Management of Mopane in Southern Africa

Proceedings of a workshop held at Ogongo Agricultural College, northern Namibia, 26th to 29th November 1996

Edited by Charlotte Flower, Grant Wardell-Johnson and Andrew Jamieson

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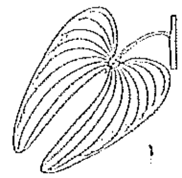

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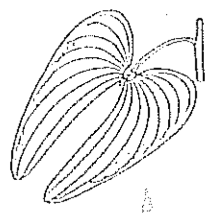
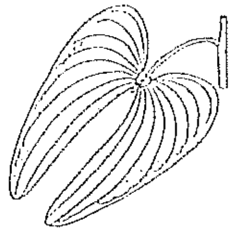


CHAPTER THREE

MOPANE SHRUBLAND MANAGEMENT IN NORTHERN NAMIBIA.



Martinus Gelens [a]

ABSTRACT

Colophospermum mopane (mopane) is an extremely important resource for the people in the central part of northern Namibia. Mopane provides a wide range of products such as poles, farm implements, household utensils, firewood, rope, fodder and food. The mopane resource, however, is under pressure from an increasing human population. Due to overcutting, much of the original tall and single-stemmed mopane woodland now persists as low and multi-stemmed mopane shrubland. The local subsistence farmers are managing the mopane shrubland, but little systematic work has yet been carried out to determine the most appropriate management strategies. This paper describes the establishment and first stages of implementation of an experiment in which several different ways of managing mopane shrubland are compared. Figures are presented on volume, basal area, woody biomass and stocking per hectare of the mopane shrubs at the site before and after the first treatments and the initial response of the plants to these treatments is described.

Keywords; *Colophospermum mopane,* mopane, shrubland, management, research, Namibia.

INTRODUCTION

*Colophospermum mopane (*Kirk ex Benth.) Kirk ex J. Léonard, commonly known as mopane, occurs widely over the central part of northern Namibia (the former Owamboland), where it may form extensive and more or less pure stands. It is here known by its oshiwambo name "omusati". In this area, it forms an extremely important resource for the local subsistence farmers, who derive a wide range of products from it (Rodin 1985, Coates Palgrave 1988, Directorate of Forestry 1994, Marsh 1994). For example, stem wood is used for building-material in huts, homestead and kraal palisades and other fences, for making axe and hoe handles, and for pestles and mortars. Stem wood is also a good fuel, and gives fires that are slow-burning and that give off an intense heat. Branches are used for making large baskets for millet or other grain storage. Bark is stripped from branches and made into rope and twine which is used for tying hut frames, homestead and kraal palisades and other fences together, for holding thatch on roofs and for tying branches together when making baskets for storage of grain. Leaves (especially new and fresh ones) provide good fodder for domestic animals, especially in the dry season, when grass and other animal feed is scarce. The mopane worm, larva of the Emperor moth *Imbrasia belina,* feeds upon mopane leaves and is eagerly sought as a source of food, or to be sold. Mopane worms are boiled and dried, fried or roasted and can be stored for a long time and are very nutritious with a high protein and low fat content.

The mopane resource, however, is under pressure from an increasing human population in many parts of the region in which it occurs. Much of the original tall and single-stemmed mopane woodland has been converted into land for settlement and agriculture, or only persists as low and multi-stemmed mopane shrubland through continuous harvesting for the wide range of products that are used locally.

Although local subsistence farmers can be seen to be managing mopane shrubland, until now very little systematic work has been carried out on how best to do this. The Research Division of the Directorate of Forestry of Namibia, under the guidance of the DFID-funded Forestry Research and Development Project (FRDP), started an experiment in the middle of 1994, to compare different ways of managing mopane shrubland. This work is carried out with the help of the local NGO, Development Aid from People to People (DAPP). The principal objective of the experiment is to assess the growth and yield of mopane shrub when protected and managed along lines that give products that are desirable to local subsistence farmers. The experiment thereby hopes to initially add a more systematic and quantitative touch to work already done by local subsistence farmers on management of mopane shrubland. The eventual aim is to be able to derive a standard on how best to manage mopane shrubland. This paper describes the establishment of this experiment and provides the results following the first treatments.

METHODS

Site

The site for the experiment is situated in the Omusati Region in the central part of northern Namibia, eight kilo-

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metres from Ombalantu at a place locally known as "Onambelela" (see Fig.14.1). The experimental site is situated at 17° 35' S and 15° 10' E, and at an altitude of 1,100 m above sea level. The site is a more or less rectangular area of approximately 20 ha. About 75 % of the area is covered with a fairly even distribution of 1.0 to 1.5 m high mopane shrubs, with just a few individuals of other species scattered amongst it. The other species include *Terminalia prunioides, Commiphora africana, Dichrostachys cinerea* and *Acacia* spp. About 25 % of the area is flooded during the rainy season and during the remainder of the year it is covered only with grass.

Mopane sometimes occurs in a shrub-like form induced by nature rather than by people. This seems to occur especially when levels of sodicity and impermeability of the soil are high (see Ellis 1950, Thompson 1960, Dye and Walker 1980, Cole 1986). However, local people could still remember the time that tall woodland, rather than low shrubland, dominated this particular area. Indeed, stumps of mopane trees can still be seen in the experimental site, although most are by now heavily disintegrated. Another indication can be found in the local name of the experimental site, Onambelela, meaning "place of the meat". This indicates that there was a lot of game at the site in the past, a situation occurring only where there is good forest cover.

Average annual rainfall is 425 mm, but rainfall is highly variable from year to year. In general, rainfall occurs between October and April and is negligible in the other five months. About 70 % of annual rainfall falls between January and March. The warm season is long with ten months (August to May) having an average temperature of 20 °C or more. The maximum temperatures in these months can be between 35 °C and 40 °C. The cold season is limited to just two months (June and July). Below zero temperatures can occasionally occur in these two months but the incidence of frost is insignificant (Beyers and Katsiambirtas 1987).

The substratum over the central part of northern Namibia is kalahari sandstone. The soil at the experimental site is a solonetz according to the FAO / UNESCO World Soil Map. The profile shows a brownish A-horizon of about 15 cm, which quite abruptly changes into a greyish B-horizon of about 35 cm with strong prismatic or columnar structure elements with rounded tops, which then gradually changes into a massive C-horizon. The B-horizon shows a marked increase in sodium (and to a lesser extent calcium and magnesium) and shows an accumulation of clay forming a dense and hard layer. The C-horizon shows a marked increase in calcium.

Experimental design

The process of designing the experiment started with a Participatory Rural Appraisal (PRA) exercise in the area around Ombalantu in July 1994 (Directorate of Forestry 1994). Considerable information about local uses and needs of mopane and its products, as well as local knowledge, experience and ideas about mopane shrub management was gathered at this time. Local farmers have taken to mopane shrub management in two main ways. Some farmers thin out shrubs to one shoot straight away and continuously remove regrowth. The remaining shoot is pruned regularly. This method gives a one-off supply of smaller material and, eventually, a pole. Others gradually thin out shrubs by removing shoots of only a certain (i.e. useful) size. The remaining shoots are pruned regularly. Regrowth is allowed to provide for shoots in future. This method gives a continuous supply of smaller material but no larger material. Both these ways of shrub management were incorporated in the experiment as treatments. Two other treatments were added, a control treatment (no cutting at all) and a mix treatment. The mix treatment is a combination of the two ways in which local people manage mopane shrub. It involves initially thinning to one shoot, but then allowing regrowth, so that there will be a continuous supply of smaller material, plus, eventually, a pole.

The four treatments are; T1 (no harvesting), T2 (single to one leading shoot, plus continuous removal of regrowth material, regardless of size), T3 (continuous removal of material when it reaches a certain minimum size) and T4 (single to one leading shoot, plus continuous removal of regrowth material, but only after it reaches a certain minimum size).

The minimum cutting size for shoots in T3 and T4 was set at a length of two metres and a diameter at the base of two centimetres. A shoot should minimally have this size before local people consider it suitable for building, fencing, making rope / twine and making millet storage baskets. Using this minimum cutting size is a simplification of reality as further nuances in the suitability for the different purposes exist. However, considering all would have made the treatments far too complicated to be implemented.

Cutting for firewood was not taken into consideration when determining the minimum cutting size. Useful fuel doesn't come from shoots of this size, but rather from larger stems. Small material is used for kindling fires, but this usually comes as a by-product when cutting for other purposes, rather than as a product in its own right.

The four treatments have been replicated five times and have been allocated at random to 20 square plots of 0.5 ha each. Within each treatment plot, there are three circular measurement sub-plots of 200 m^2, laid out at random.

It is best to carry out treatments in September as this is when the mopane shrubs are not actively growing. In addition, the shrubs are also without leaves during this time of the year, which will also greatly facilitate the work from a practical point of view. Those farmers who already have some experience with mopane shrub management also mention it as the best time for singling and pruning. Finally it is also the low season for agriculture, and therefore a time of the year when farmers have more time to spare for singling and pruning mopane shrubs.

All treatments do not necessarily have to be done each year. Whether, for example, T3 and T4 can be done in a particular year, will depend on whether shoots have reached the required minimum size for cutting. If not, treatments will have to be left until another year.

It has been decided that the lifetime of the experiment will be at least ten years. It seems very likely, however, that it will continue well beyond this period, as its value is likely to increase further with time.

Measurements

Once a year the following measurements and counts will be done on the experiment; number of shrubs per measurement sub-plot, number of shoots per measurement sub-plot, diameter at 10 cm above ground level of each shoot and length of each shoot. This will be done to regularly assess what is standing in the plots in terms of volume, basal area and / or woody biomass and to see how these parameters change as a result of treatments. June would be a good month in which to carry out this assessment. It is the end of the growing season for the mopane shrubs. This means that if treatments have been done just before the start of the growing season in September, the effects can be examined over a whole growing season. In addition, several measurements and counts will be taken whenever treatments are carried out. These include the number of shoots removed, the diameter at base of each shoot removed, the length of each shoot removed and the fresh and dry weight of material removed. In addition, the number of shoots remaining, the diameter at 10 cm above ground level of each shoot remaining and the length of each shoot remaining will be measured. This will show what volume, basal area and / or woody biomass has been removed and retained, due to the different treatments.

It was arbitrarily decided to measure only those shoots of 75 cm and longer, partly because measuring each shoot would become too time-consuming and partly because very small shoots are insignificant in their contribution to volume, basal area and / or woody biomass. Using this limit means that one has to reckon with "ingrowth" of shoots over time, which in turn means that one also has to reckon with "ingrowth" of shrubs over time.

Diameter at base or 10 cm above ground level will be measured to the nearest millimetre. Length initially will be measured to the nearest 5 cm with a long measuring stick. Later, when shoots become taller, they could possibly be measured to the nearest 10 or 25 cm.

The form-factors of 25 shoots representing a wide range of diameters and lengths were determined by measuring them as a whole, *versus* in five equal sections. The average value (0.46) is being used as a correction factor in volume calculations.

Lotus 1-2-3 Release 5 for Windows was used for doing the basic calculations and Statgraphics Plus for Windows was used for doing the statistical analysis.

RESULTS

Measurements June 1995

Results presented here are given in more detail in Gelens (1997a). The first measurements on the experiment were done in the first two weeks of June 1995. The aim was to assess the characteristics of the stand before any treatments were carried out. Pooling measurements and counts from the 60 measurement sub-plots, resulted in the following average values for the following parameters (all per hectare); number of shrubs - 988, number of shoots - 6,636, volume - 0.87 m^3, basal area - 1.53 m^2. Variation within the experimental plot was considerable, with coefficients of variation for the parameters given above ranging from 29 to 33 %.

Treatments October 1995

Results presented here are given in more detail in Gelens (1997b). The first treatments on the experiment were carried out in the second half of October 1995. These were T2 and T4 (Table 3.1) which in this stage of the experiment for both treatments meant singling to one leading shoot. T3

Table 3.1: Reduction in volume and basal area following thinning treatments in mopane shrubland in northern Namibia in October 1995

Treatment	June 1995 Volume (m^3/ha)	SE	October 1995 Volume (m^3/ha)	SE	June 1995 Basal area (m^2/ha)	SE	October 1995 Basal area (m^2/ha)	SE
T 1	Control							
T2	0.90	0.06	0.23	0.02	1.58	0. 10	0.36	0.03
T3	Not carried out							
T4	1 .07	0.07	0.26	0.02	1.81	0. 12	0.38	0.03

(continuous removal of material when it reaches a certain minimum size) was not done because few shoots had yet reached the required minimum size. The singling to one leading shoot resulted in the volume being reduced by 74 % and the basal area being reduced by 77 % in T2. The singling to one leading shoot resulted in the volume being reduced by 76 % and the basal area being reduced by 79 % in T4. The number of shoots per ha was reduced by 85 % and 87 % in T2 and T4 respectively.

The shoots that were cut in the measurement sub-plots were put together in bundles and weighed immediately after cutting to get a measure of their fresh weight. Subsequently, five percent samples were taken and air-dried for three months, before being weighed again to get a measure of dry weight. 1,660 kg/ha of material was removed in T2 and 1,820 kg/ha in T4. Dry weight came to approximately 63 % of fresh weight.

By recording fresh weight (or biomass) plus calculating volume and basal area of the material taken off during treatment, an opportunity was provided to see if there was a correlation between these variables. A simple regression analysis was therefore carried out between these variables using data from all treated sub-plots and comparing several curvilinear models to see which one would best fit the data. The so-called multiplicative model eventually gave the best fit for both the relationship between fresh weight and volume, as well as the relationship between fresh weight and basal area.

The multiplicative model for the relationship between fresh weight (biomass) and volume shows a correlation coefficient of 0.953 and a R^2 of 90.76 %. The equation is;

Fresh weight = (2,232.35 * Volume ^ 0.807).

The multiplicative model for the relationship between fresh weight (biomass) and basal area shows a correlation coefficient of 0.961 and a R^2 of 92.35 % and the equation is;

Fresh weight = (1,361.75 * Basal area ^ 0.884).

Both relationships show very good fits. However, the relationship between fresh weight (biomass) and basal area was slightly stronger than the relationship between fresh weight (biomass) and volume.

With the above "best fit" model for the relationship between fresh weight (biomass) and basal area, it was then possible to calculate how much biomass was standing in T2 and T4 before the treatments were carried out. T2 had a standing biomass of 2,040 kg/ha, and T4 of 2,299 kg/ha before treatment. Biomass in T2 and T4, was reduced by 81% and 79 % respectively after treatment.

Measurements June 1996

Results presented here are given in more detail in Gelens (1997b). Measurements on the experiment were repeated in the second half of June 1996 (Table 3.2). The response of the four groups of treatment sub-plots during the growing season was of special interest. In T1, the volume increased by 45 %, while basal area increased by 31 %. In T2, the volume increased by 83 % and basal area by 64 %. In T3, the volume increased by 35 % and basal area by 24 %. The volume in T4 increased by 65 %, while basal area increased by 55 %. An F-test in an ANOVA table using a 95 % confidence level gives p-values smaller than 0.05 indicating that there are significant differences between the four mean values of increase in volume and basal area between 1995 and 1996.

A Multiple Range Test using Fisher's least significant differences method with a 95 % confidence level shows that these significant differences occur between the following four pairs of groups of treatment sub-plots; T1 and T2, T1 and T4, T3 and T2, and T3 and T4. These are all combinations between an untreated group of sub-plots (T1 and T3) and a treated group of sub-plots (T2 and T4). This shows that the increase in volume and basal area between 1995 and 1996 was significantly higher in the treated groups of sub-plots than in the untreated groups of sub-plots.

Although measurements were carried out in June 1995 and June 1996 for T1 and T3, and in October 1995 and June 1996 for T2 and T4, it was not considered a problem because of the negligible growth of mopane between June and October.

Table 3.2: Changes in volume and basal area during the 1995/1996 growing season, following thinning treatments in mopane shrubland in northern Namibia in October 1995.

Treatment	October 1995		June 1996		October 1995		June 1996	
	Volume (m^3/ha)	SE	Volume (m^3/ha)	SE	Basal area (m^2/ha)	SE	Basal area (m^2/ha)	SE
T1	0.69	0.06	1.00	0.10	1.24	0.10	1.63	0.14
T2	0.23	0.02	0.42	0.03	0.36	0.03	0.59	0.04
T3	0.83	0.07	1.12	0.08	1.47	0.11	1.82	0.12
T4	0.26	0.02	0.43	0.04	0.38	0.03	0.59	0.05

Table 3.3: Reduction in volume and basal area following thinning treatments in mopane shrubland in northern Namibia in October 1996.

Treatment	June 1996 Volume (m^3/ha)	SE	October 1996 Volume (m^3/ha)	SE	June 1996 Basal area (m^2/ha)	SE	October 1996 Basal area (m^2/ha)	SE
T1	Control							
T2	0.42	0.03	0.39	0.03	0.59	0.04	0.52	0.04
T3	1.12	0.08	1.08	0.07	1.82	0.12	1.78	0.11
T4	Not carried out							

Treatments October 1996

Treatments were again carried out in the second half of October 1996. These were T2 and T3 (Table 3.3). Regrowth that had occurred during the 1995 - 1996 growing season was removed in T2. In T3, during the 1995 - 1996 growing season, a few more shoots had reached the required minimum size for cutting of two metre length and two centimetre diameter at base than in the previous year. These shoots were removed. T4 did not take place, as regrowth had not yet reached the required minimum size for cutting. The volume in T2 was reduced by 7 %, while basal area was reduced by 12 %. The volume in T3 was reduced by 4 %, while basal area was reduced by 2 %.

DISCUSSION

No references were found with which these figures could be compared. Whatever information is available on standing biomass, stand densities, growth rates and response to cutting of mopane has been brought together by Timberlake (1995). Data, however, are relatively few, and come from a wide ecological range. They were also collected using a range of methods, which makes them difficult to compare. Tietema (1989) and Scholes (1990) present data on coppice growth of mopane. Their context, however, is different from that presented here. Gelens (1997c) provides information on growth rates of singled mopane coppice shoots found on farms (under similar climatic and edaphic conditions as in the present experiment) which are, however, already in more advanced stages of development than those in the present experiment.

T2 and T4 showed good response to their singling to one leading shoot and showed relative increases in volume and basal area that were significantly higher than those in the sub-plots that were not treated. It is possible that growth could be improved further, if one takes into consideration that the singling to one leading shoot was a rather drastic operation that reduced biomass by approximately 80 %. The shrubs may actually still have been recovering from this treatment. It will therefore be interesting to determine whether there will be even larger increases in volume and basal area in T2 and T4 in the coming year.

T1 and T3 showed reasonably good growth, despite showing significantly lower rates than those in the treated sub-plots. This may, however, be because shrubs were still recovering from the heavy cutting that took place before the experiment began and may as yet not have reached the stage of competition between shoots within individual shrubs. It will therefore be interesting to determine whether increase in volume and basal area in T1 and T3 will indeed slow down in the coming year.

It will now be important to determine how long it will take before shoots in T3 and regrowth in T4 reach the required minimum size for cutting in substantial numbers. Similarly, the comparison between the amount of material removed in T3 and T4, including the added value of being able to cut a pole in T4, will be important. It will also be important to know whether the regrowth in T4 will significantly reduce growth of the leading shoot left standing during the singling operation, as compared with T2 where all regrowth is removed. If so, will the added value of being able to cut some smaller sized material in addition to a pole in T4 make up for this? Will the cutting of shoots that have reached two metres in length and two centimetres diameter at base in T3 significantly reduce competition within shrubs as compared to T1 where nothing is removed?

CONCLUSIONS

The experiment described here has now been operational for just over one full year. With the completion of the second round of treatments and with the achievement of differentiation between the four treatments the experiment is now completely on track. The experiment promises many interesting data.

ACKNOWLEDGEMENTS

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ISSUES RAISED DURING PARTICIPANTS' DISCUSSION

How did you measure volume?
We measured height and diameter of all shoots. To calculate a form factor, we measured 25 shoots of different heights and diameters and produced a form factor of 0.46.

Have you related volume to biomass?
We have measured the weight of the material removed in the treatments and have related that to volume and basal area.

Could there be a possible fifth treatment, where you use both treatments 2 and 3, but apply to appropriate individuals rather than as blanket treatment?
It would be interesting, but there is also a need to keep the experiment simple, otherwise it will be difficult to manage and analyze.

An additional aim has been to involve the community in the experiment. How was this achieved?
We have involved people in the design of the experiment through discussions. We also wanted to involve them in the implementation. However, the latter has been very difficult. We have had a meeting early on, explaining why we were doing the experiment and how we were doing it. We have asked people to be involved when we carried out the treatments. However, there seems to be a reluctance to do this without payment. The experimental site was very degraded and maybe at the beginning it was difficult for farmers to see the potential or point of the work, but we can already see improvement and maybe people will be more interested now.

Do you have any preliminary conclusions or recommendations from the experiment?
It is too early to say from the experiment. However, we have also been taking measurements from mopane managed by farmers, to establish chronosequential measurements of growth. These measurements give some idea about the growing potential of mopane shrub that has been singled as in T2.

The project wanted to promote community involvement in the experiment but so far the involvement is limited a little. Is there any scope for representing the community on some sort of management committee or something else?
Yes. There is a need to do something. Now that the experiment, technically speaking, is on track, this should be a priority.

Are individual shrubs mapped?
We have started by labelling and numbering all shrubs in the measurement sub-plots. Many of the labels have disappeared though. Shrubs are now only marked with paint. It is therefore now difficult to follow individual shrubs. Mapping the individuals within the measurement sub-plots would be a possibility to enable the tracking of the

progress of individual shrubs.

There seems to be a need to sit down with the community (maybe with a socio-economist) and explore why there is so little involvement and therefore understand how people could be involved. There is also a need for technical and social marriage in the design of experiments. Further, there is a need to review what we have learnt from the implementation of the experiment, especially from the community involvement. As with so many things, we have made assumptions at the time that in retrospect had little firm foundation. Learning from this should help us develop a sounder approach in the future to planning and implementing this type of research.