays an indispensable role in the functioning of ecosystems in which it occurs in southern Africa. Mopane woodland within the VLNR is found predominantly in association with Oakleaf (OaB) soils, which are well-drained deep alluviums, sandy loams or sandy clays. A strategy of harvesting between 25 - 50 % of mopane trees should be economically and ecologically viable. Harvesting levels of 25 - 50 % would yield mean weights of between about 3,700 and 7,400 kg/ha of wood with a charcoal potential. Harvesting would delay the onset of leaf senescence in autumn and stimulate leaf flush earlier in spring. A decrease in woody biomass would also mean an increase in herbaceous biomass.

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ISSUES RAISED DURING PARTICIPANTS' DISCUSSION

How did you age the mopane?
This was difficult as mopane has 'false' rings. There is also often a lot of heart rot as well.

In your model, you assumed that the trees were density independent, but later said that they were "too dense to see through"; there appears to be an inconsistency.
They did not appear to be competing as they were all the same size.

Were the growth rings evenly spaced?
Yes.

Did you dig up any roots to see if they were seedlings or coppice shoots?
No.