

DECISION SUPPORT SYSTEM on how to control bush thickening by *Acacia Mellifera* in Namibian Savanna rangelands

Dave Joubert and Ibo Zimmermann

VERSION 2, JULY 2017



Acknowledgements

The following stakeholders provided valuable information and advice: N-BiG, MAWF DAPEES, NAU, NCA and Agri Advisory Service. The booklet was funded by the MAWF/GIZ Support to De-bushing Project. We thank the Polytechnic of Namibia (now NUST) and BIOTA for providing funds for workshops and the development of the earlier version of the EXPERT SYSTEM, including the printing of the earlier version of this booklet. We also thank hosts of the workshops, such as the Cheetah Conservation Foundation, Argo Rust of Farm Sonnleiten, Richard Kamukuejandje and the farmers at the Hessen workshop, Mr. Schoenecke and farmers of Kalkfeld, and the Frenzels of Farm Esere, as well as the participants. In addition, a very valuable workshop was held with Extension officers in the Ministry of Agriculture, Water and Forestry. Johan van Eck and Dawid Botha provided valuable information on the application of arboricides. Knowledge based on the research of others, including Bessie Bester and Professor Holz on fungal dieback, was also incorporated. We also thank Luke Claassen for doing more than his share of work to get this booklet ready. Dr. Axel Rothauge provided valuable information from his manual for which we are grateful. I am sure we have left out advising farmers and those in the industry, for which we apologise. We thank you all.

Introduction

Dear Farmers and Resource Managers,

The Decision Support System (EXPERT SYSTEM) booklet is a ***work in progress***. It is not intended to be a definitive authority on how to manage bush encroachment. The EXPERT SYSTEM was originally developed for the **Highland Savanna** vegetation type of the Khomas Region, and is largely based on a conceptual model for savanna dynamics in this region, developed by Dave Joubert and Axel Rothauge (Joubert, Rothauge and Smit, 2008). The model in turn was largely based on research done on the population dynamics of *Acacia mellifera* (now referred to as *Senegalia mellifera*; *swarthaak*; *omusauna*) in this vegetation type. We have opted for the retention of the genus *Acacia*. Although the EXPERT SYSTEM was originally developed for the Highland Savanna type, we believe it has relevance to the Thornbush Savanna and other Savannas which are dominated by fine leaved *Acacias* and *sekelbos*, in situations where *A. mellifera* is the dominant encroaching species. Since *Dichrostachys cinerea* (*sekelbos*) and other species are different to *A. mellifera* biologically, different management decisions could be necessary in some circumstances. Although bush encroachment is a problem in many places in Namibia, Africa and many other parts of the world, the mechanisms of bush encroachment differ from species to species and climate to climate. This makes rangeland management (farming) challenging. We believe that: *Rangeland management is not rocket science, it's much more complex! But the expert system makes it much easier.*

The EXPERT SYSTEM is divided into two types of decisions:

1. **Adaptive decisions** (these are opportunistic decisions which would only be relevant and useful during certain circumstances related to periods of exceptionally good rainfall, drought, and after frost (See [Figure 1](#) and [Figure 2](#)). Making the right decisions at these times might be crucial in preventing large-scale transitions towards bush thickets (good rainfall), or thinning out of existing mature thickets (drought, after frost). In fact,

we believe that removing the opportunities that come with these weather extremes is a major reason for the current encroachment situation.

2. **Reactive decisions** or decisions to treat the symptoms (these are decisions on whether to and how to, treat *existing* problems – i.e. areas already under dense cover of bush). The EXPERT SYSTEM includes actual methods of bush control, while recommending that it should be done in contour strips to regenerate water and nutrient cycling. We emphasise though that much of our rangeland is **not** bush encroached at this stage and can remain this way if ongoing good management and adaptive management are applied.

Bush encroachment in a nutshell

There are many ideas regarding bush encroachment. In short, research in Namibia and southern Africa in general shows that, for *Acacia mellifera*, establishment events (events when seeds are produced, seedlings germinate and survive) only occur after and during two to three, but probably longer, consecutive good rainfall events. Seed production requires very good rainfall to produce viable seeds. Seedlings germinate very easily (after a good rainfall event) and so the seeds never accumulate in the soil or on the surface (they are also eaten). Because of this, one year of good rainfall followed by poor rainfall will not result in establishment. The resulting germinated seedlings require good, well-spaced (not too long between successive rainfall events) to survive the first year. If seedlings survive the third and following years, many saplings can still die if the rainfall is not good. Therefore, the last significant establishment events took place in the exceptionally wet periods from around 2000 to 2013.

Because good rainfall also increases grass production, and hence good fuel loads, natural fires tend to coincide with these establishment events. These fires kill seedlings, but once saplings of around 5 to 10 years have established (the exact time depends upon the rainfall and hence growth rate) they are resistant to fire. As the saplings grow, their competition with grasses increases and eventually there is insufficient fuel for a fire (although this is not always the case). The bush thickened area cannot easily revert back to a grassy state without active intervention.

These thickets can exist for centuries but as the thickets age, trees start to die back more easily from drought, frost and disease. This thicket can then open up into a grassy savanna again (through disease, frost, fire, drought and combinations of these). Naturally, farmers don't have the time to wait for this to happen and thus feel compelled to address the problem as soon as they can to increase grass production. [Figure 1](#) provides a simple scheme of how bush encroachment works.

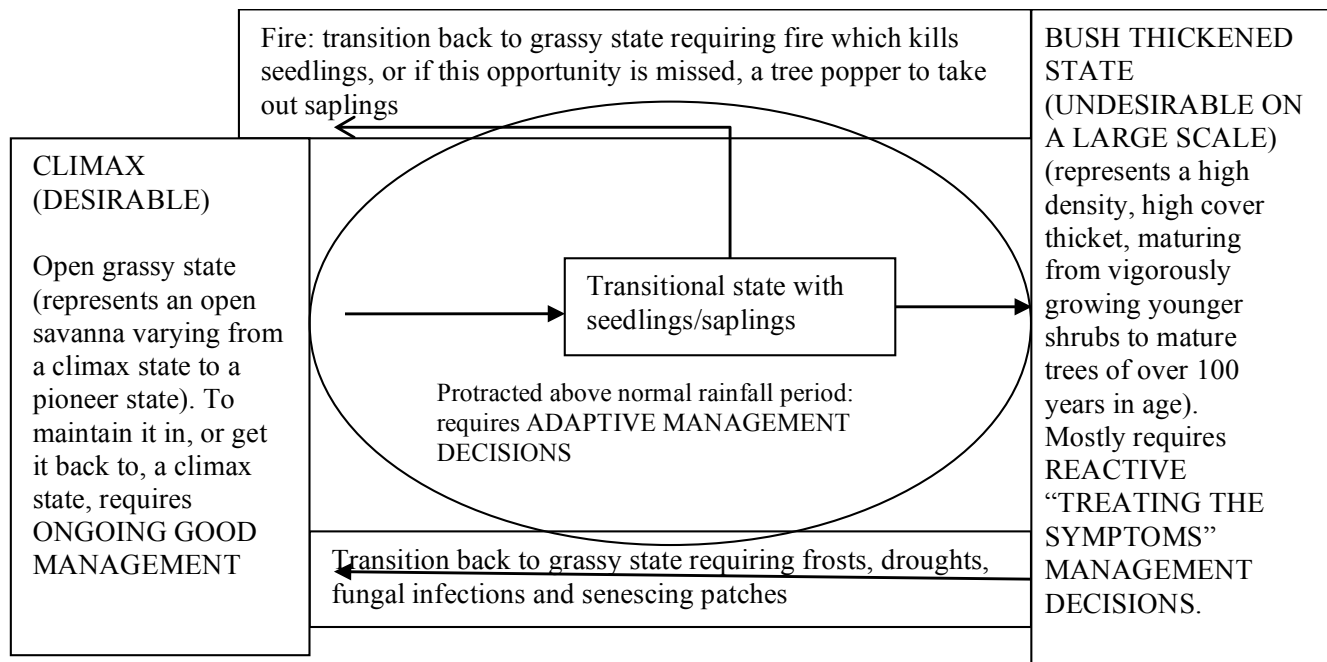


Figure 1: A simplified model of how bush encroachment occurs in a semi-arid savanna (adapted from Joubert et al., 2014).

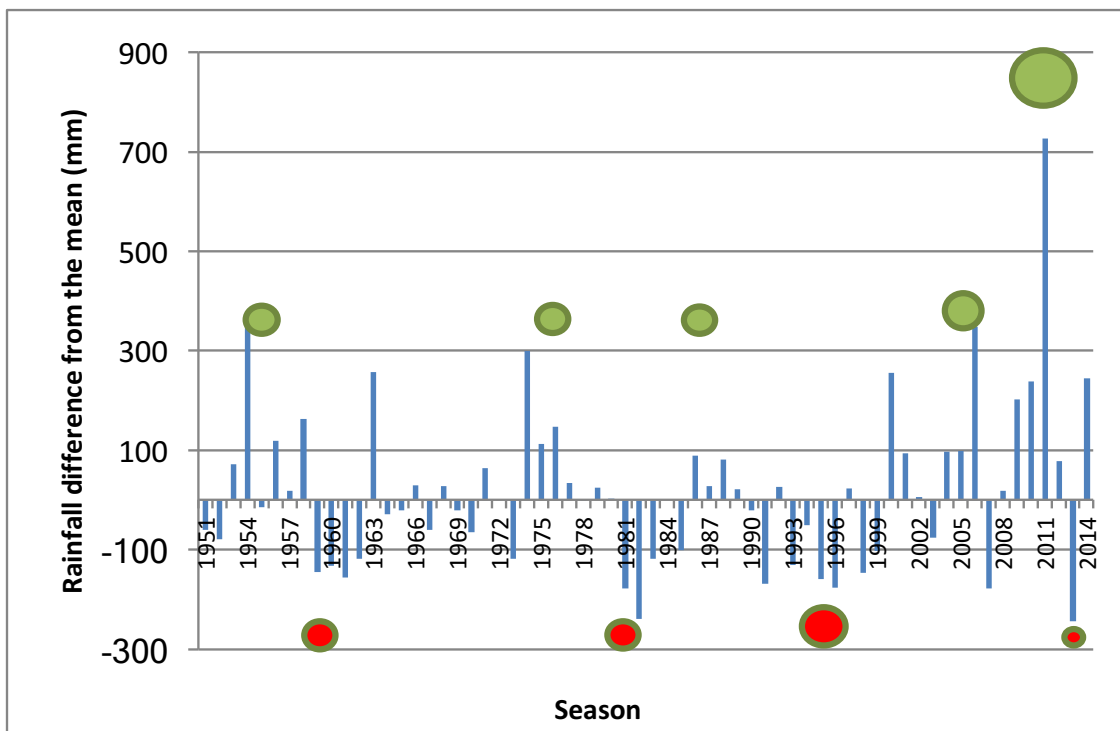


Figure 2: Rainfall Windhoek from 1951 to 2014, showing times when seedlings are likely to establish (green circles) and thus adaptive management is required, and times when mature shrubs (and saplings) might either die, or dieback (red circles). These times are also opportunities for farmers to do adaptive management. The size of the circles represents the importance of the event, establishment and dieback. Note the large green circle in the 2009-2012 period when establishment was very probably (very high rainfall period), and the large red circle in the 1990s (severe drought), when dieback was also likely. The 2013 drought was severe but was preceded and followed by high rainfall and hence the probability of dieback was likely to be low.

A precautionary note about bush encroachment control ("treating the symptoms")

Whilst this expert system booklet is all about limiting the occurrence of bush encroachment and controlling it when it occurs, we would like to make some very important ecological and rangeland health statements:

1. Bush encroachment is a natural process, in the past it occurred in areas where grazing intensity was high and hence fuel load was low, and thus fire was absent or minimal. In other words, close to available water for livestock and wild herbivores. Generally, these areas were relatively small. However, the landscape scale of encroachment we see today is the problem, partially because livestock and game are able to exist close to water in all farming rangelands, but also because farmers overstock in general, do not rest the veld adequately, and actively exclude fire, particularly when fire should occur. This is what we hope to address.
2. Thorn trees, including *A. mellifera*, have many benefits to both farmers and ecosystems alike. Some species of birds, such as Cape Penduline Tits, prefer nesting in *A. mellifera* shrubs, which protect them from predators ([Figure 3](#)). Thorn trees such as *A. mellifera* often protect important blue green algae crusts (from trampling) that in turn fix nitrogen, and protect the soil from drying out. The trees harbour nitrogen-fixing bacteria in their roots. Because of this, as well as leaf fall, soil fertility is generally higher than away from the trees. In turn, grasses are more nutritious.



Figure 3: In a survey in 2007–2009 100% of Cape Penduline Tit nests found at Neudamm were in the top centre of an approximately 2 to 2½ metre high *Acacia mellifera* tree. The thorns are an effective deterrent for predators.

3. The individual trees are important, but bush thickets as habitat are also important. Because bush thickets are natural, and not a new phenomenon, many species are adapted to them and the biodiversity of thickets is different to more open savannas. Often they even support more species of birds than open savannas. Ecosystems require a mosaic of open savannah with thicket patches, to ensure that species that require both are satisfied. Game species, even plains game, require the shelter of thickets, both from the sun and from predators, often moving there to ruminate in the shade during the hottest times of the day. Browsers such as kudu prefer thickets.
4. During drought, and/or when overgrazing occurs, shrubs are often the only form of fodder for game and livestock. Naturally one does not want to reach a stage where one relies so heavily on browse but these situations occur all over Namibian rangelands.
5. Thus individual *A. mellifera* bushes and bush thickets, provide **ecosystem services** such as nesting, shelter, substrate for the growth of lichens, epiphytes, soil enrichment and support biodiversity in general. They also provide a refuge for animals to shelter from fires.
6. Often people use the analogy of a scab to explain bush encroachment. They say bush encroachment is like a scab that needs to cover the skin until the wound heals. Scabs protect wounds from allowing pathogens to enter the body. We feel that this analogy is valid, although in the case of bushes, they are trying to restore fertility to the soil, which will eventually favour grasses once more. However, we also recognise that a farm needs to be productive and economically sustainable. Often, the large scale removal of encroached bush allows other species like *Laggeteria decurrens* (bitter bush) to increase dramatically (one solution leads to another, often worse, problem) (see [Figure 6a](#)). These also reduce the production of grasses and are unpalatable. For this reason we caution against over-cutting of bush. FSC and guideline on Forestry and Environmental authorisation process for bush harvesting projects (**Ministry of Agriculture, Water and Forestry and Ministry of Environment and Tourism**) are useful guides to prevent this.
7. Often most farmers want to focus on large trees to avoid seed production. They believe there is an annual

production of seeds and that seedlings are germinating and establishing every year. Their fear is thus that these large trees are continuously contributing to bush encroachment. We have shown that seed production is very rare, and also that seeds do not form a seed bank in the case of *A. mellifera*. We have also shown that a fire of moderate intensity can kill all seedlings of up to at least two years old (this is of course dependent upon growth rate). Large trees compete with smaller saplings, and removing those causes the rapid growth of the saplings as they are released from competition with the large trees. In other words, removing large trees can make the situation worse in a few years.

8. Bush encroachment is a symptom of rangeland degradation that is caused by many factors. These causal factors interact with each other, often leading to vicious circles that reinforce each other. Some of these factors are continuous grazing, understocking and fires that burn early in the dry season, all of which reduce the vigour of perennial grasses. Other factors are increased atmospheric carbon dioxide that favours bushes over grasses and the depletion of soil minerals and carbon.
9. When animals are removed from the farm for sale, the minerals that they obtained from the plants that they ate are lost from the farm, rather than being naturally recycled. Although many elements are lost through animal sales, most farmers only return phosphorous and nitrogen through supplementary feed which commonly brings in excess sodium that gets spread to the soil through animal dung. This loss of minerals and soil carbon is accelerated when farmers opt to sell wood or charcoal from encroached bushes off their farms. This should be counteracted by replacing nutrients lost from the system.



Highland Savanna, showing a patch mosaic pattern, with open areas and thickets, and different size classes of trees (Neudamm).



Highland Savanna, showing a patch mosaic pattern, with very open habitat, and mature thickets in the background (Krumhuk Farm).



An open savanna on the Hochfeld road with scattered shrubs and trees of different sizes.



A dead tree with a cavity nest in it.



Thorn bush Savanna showing harvesting but leaving large trees, smaller trees, patches and "fines" (near Grootfontein).



Highland Savanna showing different size classes of trees, with an open area in the background (Krumhuk).

Figure 4: Various photos showing how the landscape should ideally look after clearing (half a hectare).

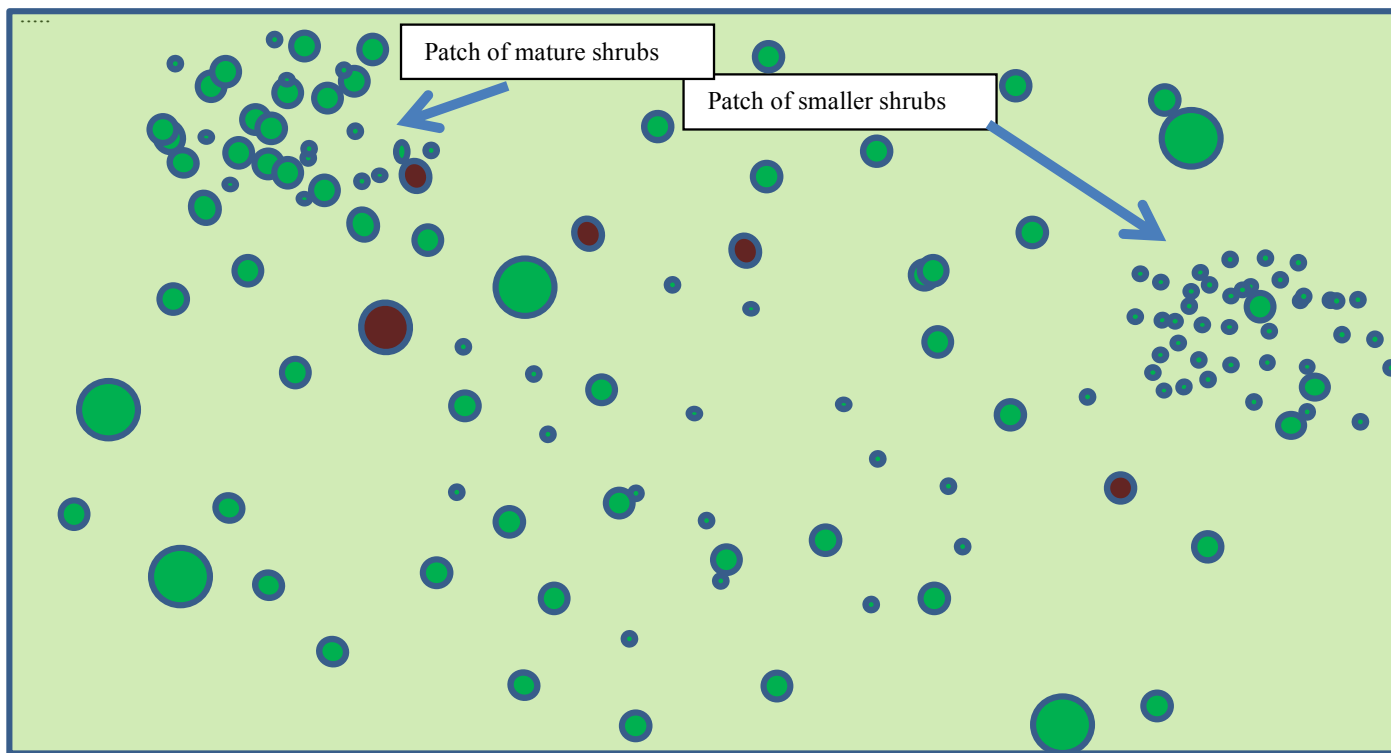


Figure 5: A bird's eye view of an optimal savanna structure with a variety of size classes of trees, some mature thickets, open parts with scattered trees, shrubs and some thickets of smaller bushes, as well as dead trees (brown). The view is of half a hectare.



Figure 6a: Consequences of overclearing include invasion by other species such as *Laggeta decurrans*.



Figure 6b: Consequences of over clearing include reduction of cover, the loss of habitat diversity and continuation with poor management.

Why an expert system?

The EXPERT SYSTEM is not designed to replace common sense decision-making based on the many years of experience of the resource manager/farmer. We believe that an EXPERT SYSTEM facilitates in making the correct decisions, based on its ability to **arrange knowledge** (*most of it already known to resource managers*) in a logical order. It helps to document the decision-making process, making it more accountable to the decision-maker. The EXPERT SYSTEM in this booklet is by no means complete. We would like to make it more flexible, incorporating, for example, decisions regarding whether a fire is feasible based on weather conditions and relations with neighbours. We would also like to incorporate more **farmer knowledge** into it. We would encourage a joint initiative (with our facilitation) with farmer's who have problems with *D. cinerea*, and other bush encroaching species, to develop an EXPERT SYSTEM for this and other species (and later incorporate it into a larger EXPERT SYSTEM which includes different bush encroaching species and different climatic situations, or alternatively a suite of different EXPERT SYSTEMS). We believe that the EXPERT SYSTEM serves not only to directly improve decision-making but also to encourage **debate** on the topic of bush encroachment and rangeland management. Developing the EXPERT SYSTEM in a workshop situation also immensely improves the understanding of it. We also believe that Decision Support Systems can be used for **other** management decisions. There is a great deal of research that is needed, in order to refine and adjust the EXPERT SYSTEM.

Initially, the EXPERT SYSTEM was designed to be accessed on the computer (either on the web or from a CD). Unfortunately this system is not available currently, but will hopefully be available. In the meantime, from the feedback of some previous workshops, we decided to develop a "hard copy" booklet as well. This is that booklet. We hope that the booklet will be useful and that you will provide us with **valuable feedback**. You will notice that there are some pages at the back for you to make notes. We hope that this will also be useful to you.


How to use this booklet

If you have fenced camps, we suggest that you use this booklet once for each camp or group of similar camps, during the three seasons in [Question 1](#). If you do not have fenced camps, or if individual large camps are too variable, then we suggest you map your grazing area into relatively homogenous areas (RHAs) and then use the booklet for each of these areas. [Figure 7](#) provides a bird's eye view of a hypothetical scenario of how different decisions could be taken in different camps, also taking into account (e.g. using burnt areas as fire breaks, not burning the whole farm in one year).

Before taking action (if action is required), take into account the realities on your farm. It might be that some decisions are not possible (e.g. rest camp for whole season) owing to grazing and drought pressures. It will then be important to prioritise camps and actions. This will hopefully be developed at a later stage.

Decision 3 deferred until the following year	Decision 3 Decision 6	Decision 4 Decision 10 and 14	Decision 3
Decision 3	Decision 6	Decision 12 and 14	Decision 2 Decision 12
Decision 2	Decision 3 deferred until the following year	Decision 6 Decision 4	Decision 12 and 15

Figure 7: Hypothetical bird's eye view of an area of rangeland divided either into 12 areas (management units or camps) and the decisions that might be taken on each camp or area.

 = bush encroached area

In [Figure 7](#), the scenario is in the hot, dry season, after a very good rainy season with survived seedlings abundant close to the bush encroached area. Some areas have seedlings and a high fuel load ([Decision 3](#)). Some of these decisions are deferred, because one cannot burn the whole farm. [Decision 4](#) is taken in a relatively small area with little perennial grass cover but many seedlings. In the encroached area, the decision to leave the bushes ([Decision 6](#)) might be for various reasons, including using the encroached area (low grass fuel) as a natural fire break between areas where fire was decided upon. [Decision 12](#) (Using a roller to flatten bushes) was made to enhance the mulch and promote the grass cover, and perhaps reseeding could occur. In other areas there are no seedlings and so [Decision 2](#) (carry on as usual) is reached. Finally, large mature bushes are targeted for cutting with a horizontal saw and using for charcoal ([Decision 10](#)) but this is followed by placing strips of fine material along contours and reseeding ([Decision 14](#)). In total, seven decisions are made for the area represented.

On the following pages are two decision trees that show the sequence of questions that lead to different decisions? It can be a useful summary of questions asked and decisions made, and it is easy to use in the veld. The two trees represent two types of decision:

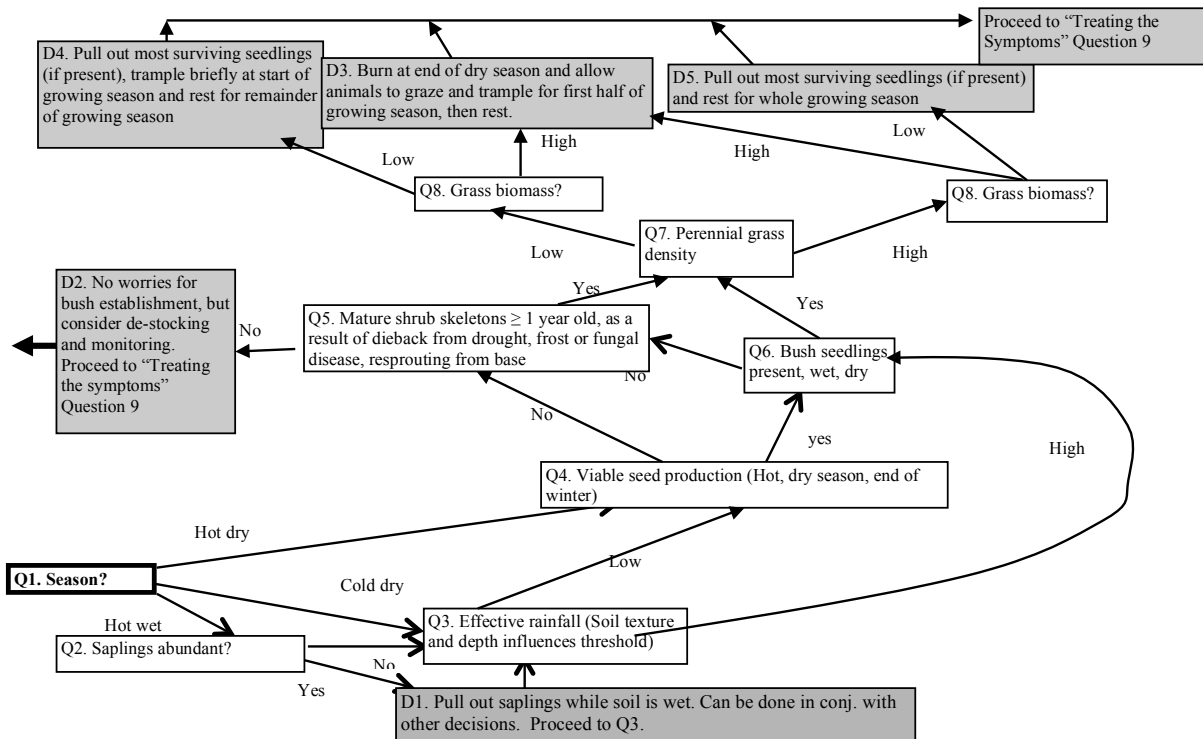
- a. **Adaptive or "opportunistic" management decisions**
- b. **Reactive or "treating the symptoms" management decisions**

We originally included a third section called "ongoing good management decisions" which referred to decisions that, if followed, along with the Adaptive management decisions, should drastically minimise the chances of bush encroachment events occurring again on the rangeland you manage. We recognise that "ongoing good management" is a vast topic to be included in this booklet, and there are a great number of opinions on what constitutes "good management".

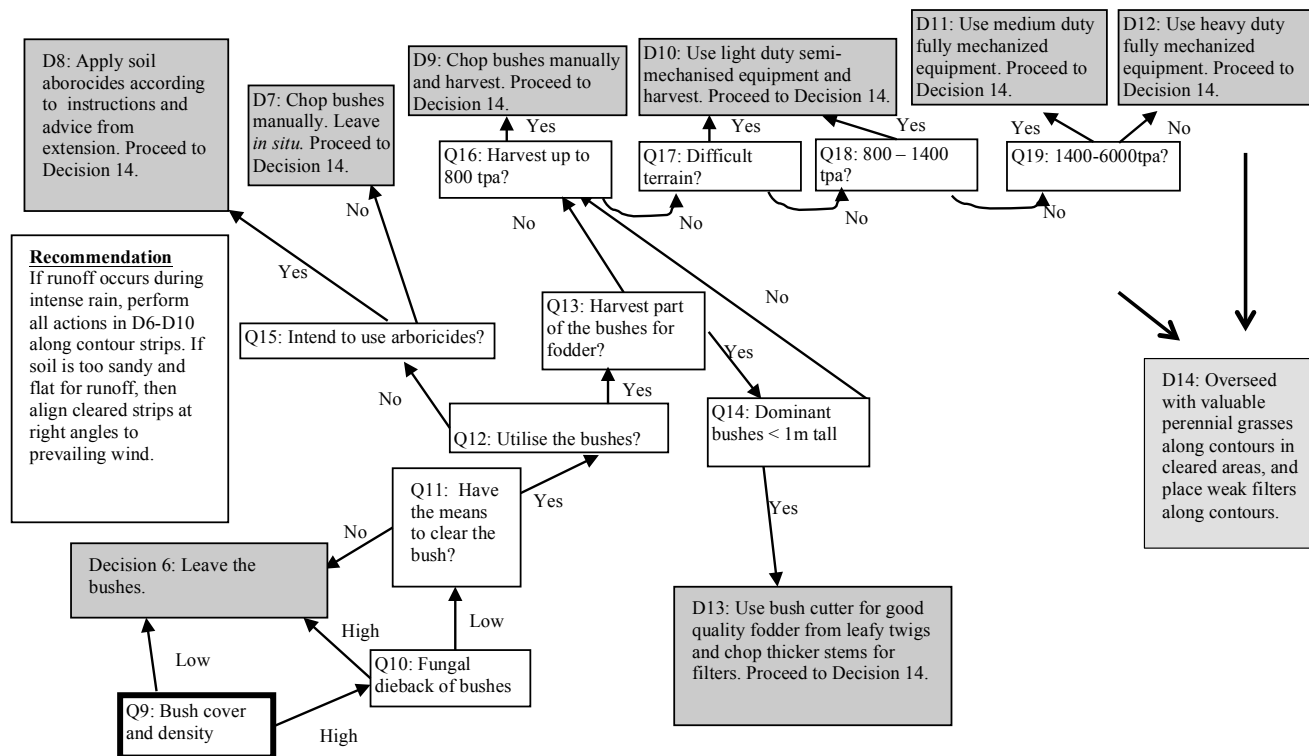
Most successful farmers agree that good grazing management is essential to maintain grass vigour, and that long rest for grass plants to regain vigour after grazing is the most essential ingredient to achieve that, preferably for a whole growing season every second year. There is some disagreement on the period of grazing, but this seems to be less controversial as there are farmers who achieve success with both long and short grazing periods, provided they provide long rest. Two examples of good grazing management being successfully applied in Namibia are based upon holis-

tic management originally developed by Alan Savory and the fodder-flow grazing strategy developed by Riaan Dames. All grazing management strategies that allow a full growing season's rest every second season are likely to be very successful, and, when combined with our adaptive management decisions, **should not allow any encroachment to occur**.

a. Adaptive or "opportunistic" management decisions



b. Reactive or "treating the symptoms" management decisions



Part 1: Questions

Carefully go through the questions, ensuring that you follow the instructions to get either to the next question or to the decision, you should run through the questions for all decisions (adaptive, treating the symptoms) three times in the year.



Question 1

Q01

What season/time of year is it?

- ▶ Hot wet season: → Go to Question 2
- ▶ End of summer/Beginning of cold dry season: → Go to Question 3
- ▶ End of winter until the end of hot dry season: → Go to Question 4

Background

Different questions would be asked at different times of the year. We can divide the year into 3 Seasons:

- **Cold Dry Season (May to July-August)**
- **Hot Dry Season (August-September to December) (also the "low rainy season"), and**
- **Hot Wet Season (January to April) (also the "high rainy season").**

Obviously there is no clear division between these and, as witnessed in 2004, 2006 and 2008 the Hot Dry Season can actually be a very wet season! Recent droughts had hardly any rain in the hot, wet season. Nevertheless, because the growth and phenology of the grass and bush is linked to these seasons, it is useful to distinguish between them.

Question 2

Are Saplings Abundant?

- ▶ Yes: → Go to Decision 1
- ▶ No: → Go to Question 3

Q02



Background

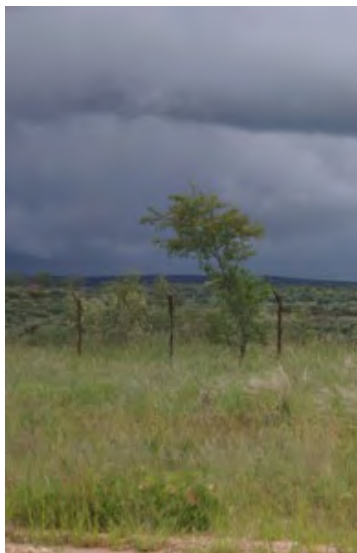
Saplings (small plants but not seedlings) of *Acacia mellifera* become resistant to fire quite quickly and alternative measures might be necessary to control them. Saplings are easily topkilled but resprout profusely after fire. Saplings might be even ten years old but remain small, partly due to competition from adult trees. In the picture, a sapling is shown, one year after fire. As can be seen, fire is not very effective against saplings. Fire has come too late in the life cycle. These saplings will progress slowly to form a thicket, unless a severe drought, heavy browsing or some other management measure is implemented.

Question 3

Q03

Has there been Effective Rainfall?

- ▶ Yes: → Go to Question 6
- ▶ No: → Go to Question 4



Background

Research has shown that mature *A. mellifera* in the highland savanna only produce significant amounts of seeds after a season of exceptionally good rainfall (Joubert, Rothauge and Smit, 2008; Joubert, Smit and Hoffman, 2013). Similar results were found in the Molopo region in South Africa (Donaldson, 1967). In these exceptional rain years, even shrubs of just over 1m height can produce a few seeds (Joubert, Smit and Hoffmann, 2013).

Research on the Farm Krumhuk showed that seed production was zero in 1998 and 1999, and only in the year 2000, when exceptional rain fell, was there significant seed production (Joubert, Smit and Hoffman, 2013). People tend to believe that *A. mellifera* trees produce seeds every year, but this is based on observations of trees growing in situations where they obtain more water than normal (e.g. in or near gardens, on roadsides or near river beds). We call these trees "privileged" trees.¹

¹ Trees that grow at points where water accumulates are referred to as such

Question 4

Q04

Has there been viable seed production (or is there likely to be, based on the current flowering)?

(Time: August to December, but this question is also asked in the rainy season)

► Yes: → Go to Question 6

► No: → Go to Question 5



Background

If a lot of viable seeds of *A. mellifera* are produced, they will germinate in January - March next year. Research shows that seeds do not carry over from one season to the next (they either get eaten, germinate and survive as seedlings, germinate and die due to lack of rain, or browsed by hares and other small mammals. So, if there are no seeds produced in a certain area in a year, it is very unlikely that seeds will be available for germination in the following year. If you come to this question at the early part of this season, be sure to check whether there are mature seeds in November-December.

What about seeds coming in from other areas? Research shows that *A. mellifera* seeds do not survive passing through the gut of livestock and game. This means that most seeds germinate close to Parent Trees (although whirl winds²) can sometimes carry seeds for considerable distances, and water can carry seeds some distance downslope).

2 A small revolving wind storm that circulates rapidly around a low pressure centre usually in a form of a coil

Question 5

Q05

Are there mature shrub skeletons less than one year old?

- ▶ Yes: → Go to Question 7
- ▶ No: → Go to Decision 2



Background

The diebacks of the aboveground parts of mature shrubs occasionally occur, through severe drought, severe frost, fungal dieback, or combinations of the above.

The resprout at the base grows slowly and typically after one year is less than 30 cm high. At this stage the skeletons of the shrubs are totally dry and therefore very flammable. A veld fire is likely to ignite the skeletons. This means the flames will scorch the resprouts for a much longer time than usual. It is likely that the resprout will be killed in this way.

Question 6

Q06

Did bush seedlings (if there were some to begin with) survive the hot wet and cold dry seasons?

Time: End of winter beginning of hot dry season (August to December)

- ▶ Yes: → Go to Question 7
- ▶ No: → Go to Question 5



Background

If the seedlings died out then they are no longer a threat. If there is germination, survival will only occur if there is well spaced good effective rainfall.

The two pictures show, on the left, a dead seedling, and on the right, a very healthy seedling, happily growing in an *Antheophora pubescens* grass tuft. This shows that direct competition is not necessarily a major factor, and that the grass may in fact facilitate growth.

Question 7

Q07

Is the perennial grass density very low, such as below one tuft per square meter? *Remember your answer*

- ▶ Low density: → [Go to Question 8](#)
- ▶ High density: → [Go to Question 8](#)



Background

High perennial grass density will provide competition with seedlings or fuel for a fire to kill them.

Low perennial grass density is likely to allow seedlings to become established, unless there is sufficient dry annual grass to allow a fire.

High density ← ————— → Low density

Question 8

Q08

Is there sufficient biomass³ to produce a fire intense enough to kill seedlings? *Remember your answer*

- ▶ Low biomass: → Go to Decision Table
- ▶ High biomass: → Go to Decision Table



Background

Even a tonne of dry matter per hectare may be able to kill all seedlings, during the hot, dry windy October, as fuel is also dry.

³ Total weight of grass material above the ground over a unit area, strictly referred to as phytomass that is made up of biomass (living grass material) and necromass (dead material still attached to the grass) but the word "biomass" is more commonly known.

Decision table

based on Questions 7 and 8:

Q7 – Perennial grass density	Q8 – Fuel load from grass	Choice
▶ Low	▶ Low	▶ Decision 4
▶ Low	▶ High	▶ Decision 3
▶ High	▶ Low	▶ Decision 5
▶ High	▶ High	▶ Decision 3

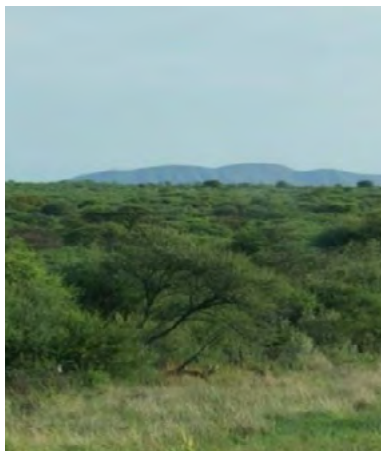
The questions following relate to "treating the symptoms" management. The farmer must use his/her discretion as to when these questions need to be asked. Preferably they should be asked in all three of the seasons (see [Question 1](#)). Questions related to grass biomass should be asked at the end of the rainy season.

Question 9

Q09

Is the bush cover in the area generally high or low?

- ▶ High: → Go to Question 10
- ▶ Low: → Go to Decision 6



Background

There is no specific threshold here. An area is termed to be bush encroached if the numerical density of 1.5m high bush equivalence (BE) exceeds twice the average annual rainfall in mm. If you are monitoring for bush encroachment, you can perhaps set a threshold of 30% cover, for answering "Yes". We find it difficult to set thresholds here and thus leave it to your discretion.

In the left hand picture, the bush cover is clearly very high, but in the right hand picture, the bush cover is not that high, and there are large trees in the area. Some would consider it too high and thus continue to Question 10, whereas others would be happy and move on to Question 14. The tree in the foreground is probably at least 200 years old.

Question 10

Q10

Is there a high incidence of fungal and/or other dieback of *Acacia mellifera* (*Senegalia mellifera*)?

- ▶ Yes: → Go to Decision 6
- ▶ No: → Go to Question 11



Background

If the trees are dying back by themselves, it may not be necessary to apply treatment to the other trees, even if the density of trees and shrubs is high enough to warrant concern. It is likely that all trees are infected and that more of them will die back with time, substantially opening up the veld. The dead trees will allow substantial mulching of the ground that should enhance the growth of grass and the germination of grass seedlings. Your management can continue pretty much as if bush cover was low (Question 9). Are you sure that the dieback is as high as you first thought? Why not determine the % of trees dying back or dead through a survey? Also, if there is little perennial grass in the adjacent area, you could consider adding seeds to the mulch.

Q11

Question 11

Do you intend to thin the bush?

- ▶ Yes: → Go to Question 12
- ▶ No: → Go to Decision 6

Background

There are numerous reasons you may not want to thin the bush at this stage. See Decision 6.

Question 12

Q12

Do you intend to utilise the bush after removal for charcoal, fodder, wood chips etc.?

- ▶ No: → [Go to Question 15](#)
- ▶ Yes: → [Go to Question 13](#)



Question 13

Q13

Can part of the bush be harvested for fodder (are the leaves green/present still)? Only in the hot, wet season.

- ▶ Yes: → Go to Question 14
- ▶ No: → Go to Question 16 (or go to Decision 6 and ask the question again in the wet season)



Background

If this question is asked in the dry season, consider leaving this area for the wet season (the following year) and then ask the question again.

Question 14

Q14

Are the dominant bushes less than 1 m tall?

- ▶ No: → Go to Question 16
- ▶ Yes: → Go to Decision 13



Background

The quality of fodder that can be harvested from short bushes is better than harvestable fodder from bigger bushes that have excessive lignin. This is because there is a higher proportion of leaf: wood biomass in smaller bushes (on the left).

Q15

Question 15

Do you intend to use arboricides? Please read the following page on the pros and cons of using arboricides before answering.

- ▶ No: → Go to Question 16
- ▶ Yes: → Go to Decision 8

Background

The use of arboricides is strongly questioned today, but it is quick to apply and relatively inexpensive, if the bush is not to be utilised for value chains. See the next page.

The pros and cons of using arboricides vs manual labour (e.g. chopping)

	Price per ha ¹	Effects on production	Regrowth	Unknown and undesirable Side effects
Arboricides	N\$500–4000	Large areas can be treated quickly. Trees take about a year to die, but once dead increase in production is rapid.	Not if the correct dose is applied.	Unknown effects on microorganisms, but wood decomposition rates have been observed to be much slower after arboricides application. Arboricides all have LD 50 values ² for insects (bees) and rabbits (similar to hares), and thus are toxic. Even if not lethally applied, accumulations of the arboricides, especially when granules are applied may cause unwanted ecosystem impacts ³ . Wood should not be used for value addition.
Chopping	N\$1000–3000	Thinning is slower, but the response is faster. In the long run, production increases is less. Wood can be used for value addition.	Usually occurs but can be lessened if cut below ground level (axe/pick).	No unknown side effects. Regrowth is generally undesirable, and is often multi-stemmed, which can exacerbate future problems.

¹ The costs will obviously depend upon the species, soils, and density of trees per hectare as well as other factors. Manual clearing is at least twice as expensive per hectare, but can be lessened with innovative tools being developed right now.

² LD (lethal dose) 50 value is the dose of toxins that kills 50% of the organism that the poison is experimentally dosed with.

³ Aerial application of arboricides is prohibited under the Forest Act of 2001 & its Regulations of 2015.

What scale of bush thinning should i do?



Question 16

Q16

Are you interested in small scale bush thinning up to 60–100 hectares per annum?

- ▶ Yes: → Go to Decision 7
- ▶ More than 100 hpa: → Go to Question 17

Background

There may be many reasons for you to decide one way or the other. To assist in this, refer to the Harvesting Guidelines on Forestry and Environmental authorisation process for Bush Harvesting Projects (2017) for valuable details on bush thinning. Bear in mind that you might have reached this decision without wanting to utilise the bush. **Bush thinning without value addition is more expensive than the likely gains made through improvements in production.**

Question 17

Q17

Is the terrain difficult (steep, rocky)?

- ▶ Yes: → Go to Decision 9
- ▶ No: → Go to Question 18



Background

Difficult terrain may make access to areas for heavy commercial machinery dangerous, difficult or impossible.

Q18

Question 18

Are you interested in a bush thinning scale of 100–150 hectares per annum?

- ▶ Yes: → Go to Decision 11
- ▶ More than 150hpa: → Go to Question 19

Background

There may be many reasons for you to decide one way or the other. To assist you in this, refer to Harvesting Guidelines on Forestry and Environmental authorisation process for Bush Harvesting Projects (2017) for valuable details on bush thinning. **Bush thinning without value addition is more expensive than the likely gains made through improvements in production.**

Q19

Question 19

Are you interested in bush thinning on a scale of 150–700 hectares per annum?

- ▶ Yes: → Go to Decision 12
- ▶ No (More than 700hpa): → Go to Decision 11

Background

There may be many reasons for you to decide one way or the other. To assist you in this, refer to the Harvesting Guidelines on Forestry and Environmental authorisation process for Bush Harvesting Projects (2017) for valuable details on bush thinning. **Bush thinning without value addition is more expensive than the likely gains made through improvements in production.**

Part 2: Decisions

Important information: Before acting upon our advice for the decisions that we recommend, please ensure the following:

1. You followed the EXPERT SYSTEM correctly. Try to repeat the process from Question 1 to see if you arrive at the same decision again. (Return to Question 1).
2. You obtain advice from an extension officer or researcher.
3. You obtain advice from other farmers who might have tried the same management. What was their experience with it?
4. If applying arborocides, please ensure that the correct concentrations are used, and all application and safety procedures are followed correctly.
5. You waited for a year with low seed production before applying arboricide, so that seedlings will not replace the killed bushes.
6. You explored options to apply the decision in the most cost effective manner.
7. You weighed up the estimated costs with the likely benefits, both short and long term, before a final decision.

Adaptive management decisions 1-5



Decision 1

D01

Pull out, or dig out, saplings e.g. with a mattock, Tree Popper, or similar, while soil is wet. A fire may be applied, but success is not guaranteed. Now proceed to → Question 3.



Background

There are a few ways one can dig out saplings, such as using a mattock (pick axe or bush axe) or a Tree Popper. A pick axe is relatively cheap to use, but tends to not remove much of the root, hence the saplings are likely to regrow. The Tree Popper is a simple device that was designed to remove alien invasive saplings in South Africa (photo left). We have done trials in Namibia and the Tree Popper has been shown to effectively remove the Swarthaak saplings (photo right)

along with most of the tap root (lateral roots not developed yet). In sandy soils this might work in the dry season, but in soils with more clay or rock, this should **only be done in the wet season**. Saplings are relatively resistant to fire after three years, depending upon growing conditions. Their tap roots are well established. Fire is not that effective against established saplings, and these saplings are the future encroachers, especially if mature shrubs (their competitors) are removed. They regrow rapidly after fire, and become much more multi stemmed than before.

Decision 2

D02

No worries for bush encroachment, or, if there are many saplings present, you will arrive at → Decision 1 when you use the booklet in the following hot, wet season.

You have reached a final decision regarding adaptive management. You should now proceed to Question 9 (questions related to treating of symptoms management).

Decision 3

D03

Burn at end of dry season and allow animals to graze and trample for first half of growing season, then rest.



Background

This fire will kill all seedlings. In addition, if there are mature skeletons (after drought or frost) with a little bit of regrowth, this fire will ignite the skeletons which will allow a longer burn, thus damaging and probably killing the regrowth. Animal trampling will prevent soil capping. If perennial grass density is low, ensure that seeds have been shed before burning.

Please refer to the next page for more information: **When is it OK to burn?**

When is it OK to burn (weather and legal requirements)?

Planned fires should be conducted in the morning before temperatures get too hot, relative humidity decreases and wind speeds increase. This will make it easier to control.

It is important to refer to the sections of the National Forest Act (2001) for more detail related to fire legislation before applying a fire. Neighbours have to be notified and adequate steps taken to ensure that a planned fire does not escape to a neighbour's property, or to a community forest or conservancy nearby.

In 2007, Mr. Gero Diekman applied a management burn on his farm Okarutuo. The area burnt was 8 hectares in extent. He informed neighbours and applied a 40 m wide firebreak around the area to be burnt by systematically grazing the firebreak with the assistance of electric fencing. The electric fencing forced the cattle to graze the rather unpalatable *Eragrostis rigidior* right down. The fire was well managed and was a success. We are monitoring its effects on various factors including *Acacia mellifera* seedling and sapling survival. Thus far, it seems that fires are effective in killing only very small saplings, up to about 5 or 6 mm in stem diameter (typical size for seven year olds). In trials at Neudamm, 100% mortality of seedlings occurred in three fires applied in 2008 and 2009 (Joubert et al., 2012).

Fires **will** occur, and so it is preferable to make fires work for you, by killing seedlings, for example. Fire does not "destroy" grazing, rather it reduces the grass biomass temporarily, but will also improve grazing quality in the following season. Planning for fire will reduce the chances of a runaway fire killing livestock, game, and even humans, and creating negative relations with neighbours.



Some useful advice from farmer Jan Labuschagne is to apply fire only when there is still sufficient residual soil moisture from the previous rainy season to allow perennial grasses to regrow even in the absence of follow-up rain. A few days before burning, Mr. Labuschagne releases some cattle into the camp, to reduce fuel load around valuable shade trees.

Decision 4

D04

Pull out most surviving seedlings with pliers, or use a hoe to dig them out, and rest the veld for the remainder of the growing season, in order that a hot fire can be implemented in the following year. Unfortunately you will also not be able to burn regrowth by burning the mature skeletons as there is insufficient fuel.



Background

Because of the poor perennial grass cover, the seedlings should be visible. Because fire is not an option and because the grass offers no competition to the seedlings, the seedlings are likely to establish successfully. There is little option other than to treat the symptom of the excessive bush seedlings to get rid of most of them. Although pulling them out with pliers requires a lot of work, it is less than would be required to remove older bushes if the seedlings are left to establish themselves. Ongoing good grazing manage-

ment should then be applied to encourage perennial grass cover and prevent bush seedlings establishing in future. Guidelines for recovery periods, if rain continues, are about 110 days on loamy soil and 120 days on sandy soil.

You have reached a **final decision regarding adaptive management**. You should now proceed to [Question 9](#) (questions related to treating of symptoms management).

D05

Decision 5

Rest the veld for the whole year and pull out seedlings.

Background

Hopefully, an entire year of rest will allow the grass to recover sufficiently to suppress growth and be sufficient for a fire next dry season which will kill the rest of the seedlings, and the resprout from mature shrub skeletons top killed from frost or drought. If unable to rest for the whole growing season, then low stocking rate should be applied. This will hopefully allow the grass to produce sufficient biomass (depending upon the rainfall of the next season) which will allow a fire to kill the surviving seedlings and the resprout from mature shrub skeletons topkilled from frost or drought, in the following dry season and possibly suppress the growth of the bush seedlings.

You have reached a **final decision regarding adaptive management**. You should now proceed to Question 9 (questions related to treating of symptoms management).

Treating the symptoms: no value addition decisions 6 – 8



Decision 6

D06

Leave the bushes.

Background

This decision might have been reached because the bush density is too low, or because the dieback is already high. But you also might have reached the decision if there was, in your opinion, a very high density and cover of bushes. This then might seem like a contradictory decision for bush encroachment management. However, we have included it explicitly, since the decision to leave the bushes might be difficult for an individual farmer, given that there is currently a sense of urgency in the country, and an individual farmer might feel obliged to comply with this. Studies have shown that mature thickets consisting of mature trees are thinning out through natural mortality. If a farmer is able to make a living without harvesting the bushes, and is reluctant to explore avenues of value chain, he should rather focus on ongoing good management as well as adaptive management.

In addition, the farmer may be clearing in another camp or area, and thus might want to defer the decision to remove and harvest for another year or more. The farmer may also want to monitor the effects of harvesting before making a decision in this camp. ***Dense bush thickets can act as fire breaks between areas that are to be burnt.*** This saves the farmer time and money.

Decision 7

D07

Chop the bushes or use light duty mechanised equipment such as horizontal saw cutters preferably in strips, and leave them in situ (consider reseeding), or proceed to → Decision 14.

Background

The increase in production is less than the costs of bush thinning if value addition chains are not utilised. However, leaving the bushes *in situ*, although not providing any direct economic benefits, will enhance the soil, and act as a nursery for any seeds of perennial grasses that blow there. If runoff occurs during intense rain, then it is strongly recommended to apply the bush control treatment along contour strips, to regenerate water and nutrient cycling. Only in situations

where no runoff occurs, should the treated strips rather be aligned at right angles to the prevailing wind. In addition, the overseeding with climax perennial grasses, in these bushes, will enhance long term improvements in productivity and species composition. Aftercare will be necessary as most stumps will resprout.



Decision 8

D08

Apply soil arboricide, preferably along strips.
Follow instructions and advice from experienced users of arboricides.
Sekelbos requires a stronger dose, as do plants in clay >20%.
Proceed to → Decision 14.



Decision 8 continued



An alternative way to use arboricides is to use half the prescribed dose of soil applied arboricide. In the following year, the weakly resprouting can be burnt by applying a veld fire. In this way arboricide costs are halved, and the arboricide residues burnt away. Furthermore, the lick application for that field can be halved.

Alternatively, a fire can be applied one year, followed by arboricide application on the resprouting shrub the following year. Mr. Johan Du Plessis of Lynpan near Summerdown has used this approach to good effect.

Background

Application of herbicide, such as Access, to surfaces of cut stems (left), prevents the bushes regrowing into a thick mass of coppicing branches, but is relatively expensive and time consuming. However, if the arboricides is effective, no after-care will be necessary on resprouts. On the other hand, it may be more economical to wait for a year and then only apply herbicide to those bushes that have regrown, as some bushes may die after being chopped, so some herbicide could be saved. Chopped bushes can be used for charcoal since they are not poisoned.

Application of soil based arboricides to the soil around trees (centre and right) is a much more rapid method. The side effects of this on the ecosystem are not well known though, and caution should be applied. See ["THE PROS AND CONS OF USING ARBORICIDES VS MANUAL LABOUR"](#). Bushes killed through this method should not be utilised.

Important environmental legislation relevant to bush encroachment and thinning

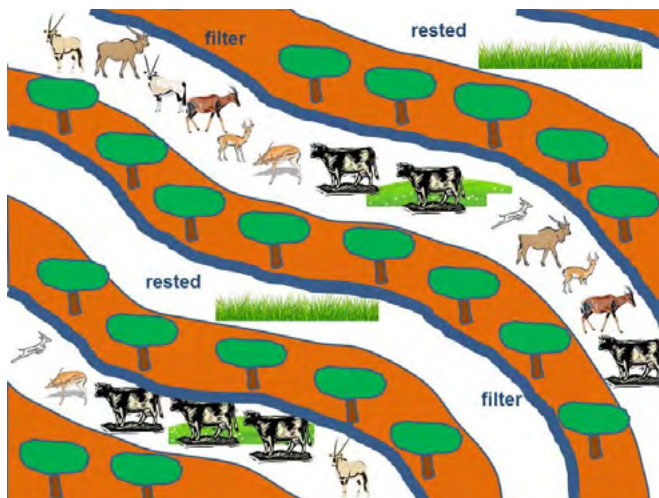
- All harvesting of trees and wood is governed by the Forest Act (2001) and its Regulations (2015). Any area <150 hectares per annum, in which trees are being cut or harvested, requires a Harvesting Permit. In addition, Transport Permit (for the transport of the wood products) and Export Permit (if the products are being exported are also required).
- Projects clearing >150 hectares requires an Environmental Clearance Certificate under the Environmental Management Act (2007) and its Regulations (2012) **in addition** to a Harvesting Permit.
- For more details on harvesting guidelines and regulations, refer to the booklet: "Forestry and Environmental Authorisation Process for Bush Harvesting Projects" (2017). It is very useful, and is available on the DAS website: <http://www.dasnamibia.org/download/policies/GIZ-deBushing-Bush-Harvesting-Guidelines-2017.pdf>

Harvesting guidelines

What follows is a brief outline of some important guidelines for harvesting in a relatively sustainable way. For more details on this, the booklet: "Forestry and Environmental Authorisation Process for Bush Harvesting Projects", is again very useful. Refer to also to [Figures 4, 5 and 6](#) in this booklet.

- ▶ All bush thinning activities should leave trees and shrubs of all sizes and all species (including some of the encroaching ones).
- ▶ Leave some dead trees.
- ▶ Leave some patches of thickets (patch mosaic approach).
- ▶ Leave some of the wood (fines and larger branches) and, if possible, lay out as bush filters.
- ▶ Try to harvest along contours (see CONTOUR HARVESTING on the next page).
- ▶ Do not harvest within 100 m of a river course.
- ▶ Avoid harvesting of protected species.
- ▶ Do not chop or remove any individual with a stem diameter of >18 cm.
- ▶ Minimise soil disturbance as much as possible.
- ▶ In the case of charcoal production, follow the guidelines for reducing the risk of unwanted uncontrolled fires. (See Fire Prevention for charcoal burners report, downloadable from NAU website: <http://www.agrinamibia.com.na>).

Contour harvesting



If the land experiences any runoff during intense rain, then it is advisable to harvest bushes in contour strips to enhance water and nutrient cycling. If some of the cut branches can be placed as filter lines on contour, then the improvements will be speeded up. Grasses will grow more densely underneath the branches, to take over their filtering function as the branches decompose. Any runoff gets slowed down by the filters, thus increasing infiltration and depositing sediment that slightly raises the soil level. This occurs in a self-reinforcing manner as more runoff flows where the grass grows less densely along the filter, resulting in more grass later establishing in the wetter soil there and more of subsequent runoff diverting to sections of the filter with lower grass density. The stimulated activity of soil organisms underneath the filter line further raises the soil level slightly, creating a slight step

in the landscape like those that were common in natural rangeland before paths created by animals or vehicles diverted water flow off the rangeland. With cleared contour strips, the tendency will be for animals or vehicles to follow the contour, thus reinforcing infiltration of rainwater.

Value addition options

The decisions that follow are for those who have expressed, through [Question 12](#), that they seek value addition options from harvesting.

Value addition	Logistic considerations	Environmental considerations
Firewood	Preferable if transport logistics are difficult. For transporting, costs will be much lower than for charcoal transport.	Minimal pollution; if used locally no transport pollution.
Charcoal production	Distance from sources to client (e.g. Jumbo charcoal); availability of transport; transport costs will be lower than for firewood and wood chips if firewood and wood chips require transporting. Low overheads compared to wood chips production.	Increased risk of uncontrolled fires on farms; air pollution; non-use of fines means there is an opportunity for "fines" nurseries ¹ . Areas harvested should be monitored to ensure that no protected species and trees with diameter of 18 cm are harvested.
Wood chips for energy production	Initial outlay costs are high. Wood-chipper is expensive. Transport costs are high and are dependent on the distance to the supplier. Although demand exceeds supply, supply likely to be sufficient within a 100 km radius of current users, hence limiting the number of farmers who will benefit. Expansion of opportunities likely in the near future.	Unlike charcoal production, wood chips are not reliant on larger trees. However, the fact that the operation can use most wood means that "fines" nurseries are less likely to be left behind.
Milling / with an option of pelletising for bush based fodder	Fodder can be used locally; milling machine needs to be purchased or hired. Pelletising is only an option if a pelletiser is available nearby. Pellets last longer than unpelletised milled material.	If milled and fed to livestock, nutrients remain in the ecosystem.

¹ Fines nurseries refers to the small piles of smaller wood waste (fines) that can act as nurseries for grass seed germination and establishment, left over after harvesting for charcoal production. They also increase mulch and return nutrients to the soil.

Decision 9

D09

Chop or saw the bushes preferably in strips and utilise to make wood chips (wood chipper needed for this) or charcoal (see VALUE ADDITION OPTIONS).

Leave some wood and proceed to → Decision 14.



Harvesting Namibian Encroacher Bush study estimates that costs (wood chips) for small scale manual operations, clearing 800 t.p.a.: N\$ 930 tonne (excludes costs of machinery).

Charcoal costs are similar but with much lower capital outlay.

Background

For a small scale operator, overhead costs are too large to purchase small, medium or commercial scale machinery. Medium to large machinery would not be able to traverse difficult terrain effectively. You might not prefer the logistic complications that would go with medium to commercial scale machinery. In addition, you might also be concerned with the potential for soil damage that some warn against, using heavy machinery. Please refer to "Harvesting Namibian Encroacher Bush" for valuable details on this including costs. If milling of the leaves and twigs is considered see this factsheet on the DAS website: <http://www.dasnamibia.org/download/brochures/Bush-to-Feed-Factsheet.pdf>. Aftercare will be necessary as most stumps will resprout.

Decision 10

D10

Use light duty mechanised equipment such as horizontal saw cutters, and utilise to make wood chips (wood chipper needed for this) or charcoal. Leave some wood and proceed to → Decision 14.



Estimates of costs (wood chips) for light duty semi-mechanised operations clearing 1400 t.p.a.: N\$ 910/tonne (excludes costs of machinery).

Charcoal costs are similar but with much lower capital outlay.

Background

For a small scale operator, overhead costs are too large to purchase medium or commercial scale machinery. Medium to large machinery would not be able to traverse difficult terrain effectively, but light duty machinery might be suitable. You might not prefer the logistic complications that would go with medium to commercial scale machinery as well, but would like to speed up clearing. In addition, you might also be concerned with the potential for soil damage that some warn against, using heavy machinery. Please refer to "Harvesting Namibian Encroacher Bush" for valuable details on this including costs. If milling of the leaves and twigs is considered see this fact-sheet on the DAS website: <http://www.dasnamibia.org/download/brochures/Bush-to-Feed-Factsheet.pdf>.

Decision 11

D11

Use medium duty fully mechanised equipment such as a medium duty excavator for felling, preferably along strips. Leave some wood and proceed to → Decision 14.



The Harvesting Namibian Encroacher Bush booklet estimates the costs (wood chips) for medium duty fully-mechanised operations clearing 6000 t.p.a.: N\$ 600-800/tonne (incorporating very high costs of machinery).

Charcoal costs are similar but with much lower capital outlay.

Background

This option could be done alone (leaving the excavated bushes in situ or as part of a larger operation in which the felled shrubs are utilized for wood chips). Economic studies have shown that, clearing without value addition chains, is more expensive than the likely improvements in production. Please refer to "Harvesting Namibian Encroacher Bush", from where this image is extracted, for valuable details on this including costs. If milling of the leaves and twigs is considered see this factsheet on the DAS web-site: <http://www.dasnamibia.org/download/brochures/Bush-to-Feed-Factsheet.pdf>. Note that mechanised clearing has significant impacts on soils, including soil compaction, loss of structure, and potential soil erosion.

Decision 12

D12

Use heavy duty fully mechanised equipment such as an 18–21 tonne excavator for felling, preferably along strips. Leave some wood and proceed to → Decision 14.



Harvesting Namibian Encroacher Bush booklet estimates the costs (wood-chips) for medium duty fully-mechanised operations clearing 8000 t.p.a.: N\$ 500-750/tonne incorporating very high costs of machinery).

Charcoal costs are similar but with much lower capital outlay.

Background

There are **various heavy duty mechanical** bush control methods, nicely outlined in the booklet: Harvesting Namibian Encroacher Bush (from where this image is extracted), along with costs. This option could be done alone (leaving the excavated bushes *in situ*) or as part of a larger operation in which the felled shrubs are utilised for wood chips. Economic studies have shown that, clearing without value addition chains, is more expensive than the likely improvements in production. If milling of the leaves and twigs is

considered see this factsheet on the DAS website: <http://www.dasnamibia.org/download/brochures/Bush-to-Feed-Factsheet.pdf>. Note that mechanised clearing has significant impacts on soils, including soil compaction, loss of structure, and potential soil erosion.

Decision 13

D13

Use a bush cutter or something similar for cutting the small bushes, preferably along strips. Mill the leaves and small twigs. Now proceed to → Decision 14.



Photos © Dr. Axel Routhage

Background

During the bush growing season, using a bush cutter to remove the smaller bushes (< 1 m) allows a better quality fodder to be milled than if the bushes were larger and larger twigs and branches were milled. Milling is a viable option for communities and commercial farmers who can use the resultant fodder close by and soon after milling. If a pelletiser is available, making pellets can be an option for commercial sale or storage for longer. In this case, harvest the smaller twigs and leaves and the larger twigs and branches can be handled as suggested in Decisions 9-12. Look at the factsheet on the DAS website for more details: <http://www.dasnamibia.org/download/brochures/Bush-to-Feed-Factsheet.pdf>.

Decision 14

D14

What to do with the left over wood, or in the case of decisions where the wood remained unutilised, what to do with the wood?

This decision is included as an additional "Treating the Symptoms" decision for all decisions except Decision 6. We look at 3 options and point out their advantages and disadvantages.

Decision 14 (Option 1)

Overseed with valuable perennial grasses in cleared strips and cover with bush filters from the excess unutilised bushes.



Explanation and advantages:

Where runoff occurs during heavy rain, control activities should ideally be applied in strips on contour, while leaving uncleared strips of bush in between. The uncleared strips help to fertilise the treated strips below them and serve as windbreaks. Over time they would thin out to a lower density of taller bushes and trees. If bushes are cut in the treated strips, they or the non-consumptive branches from them, should be placed as a filter on a contour. This improves infiltration

of rainwater and initiates nutrient cycling. Although such a bush filter would eventually decompose, its filtering function would be taken over by perennial grass encouraged to grow underneath it. This would occur in a self-reinforcing way, because after any rain event, more water would flow through the filter where there is less grass, thereby wetting the soil there more, so encouraging more grass to grow there. By the time of the next rain event, it is likely that more water will flow through the filter at another location, due to the repair from grass growth at the previous location, and the process would repeat itself with every subsequent rain event. Alternatively, grass seed can be mixed with supplementary feed, for animals to spread in their dung.

Disadvantages: This method is labour intensive and time-consuming.

Decision 14 (Option 2)

Leave the excess unutilised wood (often the "fines" after charcoal harvesting) and add seeds of valuable perennial grasses.



Explanation and advantages:

The charcoal industry only uses wood >2 cm (and usually thicker) in diameter. This means it is a messy business, and each tree or small group of trees leaves a pile of these "fines" which are ideal places for improving the soil conditions as the "fines" decompose, and also for trapping seeds of grasses and protecting these germinated grasses from grazing for the first few years. If wood chipping is being done (i.e. all stem diameters are usable) then it is important, if one is looking at this option, to "re-invest" in ecosystem services by leaving a sizeable proportion of the wood (>20%) in these "Fines nurseries".

Disadvantages: The "fines nurseries" may be a hindrance to transport in the field. If so, piles can be strategically managed to minimise this. It reduces the amount of wood that can be harvested by >20%.

Decision 14 (Option 3)

Put the excess unutilised wood into large piles and burn them.



Explanation and Advantages:

Farmers often make large piles of unutilised wood and burn the piles. This makes access into camps, and to charcoal kilns in the camps, much easier.

Disadvantages: Burning large piles of wood increases the intensity and duration of fire to such an extent that soils become totally sterile (all soil microorganisms killed). In addition, the remaining ash is often many centimetres deep. Plants cannot grow in this excessive ash, as is seen in the areas burnt in the middle and right hand pictures above, burnt two years ago.

Some Notes on Aftercare

Many farmers and scientists emphasise the importance of "aftercare". Most of the methods of treating the symptoms shown here do not kill the bushes. Thus some form of aftercare would be necessary to deal with regrowth. Aftercare is described in detail in Chapter 3: ROTHAUKE, A., 2017. Bush Control Manual (see [USEFUL DOCUMENTS](#)). Below is a photo of one season's regrowth of *Acacia mellifera* after harvesting in Okondjatu. What aftercare will work? Can the regrowth be used for a better quality milled **fodder**? Yes, but the quantity will be low and so the cost/benefit of this needs to be tested. Will **browsers** control the aftercare directly? Observations and research suggest no, although **hares** may slow down the regrowth significantly. There is not sufficient fuel to **burn**, so the area will have to be **rested, reseeded** (with **perennial** grasses) and burnt later, but once a fire is applied, this may be too late. **Arboricides** therefore remain a controversial but effective alternative with negative side effects.



Once the ecosystem has returned to a more open productive savanna (with occasional thickets and heterogeneity in the landscape) then "aftercare" would be the same as **continuous good management** (REST, ETC.) and **adaptive management e.g. fire after seedling establishment** as outlined in this booklet, i.e. **AFTERCARE = ADAPTIVE MANAGEMENT + GOOD GRAZING MANAGEMENT**.

Conclusions

This booklet is a copy of a more sophisticated web version that is being developed. The advantages of accessing the website is that it will be able to be updated regularly (the information in this booklet might be a bit outdated when you use it) and will contain additional information that is unavailable in this booklet (it would make the booklet become a very heavy book and difficult to use in the veld).

We hope you enjoyed using this booklet and that it was useful. In a field such as rangeland management there are always many opinions. We would therefore welcome your opinions and encourage you to send your suggestions for improvements. Please send them to the De-bushing Advisory Service, (info@dasnamibia.org) or call (+264 61 429 256).

Useful Documents

- ▶ MAWF/GIZ Support to De-bushing Project (2016). **Drought Resilient: Bush-to-feed.**
<http://www.dasnamibia.org/download/brochures/Bush-to-Feed-Factsheet.pdf>
- ▶ M.J De Wet (2015). **Harvesting Namibian Encroacher Bush: Compendium of Harvesting Technologies for Encroacher Bush in Namibia.**
 Commissioned by Support to De-Bushing Project of Gesellschaft für internationale Zusammenarbeit (GiZ), Windhoek, Namibia.
<http://www.dasnamibia.org/download/studies/STUDY-Harvesting-Final.pdf>
- ▶ MAWF/GIZ Support to De-bushing Project (2016). **Financing Bush Control**, based on BFS 2015 report on Assessment of existing incentives relevant for bush harvesting and value addition. Commissioned by Support to De-Bushing Project of Gesellschaft für internationale Zusammenarbeit (GiZ), Windhoek, Namibia. <http://www.dasnamibia.org/download/studies/STUDY-Financing-Final.pdf>
- ▶ MAWF/GIZ Support to De-bushing Project (2017). **Bush-based Animal Feed Survey Findings.**
http://www.dasnamibia.org/download/brochures/Factsheet_Animal-Feed-Survey-2017.pdf
- ▶ GOVERNMENT OF THE REPUBLIC OF NAMIBIA (2001). **Forest Act no.12 of 2001.**
<http://www.dasnamibia.org/download/policies/Forest-Act-2001.pdf>
- ▶ A Rothauge (2017). **Bush Control Manual.** Commissioned by Support to De-Bushing Project of Gesellschaft für internationale Zusammenarbeit (GiZ), Windhoek, Namibia.
- ▶ MINISTRY OF AGRICULTURE, WATER AND FORESTRY AND MINISRY OF ENVIRONMENT AND TOURISM. (2017). **Forestry and Environmental Authorisations Process for Bush Harvesting Projects.**
<http://www.dasnamibia.org/download/policies/GIZ-deBushing-Bush-Harvesting-Guidelines-2017.pdf>
- ▶ DECOSA (2015). **Value Added End-use Opportunities for Namibian Encroacher Bush.**
 Commissioned by Support to De-Bushing Project of Gesellschaft für internationale Zusammenarbeit (GiZ), Windhoek, Namibia.
http://www.dasnamibia.org/download/brochures/Brochure_Debushing_Value-Chains-2015.pdf

Important Contacts

CONTACT	VALUE/FUNCTION
De-bushing Advisory Service Namibia 061 429 256 info@dasnamibia.org www.dasnamibia.org	A national information sharing and capacity building platform for providing advice to farmers on sustainable bush control and value addition opportunities. The website has a number of downloadable documents, videos, and other information, relevant to decision making regarding bush encroachment.
Namibia Biomass Industry Group (N-BIG) 061 371 196 info@n-big.org www.n-big.org	A non-profit organisation, representing all businesses that harvest and process bush-biomass in the country. Support members to access markets and conduct trainings on how to utilise harvesting machines among others.
Namibia Charcoal Association (NCA) 067 304 220 info@ncanamibia.com www.ncanamibia.com	A non-profit voluntary membership Association created to serve the charcoal industry in Namibia from producers and processors to suppliers and all other stakeholders. Provide professional support to charcoal stakeholders with respect to the implementation of environmental and social standards, quality assurance, market identification, modernisation of production, advocacy and public communication. Aims to strengthen the charcoal industry in a sustainable manner.
Ministry of Agriculture, Water and Forestry: Directorate of Forestry (DoF) Head office: 061 208 7111 www.mawf.gov.na	Responsible for issuing of permits for harvesting, transporting, exporting and marketing of forest resources, including from bush encroaching species. Website includes downloads for applicants, explanation of requirements outlined in the Forest Act (2001). Various reports and articles of relevance to bush harvesting.
Ministry of Agriculture, Water and Forestry: Directorate of Agricultural Research and Development (DAPEES) Head office: 061 208 7111 www.mawf.gov.na	"Promote the adoption of improved agricultural technologies and practices in order to increase agricultural production..." including advisory and training services to farmers.

CONTACT	VALUE/FUNCTION
Ministry of Environment and Tourism (MET): Directorate of Environmental Affairs Head office: 061 284 2111 www.met.gov.na	Responsible for issuance of Environmental Clearance Certificates for bush harvesting projects.
Agri Advisory Services 061 207 4265 www.agribank.com.na	Previous known as Farmers Support Project, this advisory service of Agribank provide mentorship and trainings on rangeland management, livestock, crop and horticulture production to Agribank clients in all 14 regions.
Namibia Agricultural Union (NAU) 061 237 838 nau@agrinamibia.com.na www.agrinamibia.com.na	Umbrella organisation of Namibian farming communities to promote a conducive environment for sustainable agriculture.
Namibia National Farmers Union (NNFU) 061 271 117 info@nnfu.org.na www.nnfu.org.na	A mouthpiece for Namibian communal and emerging (NECFU) farmers. Aims to improve food production in these systems.

Notes

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Notes

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....