# MECHANICS

## FARMERS' SUPPORT PROJECT (FSP)

# MECHANICS

*Photograph by Marina Coetzee*

Compiled by
**HELMUTH STEHN**

NAU – NLU

NNFU

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Ingo Jacobi
(Project consultant)

# Preface

It is with great pleasure, gratitude and pride that the JPC presents this production manual.

After years of deliberations, careful planning, and a lot of dedication the NAMIBIA AGRICULTURAL UNION and the NAMIBIA NATIONAL FARMERS' UNION jointly embarked on the EMERGING COMMERCIAL FARMERS' SUPPORT PROGRAMME. This programme resulted from the realisation that the new group of emerging commercial farmers who, having been previously disadvantaged and mostly coming from the background of communal farming, were in dire need of basic (sophisticated) skills training to manage modern farming techniques. The planning phase entailed, amongst others, a need assessment way back in 2004/5, which clearly identified the areas of assistance required. After having analysed all the relevant data, the two unions set about structuring a two-year programme which would address the challenges faced by new farmers so that ultimately they would be able to deal with the daunting task of becoming successful commercial farmers. Besides a dedicated programme of lectures, training courses, study tours and mentoring, it was decided to also produce and publish a set of eight PRODUCTION MANUALS which would serve as valuable training guides with technical details, but would also be a source of reference for future everyday practical farming in Namibia.

It is with gratitude that we acknowledge the unrelenting support of many individuals, too numerous to name, and certain institutions which supported and still support the whole Emerging Commercial Farmers' Support Programme.

We sincerely hope that this initiative will make a lasting contribution to sustainable agricultural land utilisation and to the goals of land reform in Namibia.

On behalf of the JPC,

Raimar Von Hase
(President, Namibia Agricultural Union)

Pintile Davids
(President, Namibia National Farmers Union)

Windhoek, December 2007

# Foreword

Agriculture as the backbone of Namibia's economy has a major role to play in achieving Vision 2030. However, to be able to make a significant contribution towards the growth of the economy and thus wealth creation, agricultural production/output has to increase manifold. For the realisation of such an increase the following crucial issues have to be addressed. Subsistence farming should become commercialised, e.g. landownership in some form or other should be allocated to individuals, underutilised areas should be developed and put into production and the problem of bush encroachment should be addressed and solved at national level.

Food production at competitive and affordable prices for the consumer is the biggest challenge that farmers worldwide have to face. With input costs increasing at a higher rate than the increase in prices realised for produce from the farm, it is clear that productivity and the production capacity on farms have to improve continuously. This also applies to Namibia's agricultural sector.

Furthermore, if we want to participate in international trade with our export commodities, currently being beef, mutton, Karakul pelts and grapes, we have to be able to compete worldwide against all the countries exporting the same commodities. Apart from being price competitive we also have to be competitive in satisfying the needs of the sophisticated consumer in terms of quality, health issues, traceability, animal welfare and other ethical production norms, e.g. personnel management, conservation of biodiversity/ecology (fauna, flora and water resources), etc.

Agricultural production is no longer just a matter of producing whatever the farmer is able and willing to produce and then expecting to achieve good prices for the product.

Farmers have to become more involved in the value chain, and should become much more market orientated by being sensitive to the needs and preferences of the consumer whom they want to serve. In addition they have to adhere to international trading rules and regulations as prescribed by the World Trade Organisation (WTO), and also comply with the Sanitary and Phytosanitary (SPS) requirements of the various countries with which they want to trade. Norway, for instance, has zero tolerance for salmonella in beef/mutton, which is imported into that country, thus making it very difficult to serve this lucrative market.

*It is obvious that survival and growth in the agricultural sector can only be achieved if the farmer in future **pays greater attention** to the world around him, as has been the case in the past.*

Skills development and training of farmers and their employees are becoming imperative, and are of national interest.

Being a farmer and thus the owner of agricultural land in Namibia should be regarded as a privilege. Not every citizen in Namibia, as in countries all over the world, can own agricultural land. There is just not enough land available. Therefore every farmer has a responsibility to use his piece of land in a productive but also a sustainable way. Productive means exploiting the full production potential of the farm, furthermore contributing towards job creation in the primary and secondary sector, towards food production on national and international level and towards revenue for Government in terms of taxes paid. Sustainable means preserving and even improving the production potential, so that the generations to come can still make a living from that land. It should be the aim of every landowner to leave behind a farm that is in a better condition than the one he started off with, including production capacity, infrastructure and natural resources, e.g. underground water, fauna (game) and flora (plants).

Commercial farmers in general are often perceived as being wealthy, which, however, is not the case. Becoming a successful farmer in Namibia may take years and even generations, and requires love for and dedication towards farming, hard work, good management skills, financial discipline, persistency and a positive attitude.

Climate (rainfall) and other external unforeseen events can have a major influence on the progress made on the farm, and can ruin achievements made over years within a matter of time.

To get an indication of the current gross/net income on a cattle farm, the following indicators could serve as a guideline.

The average stocking rate on cattle farms in Namibia is ± 25 kg biomass (live mass) per ha. In old terms this meant ± 14 ha for every animal on the farm. In a cow/ox production system the production of beef (live mass) should be about 35 % of the stocking rate.

This means that if no herd building takes place, the farmer has 25 kg x 35 % = 8,75 kg live mass/ha available for sale every year.

At an average selling price (cows, oxen, heifers combined) of N$9.00/kg live mass he/she would be able to generate a gross income of N$9.00 x 8,75 kg = N$78.75/ha (± N$80.00).

The operational costs will be at least around 50 % of the gross income, which leaves a net income of N$80.00 x 50 % = N$40.00/ha.

On a 5 000 ha cattle farm the gross income will thus be ± N$400 000 and the net income, if operational expenditure is well managed, ± N$200 000. This amount is available for interest and capital repayments (Agribank), new improvements/replacements on the farm and private expenditures.

These indicators clearly show that a 5 000 ha cattle farm will not enable a farmer to become wealthy overnight. To the contrary, for those farmers to survive they often either create additional income with employment elsewhere, or they venture into diversification on the farm e.g. guest farms, hunting, crops, hay, olive and charcoal production, etc.

*It is advisable not to diversify as long as the main production line is not well managed and exploited to its full potential.*

Although the commercial farmer functions in isolation on his property and to a great extent depends on himself concerning the day-to-day activities and progress on the farm, it is still important to establish and maintain good relationships with the neighbours. The control of stock theft and illegal hunting, predator control and the maintenance of border fences, etc. require good and open communication with, and trust in the neighbours.

In conclusion, farming should be a constant process of learning. Even farmers with formal agricultural qualifications still have to keep in touch with the latest developments concerning farming practices, market requirements, consumer preferences, etc. It is advisable to make use of every opportunity to improve their own knowledge and skills, to enable themselves to adjust and therefore survive and prosper in an ever-changing world. Farmers' days, study groups and established successful farmers can be a good source of knowledge and new ideas and are often a stimulation to creative thinking.

# INTRODUCTION

Modern, production-orientated farming in Namibia is unthinkable without a certain amount of mechanisation. Even in the most far-off corners of the country and even with the most extensive farming methods, some mechanics are necessary to extract water from the ground and to move to the nearest market, shop, school or clinic. Fences, which separate land of several owners and are part of a modern multicamp grazing system, need to be erected and maintained.

In every camp animals must have access to water. Therefore the investment in infrastructure is phenomenal as can be seen from the following calculation, taking an average 5 000 ha farm as example:

A single borehole with a basic installation, e.g. a windmill and reservoir will cost roundabout N$100 000,00. A stock-proof fence costs about N$6 000,00 per km to erect and a normal 5 000 ha farm with normal shape has about 30 km of border fence plus 50 km inner fences, depending on the number of camps.

In total there will be:

| | |
|---|---|
| 30 km + 50 km = 80 km fence x N$6 000,00 = | N$480 000,00 |
| If there are three fully equipped water installations on the farm this will be: 3 x N$100 000,00 = | N$300 000,00 |
| These boreholes will have to supply water to several camps through pipelines, reservoirs and troughs, which will easily amount to another | N$100 000,00 |
| To this, one should add the price of kraals, proper handling facilities, loading ramp, workers' housing, storage rooms and own house, which will be at least | N$500 000,00 |
| The total immovable (fixed) improvements on a 5 000 ha farm could therefore amount to | N$1 380 000,00 |

*This excludes all machinery, equipment and tools placed under the responsibility of the commercial farmer. No doubt it is worthwhile maintaining this and not only by the way, but surely as a high priority!*

With more intensive farming enterprises like crop production, horticulture, etc, mechanisation even increases. To keep the costs at a minimum, sound maintenance is absolutely necessary. As many of these maintenance tasks are not sophisticated but need to be done regularly, it is much wiser for the farmer to gain knowledge in this field and do his own thing rather than try to involve an expert mechanic each time a breakage occurs.

It is thus the aim of this manual to give basic information on various aspects of repair and maintenance that can normally be done by the farmer himself. The manual does not claim to deliver a trained mechanic who can rebuild an engine. The manual will most probably not even serve the needs of a crop producer who will need much more information about maintenance, settings, repairs, etc. of a vast number of different implements in use in his

operation. Books have been written on these subjects, but they become outdated as soon as new technology is available on the market. It is hoped, however, that the stock farmer who has a borehole, windmill, power head, stationary engine, a light truck and various fences and drinking troughs under his control will find some useful hints on how to maintain these in good order.

*The following basic rules should always be considered with regard to the maintenance of infrastructure and equipment:*

- *Never neglect any safety recommendations when conducting services or repairs.*
- *Infrastructure is expensive and immediate repair should receive high priority.*
- *Do not repair provisionally (with a piece of wire). If you repair, do it properly.*
- *Get advice from a neighbour or someone else if you do not know how to do the job.*
- *Keep all service and repair record books/cards up to date.*

# CHAPTER 1
# Water Installations

The purpose of this chapter is to introduce the reader to the many different drivers for water pumps and to explain the basic maintenance procedures for water installations, e.g.

- pulling pipes and repairing cylinders;
- basic servicing of windmills, power heads and force heads;
- maintenance of reservoirs, pipelines and troughs.

## 1. Various drivers for water pumps

Obviously, all types of water pumps need some source of energy input to operate the pumping system. This might be manpower (manual) by means of an engine (diesel or petrol), wind energy (windmill) or by means of electricity (grid/Nampower, generator or solar). Which driver is to be used greatly depends on the amount of water that needs to and can be extracted, the depth of the water level and the availability of a source (e.g. Nampower or an existing windmill).

### 1.1 Manually operated pumps

Most manually operated pumps are based on a cylinder and piston type installation, which is driven by means of a lever or turning wheel. It should be clear that such a system is not suited for a commercial type of farming operation.

### 1.2 Windmills

Windmills are commonly used in Namibia as a driver of water pumps and have a reputation for being effective with fairly low maintenance needs. Most windmills are designed to drive a cylinder and piston type pump, but rotating windmills which drive monopumps are also available. With the right design of a windmill pumping system (head size of windmill matched to depth of water level and needs and availability of water – consult an extension technician to do these calculations), they have a record for being reliable and effective. Provision should be made, however, for times of little wind by having ample water storage capacity when relying on wind only.

### 1.3 Diesel or petrol engines

Sometimes few other options exist than driving a pump by means of a diesel or petrol engine, e.g. boreholes in deep ravines where there is very little wind or where boreholes are very deep. With high fuel prices and high inputs in terms of maintenance and replacement, they obviously have their disadvantages. Again, an extension technician should be consulted to design the correct combination of engine (kW or HP and revs), power head and cylinder or mono-element size for the given circumstances of the borehole.

### 1.4 Nampower or generator power

Where grid/Nampower electricity is available, a submersible pump is an easy and convenient installation, although a monopump or even a power head driven by an electric motor is a less favoured possibility. Obviously, a diesel or petrol generator can be used just

as well. This, however, only makes sense if an installation is temporary or where a single mobile genset is used to power various pumps in sequence. Technically, much energy is lost when converting mechanical energy (the diesel engine) to electrical energy and converting it back to mechanical energy again (the electric motor driving the pump).

## 1.5 Solar energy

Photovoltaic (PV) energy to drive water pumps has long been regarded as an expensive option, but with rising energy (specifically fossil fuel) prices and advanced technology available in this field, this is a real option to consider within the limitations that do exist (very deep water levels and very high water demand). In many cases of boreholes with low deliveries, solar pumps offer a real opportunity to constantly, over 8 to 10 sunshine hours a day, deliver enough water to supply a herd of animals with drinking water. Even with higher demands, a solar pump might be an option up to a certain limit. The upfront costs of installation are usually higher than those of a power head/diesel engine installation, but with no fuel costs involved and low maintenance costs, a breakeven can be reached within a reasonable period of time (see Table 1).

Table 1. Years needed for a photovoltaic pump system to break even with a diesel pumping system at the same flow rate and depth. *(© Scholle, A. 2006)*

| Depth (m) | Daily volume flow (cubic metres per day) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3 | 6 | 8 | 12 | 20 | 40 | 60 |
| 40 | 0 | 0 | 0.3 | 0.4 | 1.2 | 4.4 | 4.7 |
| 80 | 0 | 1.1 | 1.9 | 2.2 | 5 | 6.6 | 6.6 |
| 120 | 0 | 2 | 3.5 | 6.1 | 6.8 | Diesel | Diesel |
| 160 | 0 | Diesel | Diesel | Diesel | Diesel | Diesel | Diesel |
| 200 | 0 | Diesel | Diesel | Diesel | Diesel | Diesel | Diesel |

Although a cylinder and piston type of pump can be solar powered (e.g. a Juva power head), again the preferred option is a submersible pump (no steel pipes and rods involved). Most of these special photovoltaic submersible pumps operate on DC (direct current) power (15 to 150 volt), which makes conversion of DC power to AC (alternating current) power obsolete.

The system consists of PV modules, fixed to a PV array. The array can be fixed to a certain angle, facing north (25 degrees in northern Namibia, 35 degrees in southern Namibia). A tracking system can be installed which ensures full exposure of the PV modules throughout the day. This can increase effectiveness by 40 % or more.

As with any submersible pump, a controller (control box) is installed (mostly aboveground) to regulate the operation, starting and stopping, of the pump. Just above the pump a water sensor can be installed to protect it from running dry. This is especially useful in very weak boreholes that tend to be pumped empty.

No batteries are needed. The pump only operates when the sun shines. A battery is usually the bottleneck of any electric system that supplies electric power off-grid.

Maintenance is usually limited to a regular wipe-off of the PV modules to remove dust and bird droppings and adjustments have to be made to have maximum exposure of the panels to the sun. When installing a PV pump, expert advice should be obtained as this is a very specialised field of work.

One of the most serious problems experienced with any PV system is the theft of PV modules. No insurance for this is available any more, whilst the ingenuity of the thieves seems to outscore the methods used by system owners to protect their property.

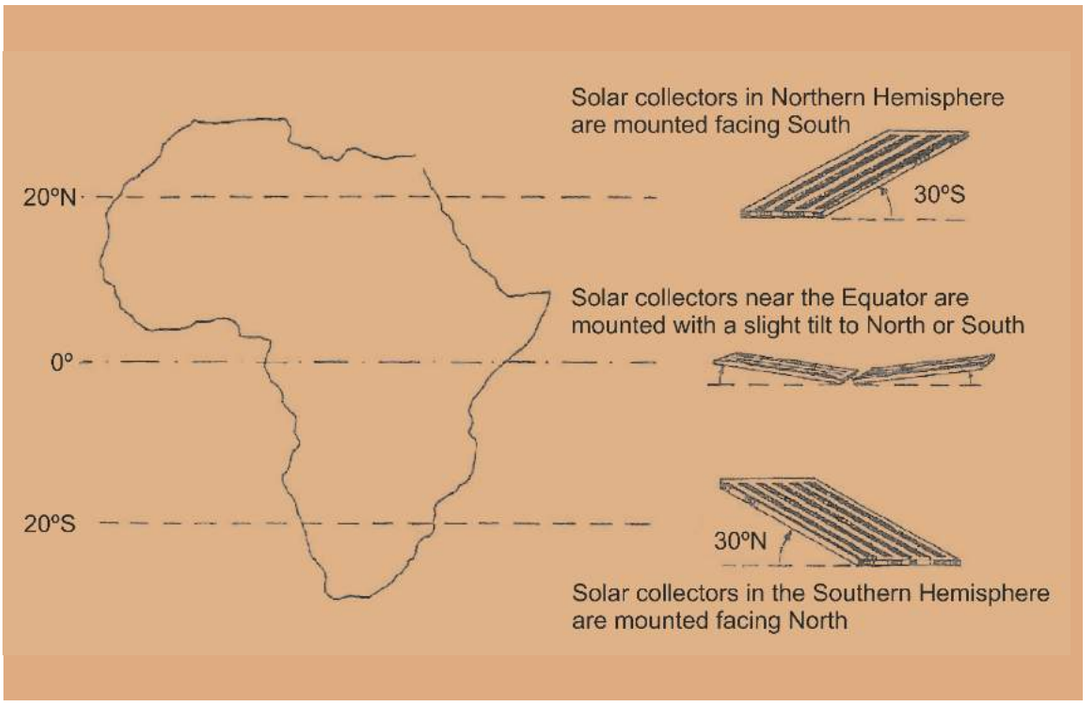


Figure 1: Mounting angles for fixed solar collectors *(© Hankins, M. 1995)*

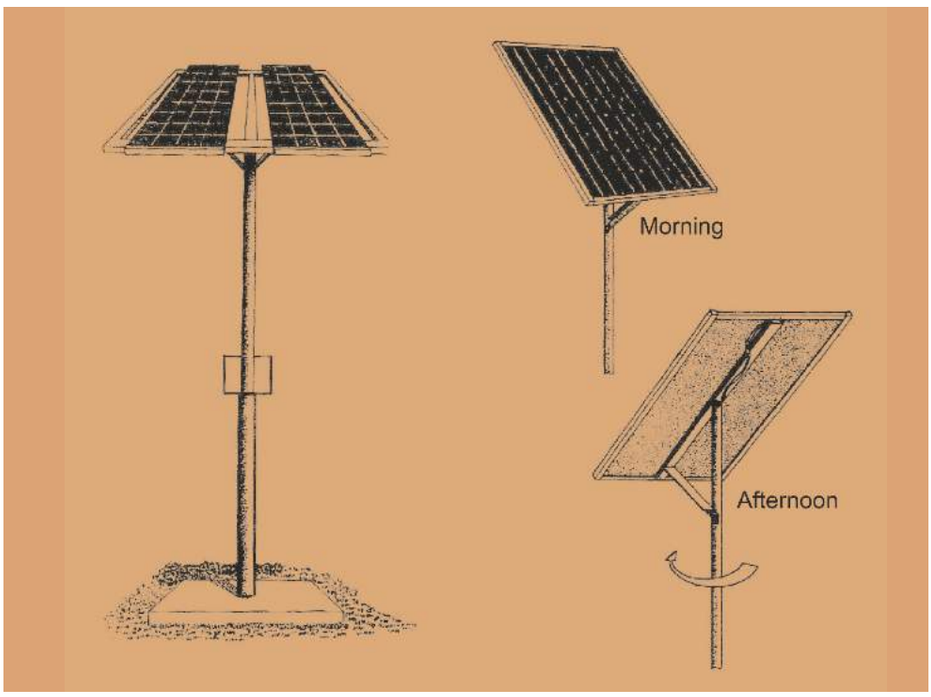


Figure 2: Manually operated solar cell mounts for arrays of double or single modules *(© Hankins, M. 1995)*

# 2. Pulling pipes

## 2.1 Danger of pulling pipes

Virtually all types of borehole installations used in Namibia consist of free-hanging equipment in the borehole. Considering the fact that in many instances steel pipes and steel rods are used to reach the water (which may be at a considerable depth), it is obvious that the installation is very heavy. Falling installations or tools may be fatal and a borehole can be lost if equipment or tools get stuck in a borehole in such a way that they cannot be removed. To minimise the danger of accidents, a few basic rules should be adhered to:

- Wear safety equipment (hard hat, overall, steel-tipped shoes).
- No loose clothing or accessories – loose shirts, sleeves, necklaces, even long hair, may get caught by falling equipment.
- Make sure that all equipment, e.g. pipe vice (*vastrap*), pipe clamp, pipe spanners, etc. is in a good working condition – a pipe vice which does not hold especially new pipes properly is a very big point of danger.
- Ensure that there is no way that any pulley used can get loose or that equipment can unhook in the process of pulling pipes.
- Be sure that the tripod steel cable, pulleys and winch or truck used to pull the pipes are strong enough to pull the load of the installation.
- The work area around the borehole should be clean and free from unnecessary tools. Rocks, grass and tools may cause people to trip and dislodge tools which are securing the installation.
- After each step, ensure that everything is secured before moving on to the next step.
- When using a tripod, make very sure that the tripod cannot fall over or collapse. In any case, never pull from the top of the windmill or tripod in a horizontal direction. The steel cable should run directly down to a pulley attached to one of the legs of the windmill/tripod before running horizontally to the winch or truck that does the pulling.
- When installing a borehole, make sure that all pipes and rods are properly fastened and that the threads of the pipes are in a good condition. Cracked sockets may cause pipes to dismantle and fall. This can result in permanent loss of a borehole if the installation cannot be recovered.

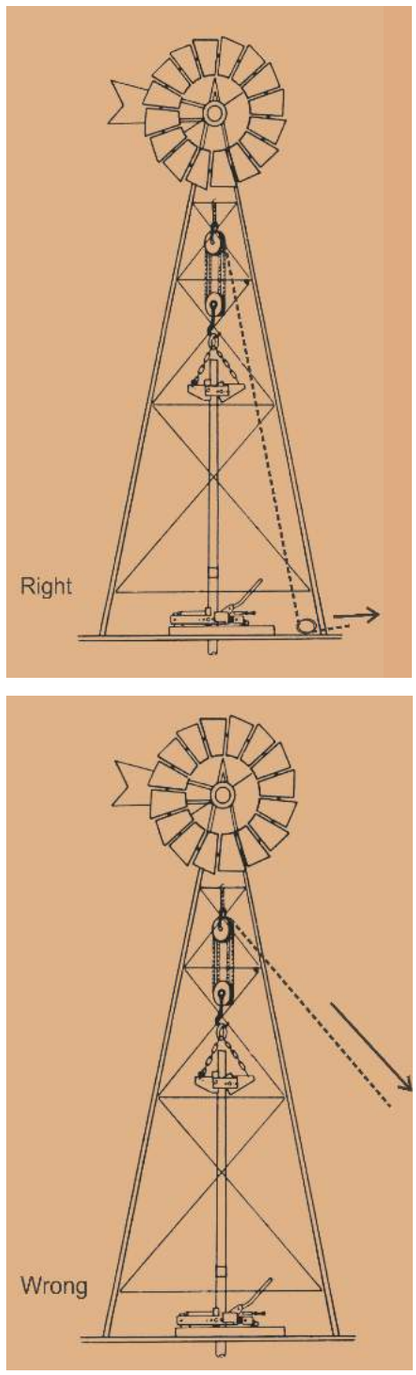


Figure 3: The right and wrong way that a cable should run when pulling the pipes of a windmill *(© Aidco)*

## 2.2 Equipment for pulling pipes

### 2.2.1 Tower or tripod

To be able to pull steel pipes out of a borehole some sort of tower has to be available directly above the borehole. A windmill tower is very good, but a tripod will also work. It is in any case convenient to have a tower high enough to have one 3-metre pipe plus a pipe vice at the bottom plus a pulley (or block and tackle) at the top plus enough space to lift the pipe to reach the rod socket without having to regrip the pipe. A tripod constructed of 6-metre pipe or a 6-metre windmill tower will comply with these needs.

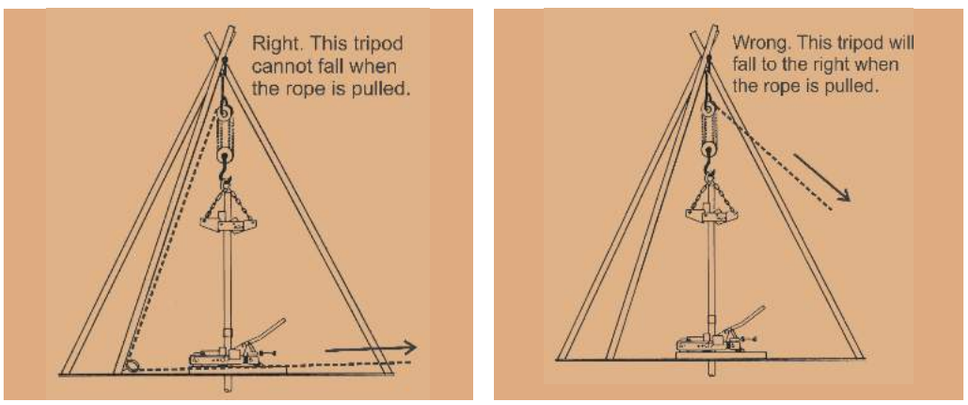


Figure 4: The right and wrong way that a cable should run when pulling pipes with a tripod *(© Aidco)*

### 2.2.2 Pipe vice (*vastrap*) to secure the pipes on top of the borehole

Various models are available. They are convenient, but expensive. A pipe vice normally used on a workbench works just as well. Even a windmill base plate (which is bolted around the pipe) or two pieces of heavy flat bar, which have been bent to fit tightly around the right size of pipe when bolted together work well.

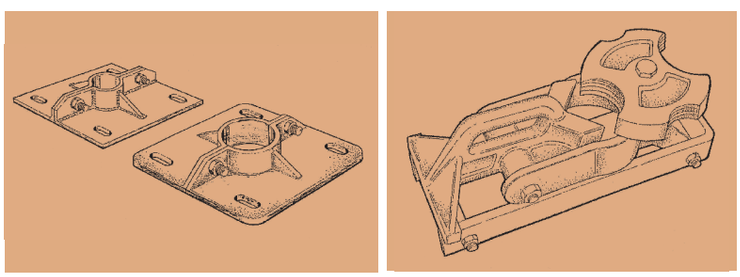

Figure 5: Base plates or *vastrap* can be used to secure the pipes on top of the borehole *(© Agrifutura)*

### 2.2.3 Pipe clamp to attach pipes to the cable or block and tackle

Some good clamps are available. Like the pipe vice, they can be adjusted to fit various sizes of pipes. Again, some cheaper methods do exist. A short piece of pipe with a handle welded to it can be screwed into the top socket. Even a piece of chain attached to the top pipe by means of a clove hitch works very well. Make sure that the clove hitch is tied properly.

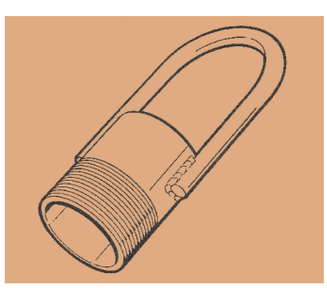

Figure 6: Pipe shackle to attach top pipe to pulley *(© Agrifutura)*

### 2.2.4 Block and tackle or cable and pulleys

The purpose is to pull the pipes out of the borehole. This can be done with a block and tackle (chain type) or with a steel cable (usually 12 mm in diameter will do) and various pulleys. The cable needs to be long enough to run from the top of the borehole over a pulley at the top of the tower over a pulley at one foot of the tower to the winch or truck that does the pulling. With heavy (deeply installed) pumps, it might be necessary to run the cable more than once in the tower over double and triple pulleys at the top of the tower and on top of the pipes to have a transmission for easier pulling.

### 2.2.5 Winch or truck

When not using a chain-type block and tackle some strong mechanism has to be used to pull the pipes out of the borehole via the cable attached to it. The old hand-operated winch, secured by sandbags or bolted to a block works very well and is a slow but safe method. Today, it is often observed that the cable is attached to a 4x4 truck or tractor to do the pulling. This also works well, but requires the driver to be **wide awake!**

*The old hand-operated winch secured by sandbags or bolted to a block works very well and is a slow but safe method.*

### 2.2.6 Tools

Two pipe wrenches, big enough to fit the pipes that must be unscrewed, are essential. Two smaller wrenches to loosen the rods are convenient. Various vice grips (at least two, but four are better) might be necessary if pipes or rods have to be unscrewed. Various chains are needed to secure pulleys.

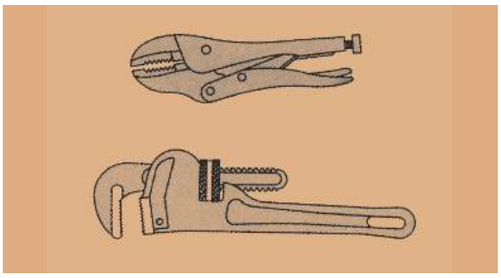

Figure 7: Vice grip and pipe wrench
*(© Agrifutura)*

## 2.3 Procedure of pulling and replacing pipes

- Set up the tripod in such a way that it stands exactly over the borehole and secure it in such a way that it cannot collapse or fall over. This step is not necessary if there is a windmill or windmill tower above the borehole.

- Firmly attach the block and tackle to the top of the tower exactly over the borehole (or the top pulley if working with pulleys and a steel cable). With a windmill tower, affix a steel cable or a chain between the legs of the tower below the head in such a way that the pulley can hang right in the middle above the borehole. Attach the second pulley firmly to one leg of the windmill or tripod. Run the cable from the top of the borehole over the pulley in the top of the tower over the pulley at the leg of the tower to the winch or truck and fasten it firmly. (If it is necessary to work with transmission, the cable is run from the top of the tower pulley to a pulley at the top of the borehole, again to the top of the tower over a second pulley and only then over the pulley at the foot of the tower.)

- Attach the rod to the cable, loosen the rod and lower it slowly until it stands in the bottom of the cylinder. **This is very important. If the rod is only loosened and let go of, it might happen that pipes become unscrewed and a great part of the**

**installation will fall into the borehole.** If the rod does not stand, it will have to be secured by means of vice grips at the top of the pipes.

- Remove the power head or tower rod from the windmill to gain working space and remove the force head.

- Attach the cable to the discharge head and pull very slowly until the pipe vice can be attached to the first pipe below the discharge head.

- Unscrew the discharge head from the first pipe and remove it. In some cases it might be necessary to unscrew the rod of the force head as well, but in other cases the washers are small enough to have the next pipe slide over the washers when unscrewed.

- Attach the pipe clamp to the top of the first pipe. For security reasons the pipe protruding from the borehole should always have a socket at the top. Attach the cable to the clamp and pull out the first pipe. If the tower is high enough, two, or even three lengths of pipe can be pulled at a time. While pulling the pipe, the vice should not be opened completely and should stay on top of the borehole. In case something slips or breaks, it should be possible to close it immediately before the falling installation gains momentum. Secure the pipe vice firmly below the next socket. Unscrew the pulled-out pipe at the top of the socket (the socket remains on the pipe which is still in the borehole). Lift the pipe until the rod socket protrudes and unscrew. Put the dismantled pipe and rod aside and repeat this step until all the pipes are extracted.

  Pipes can stand in the tower or be laid down next to the borehole, but keep them in sequence and reinstal in the same sequence. While pulling out the pipes, check for wear and tear, leaking pipes, etc., and replace where necessary. No pump can work efficiently with leaking pipes.

- When reinstalling pipes, the reverse procedure is followed. Pull the pipe up in the tower, affix the rod (apply some grease), screw the pipes together (apply grease), pull the cable tight, open the pipe vice and lower slowly into the borehole. When installing the pipes, make sure that they run down smoothly into the borehole. The cable **must** be tight at all times. If the pipes block, stop immediately, pull them back a little bit, spin them to and fro and try to lower them further.

- When all the pipes have been reinstalled, make sure that the stroke is set correctly **before** affixing the power head or windmill. Refer to the heading *Check and adjusting the stroke* (on page 19) in this regard.

## 2.4 Borehole cylinder maintenance

With a conventional cylinder type pumping system, very few things can actually go wrong.

### 2.4.1 The pump may lose water

This might be due to a hole in a pipe or a defective cylinder foot valve. You will observe this immediately when you start pulling the pipes because the pipes will be empty. Even a small hole in a pipe or a slightly leaking foot valve will result in a windmill being totally ineffective.

### 2.4.2 The pipes are full of water, but very little or no water is discharged

In this case, a broken rod or worn washers might be the reason. A broken rod will, in most cases, also be observed right at the beginning when loosening the rod. It will not stand in the bottom of the cylinder.

When dismantling a cylinder, take care that the cylinder itself is not clamped into a vice or worked with a pipe wrench. This might result in a dented cylinder which is absolutely worthless. Thus only apply power to the head or tail fittings of the cylinder. The cylinder consists of two vital parts, namely:

- the piston
- the foot valve

The piston moves up and down in the cylinder and is connected to the rods. In its centre, there is a valve which closes when the cylinder moves up. Generally, very few problems are experienced with this valve. Sometimes it gets entangled in its cage and does not close when the piston moves up. The bigger problem is the washers, which seal the piston to the cylinder wall. Washers wear out and must be replaced. Dismantle the piston and replace all (two or three) cup washers (for brass cylinders). Cylinders come in different sizes and the right size of washer has to be fitted. Stainless steel cylinders (Jooste cylinders) have a plastic type ring as washer, but the principle is exactly the same.

Cup washers for brass cylinders come as leather washers and neoprene ("plastic") washers. Both are effective. Leather washers should be soaked well in oil before installation, whilst neoprene washers can be installed right from the shelf, but

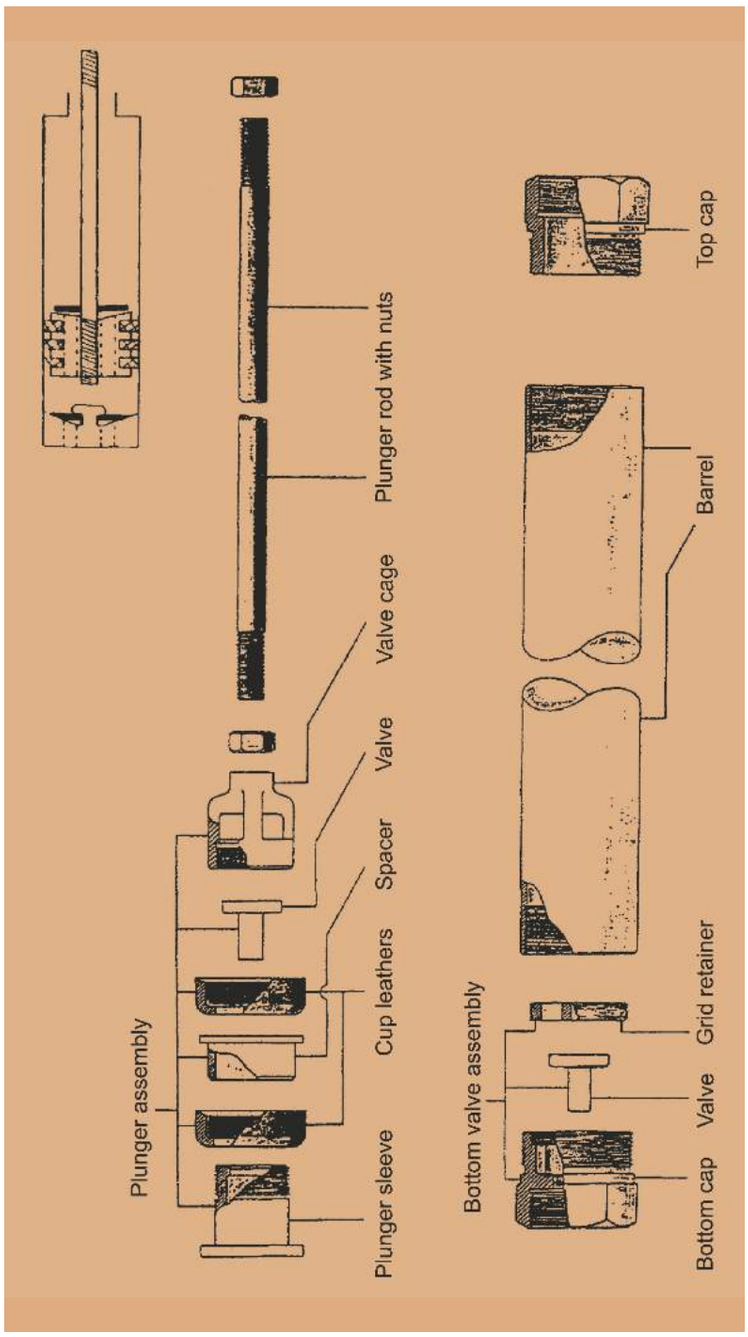


Figure 8: Inner view of a cylinder *(© Agrifutura)*

are more expensive. They do, however, last longer. At the bottom of the cylinder there is a foot valve. This valve opens when the piston moves up to have water enter the cylinder and closes when the piston moves down. It is vitally important that the foot valve closes completely. Some foot valves have rubber packing which can be replaced while others are pure brass which will need turning and fitting if worn out. The stainless steel (Jooste) cylinders have a plastic type washer as foot valve which is very effective.

Having replaced the washers and repaired the foot valve, test the cylinder by placing it in a bucket of water and working the piston up and down. (With new washers, the piston should not move freely.) Water should be pumped out at the top of the cylinder. When the cylinder is filled and pulled out of the bucket, the cylinder should remain full. If the water level drops, the foot valve does not close properly.

## 2.5 Check and adjust the stroke

It is obvious that the length of the stroke which is possible within a cylinder has to comply with the stroke of the windmill or power head. Most cylinders on the shelf easily accept a 12-inch (30-centimetre) stroke, but some older types of power heads (even windmills) have an 18-inch (even a 24-inch) stroke. A cylinder which accepts a 12-inch stroke, is obviously not suited for these power heads.

What is, however, more important, is to make sure that the stroke is adjusted correctly after reinstalling an installation. A replaced pipe or cylinder may result in a longer or shorter rod or pipe and adjustments will have to be made to have the piston move within the boundaries of the cylinder without bumping against the top of the cylinder or the foot valve. Generally, it should be necessary to lift the rods 3 to 5 cm to comply with the lowest point of the windmill or power head. If the rod needs no or very little lifting or, even worse, has to be forced downward to comply with the lowest turning point of the windmill or power head, the rod **below the discharge head** has to be shortened. This might involve taking the discharge head off again to saw off the rod, put on new thread and fit the discharge head again.

In cases where the rod is much shorter, it might be worthwhile to hook the rods to the power head or windmill first and test carefully (turn by hand) before elongating the rod below the discharge head by adding an extra piece of rod. Most cylinders can easily handle a 12-inch stroke while many windmills only have a 6-inch stroke. Thus there is fairly much space to the top before the piston will bump against the top of the cylinder. It is in any case important to test (by turning the wheel of the windmill or by turning the power head) **by hand** to ensure that the piston moves freely in the cylinder.

*Make sure that the stroke is adjusted correctly*

*A replaced pipe or cylinder may result in a longer or shorter rod or pipe and adjustments will have to be made to have the piston move within the boundaries of the cylinder without bumping against the top of the cylinder or the foot valve.*

## 2.6 Monopumps

The procedure of pulling pipes with a monopump is basically the same as with piston pumps. Again, make sure that the rods stand on the bottom of the element before it is dismantled from the cable.

Note that the thread of the rods of a monopump is anti-clockwise.

As with a piston pump, the rods have to be lifted a few centimetres before they are locked to the drive pulley.

Monopumps do not normally have a foot valve, thus the pipes should be empty when pulled. Make sure the bobbin bearings (which guide the rod) and the pipe guides (which stabilise the pipes in the borehole) are in a good condition.

| Component | Discription/function |
|---|---|
| Strainer | Prevents large articles from entering into the pump element. |
| Pump element | Consists of the stator and rotor (see below). The pump element is screwed onto the rising main and is thus suspended from it. |
| Stator | Rubber part of the pump element resembling the shape of a cylinder, with the inside opening resembling the shape of a double spiral. |
| Rotor | Stainless steel part of the pump element resembling the shape of a spiral. Rotation of rotor inside the stator pushes the water up. |
| Rising main | Pipe through which water is pumped up to ground level. |
| Pump shaft | Consists of rods interconnected by couplings. Extends from the discharge head to the rotor. Transmits rotating power. |
| Stabiliser | Rubber that holds the pump and rising main firmly in the borehole, damping vibration and eliminating noise. Place one stabiliser every 13 m. |
| Bobbin bearing | A styrene butadiene compound which grips the column pipe walls and supports the drive shaft. These bearings are water lubricated. |
| Discharge head | Cast iron body with gland from which the column is suspended. The pulley bearing assembly contains two prepacked ball bearings. |

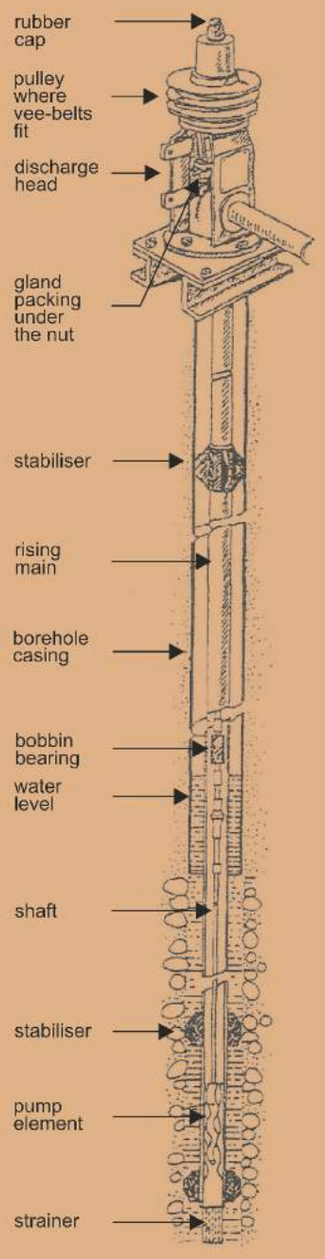


Figure 9: Borehole with a monopump *(© Agrifutura)*

### 2.7 Submersible pumps

These pumps are driven by an electric motor, which is fitted below the rotating element. The big advantage is that no system of steel pipes and rods is needed, but the pump unit (pump plus electric motor) is fitted to a heavy-duty plastic pipe, a cable is attached and the pump is lowered into the borehole by means of a nylon rope. No tripod or tower is necessary. A 200-litre drum or some kind of fairly large wheel that will ensure smooth movement from the borehole to a horizontal position is enough. The pump can be powered by a generator, Nampower electricity or solar power.

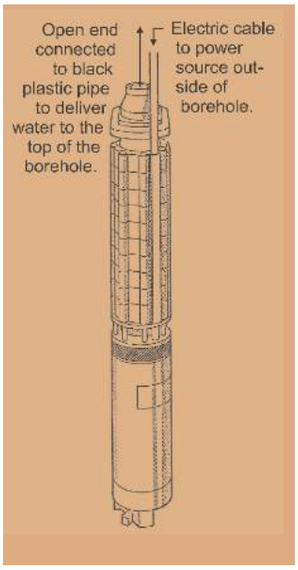


Figure 10: Submersible pump
(© *Agrifutura*)

## 3. Some general remarks on boreholes and pumping systems

- Delivery of a borehole is primarily determined by the ability of the rock formation to store and make water available. A borehole should be tested to arrive at a figure of maximum long-term ability to deliver water. The pump installation size should be calculated accordingly (normally not larger than 60 % of the borehole's ability).

- Pump size is determined by the size of the cylinder (diameter) or mono-element (submersible pump element). Obviously, the size of the pump will determine the size of the pipes and rods needed and the size of the power head and engine/windmill needed to drive the installation.

- With windmills, it is often advantageous to opt for a smaller installation (smaller cylinder, lighter rods, thinner pipes). Such an installation will deliver less water if a storm blows, but the windmill will turn more easily if only light wind is experienced.

- Trees close to boreholes might cause problems as the roots might grow into the borehole, which, in turn, might cause immense problems when trying to pull the pipes. The only permanent solution might be to chop down the trees close to the borehole.

- Some boreholes have a problem of sand entering the borehole from underground aquifers. This reduces the lifetime of washers immensely. One possible solution is to affix a fairly wide diameter pipe underneath the cylinder (bottom end open). This gives the opportunity for the sand to descend between strokes before entering the cylinder.

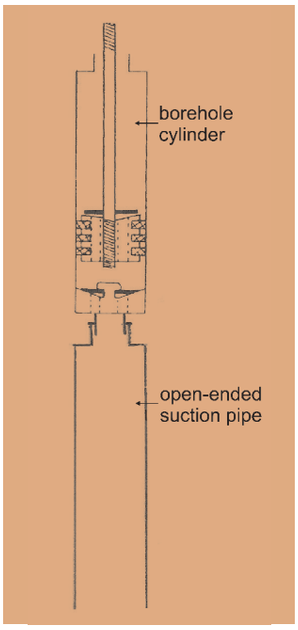


Figure 11: Cylinder with sand pipe
*(Illustration by H. Stehn)*

- Another problem which arises with sand is that the borehole fills up with sand over time. Such boreholes will have to be cleaned by a drilling contractor occasionally.

- Always make very sure that any positive replacement pump (piston or monopump) has an outlet somewhere (usually on the highest point of delivery) that cannot be closed by a tap or ball valve.

# 4. Windmill maintenance

Windmills are commonly used water pumping devices in Namibia. They ask for little maintenance, but are not maintenance free. A little maintenance will extend the life span of a windmill immensely and will avoid costly repairs.

*The following safety procedures should be followed before working on a windmill:*

- *Check the ladder and make sure that all the steps are in position.*
- *Check the platform for rotten or broken planks and replace if necessary.*
- *Tighten all platform security bolts.*
- *Never work on a windmill without a safety rope or harness. Fasten the harness tightly around your body with the other end fastened as high up as possible.*
- *Wear shoes with good grip rubber soles.*
- *Always keep the platform free from oils and tools.*
- *Never throw tools down from a windmill.*
- *Use a container which is fastened to the tower to store your tools.*

Furthermore, not too much faith should be put in a windmill brake while working on top of a windmill. First secure the wheel with a rope or chain before ascending beyond the platform.

*NB: Never tie the wheel to the tower, but sling around the tower. A change in wind direction may otherwise cause damage to the wheel and the tower.*

Figure 12: A correctly slung wheel *(© Windmill by Climax Windmills)*

On a regular basis (say, once a week) grease the rod guides in the tower and the reefing collar on the lower side of the head. Some windmills have grease caps on the lower side of the head, which should be filled up once a year. Unscrew the grease cap completely and remove all old grease. Fill up with new grease and replace the grease cap. Tighten the grease cap completely and make sure that grease passes through the grease channel and reaches the working parts to be smeared. Thereafter unscrew and fill up the grease cap once more to ensure that reserve grease is available in the grease cap, which should then be turned in a little bit once a week.

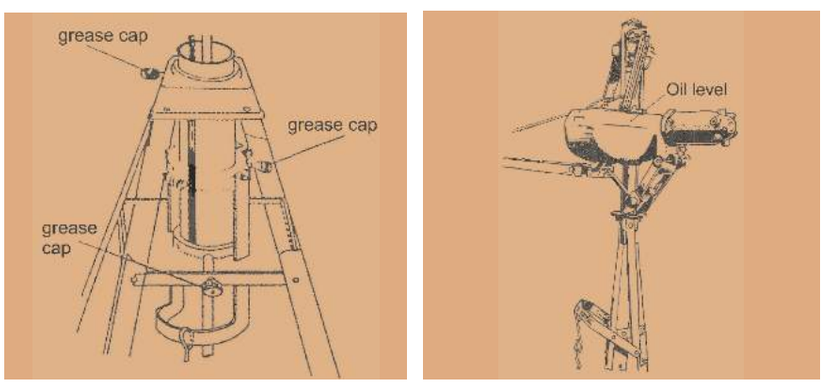


Figure 13: Windmill maintenance *(© Windmill by Climax Windmills)*

A number of pins and pulleys on the outside of the head should be oiled on a monthly basis. This will limit wear and tear of these parts, which do not move much, but regularly.

As with any other engine, regular oil checks are necessary. With a windmill an

oil check every six months and a fill-up if necessary should be enough unless oil spills are observed (which might indicate an overfilled crank case or an oil leak).

Also every six months check all the bolts of the wheel, on the tower and on the rod and rod guides for tightness. Bolts tend to loosen as a result of the permanent movement which is experienced.

If the windmill does not brake properly, it might be necessary to tighten the brake belt. Oil spills on the brake band might result in the windmill not braking even though the brake belt is tight enough. Also make sure that the vane is properly folded in when braked (up to the stopper). With some types this can be easily adjusted by moving the brake handle down on the windmill leg.

A windmill should not be allowed to run with missing fan blades. The wheel is unbalanced and the vibrations will loosen bolts and damage bearings/bushes.

An oil change every one and a half to two years is not too much. Although some farmers prefer using SAE 30 engine oil, it should be remembered that a special windmill oil (SAE 10 – very thin) is available. As it is a slowly running gearbox, there is no danger of a thin oil getting hot and losing its smearing ability in a windmill.

There is no oil seal between the housing and the drive shaft. Therefore the oil level should be lower than the drive shaft. On most windmills a line on the outside of the housing indicates the recommended oil level. The housing should once in a while be rinsed with clean paraffin to remove dirt which accumulates in the housing over many years. Remember to tighten the drain plug properly but make sure not to strip its thread. After an oil change, replace the cap and make sure that it is placed properly in its right position. Finally, do not forget to tighten the nut on top.

## 5. Force head maintenance

In some cases where the reservoir is close to the windmill no force head is necessary and a pipe in the windmill tower is enough. In cases, however, where water is pushed by a windmill into a pipeline or where a power head or monopump is involved, a force head is needed to "seal" the top end of the pipe while allowing the rod to pass through. Various types exist. Some work with a cylinder and washers while others work with some kind of packing around a smooth piece of rod.

All types require some maintenance. The cylinder and washer type requires replacement of washers occasionally. In some types, the washers are mounted over a rubber bush with an adjusting nut above the washers. By tightening the nut, the rubber presses outward and pushes the washers against the cylinder wall. This procedure seals to such an extent that no water leaks through the force head.

With the Jooste force head, a stainless steel rod passes through a plastic and grease bush. By adjusting a nut on top of the bush, the plastic and grease are pushed against the rod and seal off any water. It is important with these types of force heads that the tightening has to be enough that no water passes through the bush. Furthermore, beware of damaging the smooth stainless steel rods with tools when dismantling is necessary. This will lead to a rough surface that will grind away the plastic when the rod passes through the force head.

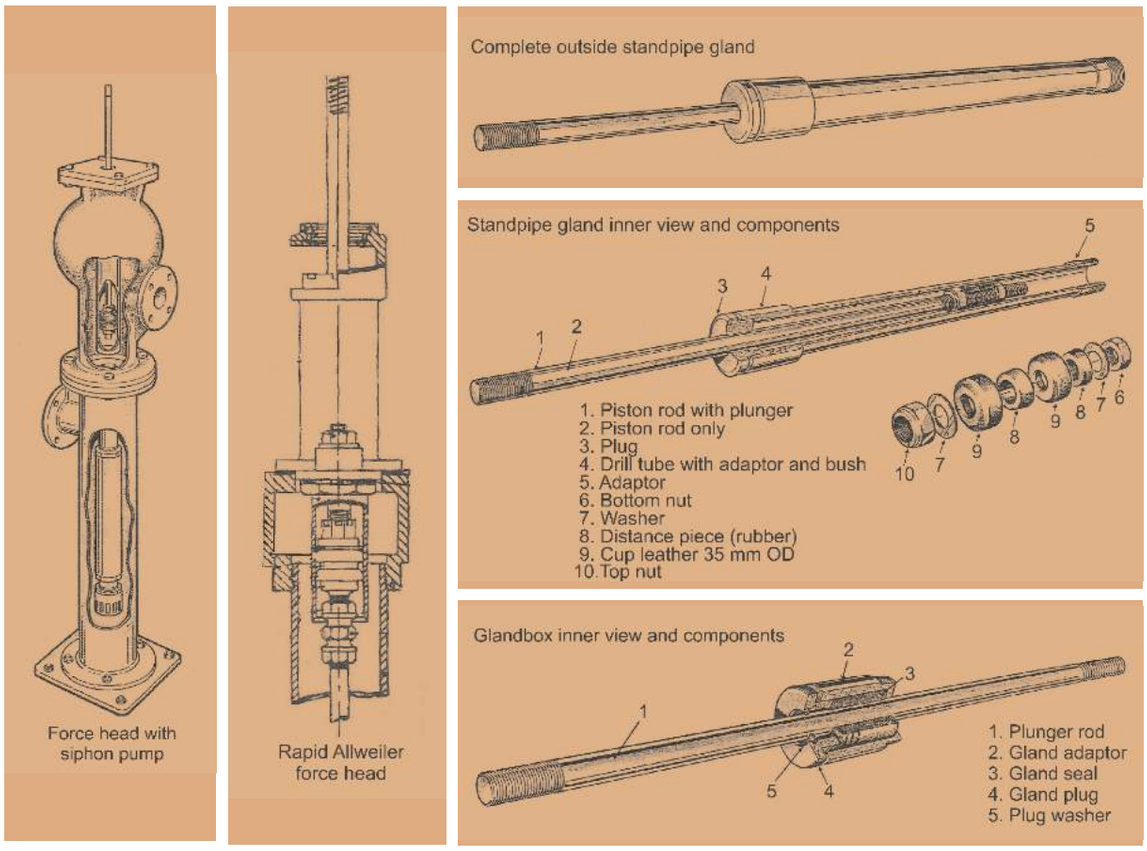


Figure 14: Force heads *(© Climax Windmills and Rapid Allweiler)*

*Beware of damaging the smooth stainless steel rods with tools when dismantling of a force head is necessary.*

A monopump has a gland in the discharge head which seals by means of a "waxed" (or graphite-treated) "rope". Again, tightening nuts presses this rope closer to the rod. These force heads should be tightened only so far that a little water is allowed to seep through. It will be necessary to replace the waxed rope occasionally.

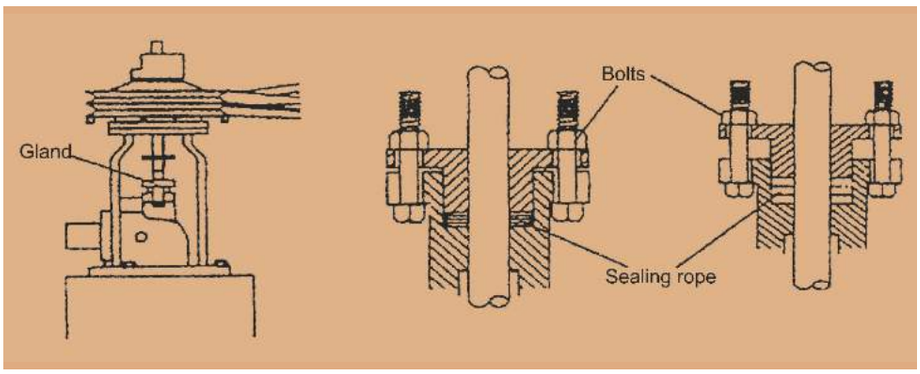


Figure 15: Monopump discharge head *(© Agrifutura)*

## 6. Power heads

Assuming that the pump installation has been erected correctly, the power head will require very little attention. It is, however, no different from any other piece of equipment in that systematic inspection and lubrication will prolong its span of life.

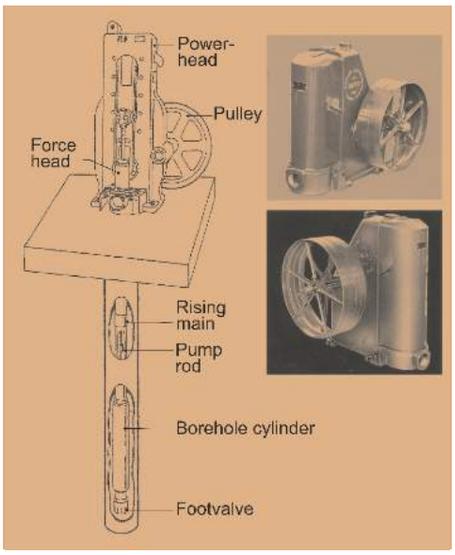


Figure 16: Power heads
*(© left, Agrifutura; right, Rapid Allweiler Pump & Engineering Company)*

While monopumps run on sealed bearings, which should last very long unless water spurts into the head due to a defective gland, power heads profit from the following basic maintenance:

Every two months:

- Check the quality and quantity of the oil in the pump.
- If the stuffing box or force head leaks, tighten only enough to stop leakage.
- Check tension on the belt. If the belt is too loose, adjust the engine or shorten the belt.
- Some power heads are equipped with grease caps. Turn the grease caps in a little bit.

Every year:

- Drain and replenish oil.
- Refill grease caps if applicable.
- Ensure proper working of the oil pump after oil refill on power heads where applicable.
- Make sure that frost protection is in place where this may be necessary.

## 7. Frost protection

Some parts of Namibia become very cold in winter with frost at night. Whilst belowground parts of pumps are not normally affected, aboveground parts, especially force heads, tend to freeze. As water expands when freezing the result may be burst force heads, which could lead to enormous spills of water as reservoirs may run empty and water is pumped onto the ground. It helps to wrap force heads in the affected areas with a thick layer of any isolating material (hessian, wool, etc.) and, if possible, try to avoid running the pumps while parts may still be frozen.

## 8. Record-keeping

It makes sense to keep record of boreholes and pumps. This might help to make a diagnosis if problems are encountered. The following should be written down and kept in a file.

- Name of post or water installation.
- Drilling report. This indicates what formations were reached at what depths, the diameter of the hole, the casing fitted and delivery test results.
- Water analysis. This indicates the quality of the water.
- Water level and depth of borehole. It makes sense to measure these every time the pipes are pulled. This may indicate if the water table is stable or is decreasing and whether the borehole is filling up with sand. Appropriate action can then be taken in time.

- Depth of cylinder and pipes (number of pipes).
- Type and size of cylinder and types of washers used.
- Date of last work conducted (service/repair, etc.).
- Reasons why the pump had to be pulled. This might indicate a continuously recurring problem which can be addressed.
- Problems which might have occurred when pulling and lowering the pump and at what depth. This might give guidance as to where to be careful in future when pulling pipes.

# 9. Reservoirs, troughs and pipelines

## 9.1 Reservoirs

Reservoirs should be designed in such a way as to hold enough water for at least 2 weeks for the herds of animals which are normally fed from this reservoir. (Remember, cattle drink up to 50 litres of water every day. For small stock, 5 litres per day is calculated per head.) There is a tendency to replace reservoirs with smaller tanks. This may work, but bear in mind that any water problem (broken windmill, pipeline or engine) will have to be attended to immediately, if animals are not to stand without water.

Reservoirs should be kept as full as possible when livestock are assigned to them. If the respective camps are not utilised, they should be full or have at least 30 cm of water in order to prevent the concrete structure from cracking.

Reservoirs should not be allowed to leak or to spill over for long periods of time because the foundation will start sagging, wildlife or livestock will dig underneath to deepen the holes and cattle will fight for water and damage the structure.

Trees growing close to the reservoir should be taken out because roots will lift the floor in search of water and insects will get underneath and be dug out by insect-eating animals like ant bears.

If a reservoir or trough leaks, drain all the water and clean it thoroughly. Then it should be left to dry for at least 14 days before repairs are attempted, especially with chemical substances. The cracks should be chiselled out and, depending on the product to be used, treated accordingly. Sometimes it is advisable to cast a completely new floor after cleaning and repairing the old one.

Some areas experience problems with baboons drowning in half-full reservoirs. An old fencing pole affixed to the side of the reservoir and protruding into the water at an angle can solve the problem. An old tyre floating on the water is also very effective to prevent birds from drowning in the water. This is very important in order to minimise the build-up of salmonella in the water, which is reflected in the quality of export beef to the European Union.

## 9.2 Troughs

Various designs exist. A round trough with a ball valve in a centre tower has the advantage that it holds a fairly large amount of water. Even with a slow-flowing supply, animals should not run out of water. Furthermore, the water is equally fresh on all sides. This avoids crowding of animals close to the ball valve, which is often experienced with long troughs. These troughs, however, are very difficult to clean and a large amount of water is lost during cleaning.

Long troughs also work well. If the supply line can deliver water fast, a big trough is not needed. A trough raised above the ground has the advantage that less dust accumulates in the trough. Care should be taken that a trough is designed in such a way that calves (and sheep) cannot get stuck in the trough and drown when shoved into it. With cattle it is important to have a strong footing of at least one cattle length around the trough to avoid trampling out, especially on sandy soils.

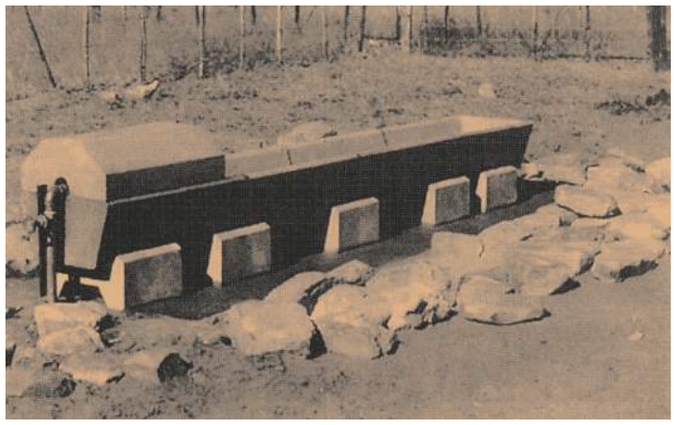

Figure 17: Concrete drinking trough, available in sections of 1 m for cattle and sheep. Take note that this footing is not finished yet and still needs to be enlarged to at least one cattle length (± 2 metres) *(© Adcon)*

## 9.3 Pipelines, air vessels and air valves

Pipelines are essential to convey water from a borehole to places where it is needed. The decision between drilling another borehole and laying a pipeline depends mainly on the possibility to drill water successfully and the costs involved in drilling and installing a borehole compared to the costs of a pipeline with accessories.

There are various types of pipelines on the market but the most common ones are the blue (PVC) and the black polyethylene pipes.

PVC pipes are glued together and should be buried at least 30 cm under the surface because they are not UV resistant (may not be exposed to sunlight).

Polyethylene pipes are more UV resistant but it is advisable to bury them as well or cover them with loose stones. Where they are hung on a farm fence one should paint them with industrial aluminium paint in order to keep the temperature down and minimise UV exposure.

Pipelines should always be surveyed and calculated by an extension technician. In his presentation he will indicate where air valves should be installed and the size of the air vessels needed.

If pipelines run uphill, water has to be pumped up to the highest point, where some type of reservoir will have to be installed. Downhill pipelines can feed a trough directly without an extra reservoir.

The following practical points should be considered with pipelines:

- If a pipeline is hung on a farm fence, frost protection must be considered in some parts of Namibia.
- The water from an aboveground pipeline should not be delivered directly into the drinking trough. A reservoir must be installed to allow the water time for cooling down, particularly during the hot months of the year, when the water from the pipeline will be steaming hot while the water requirements of animals are at their highest.
- Free-flowing pipelines (downhill), especially with little gravity, should be constructed

a bit bigger in diameter than recommended. Dirt may accumulate from the reservoir above, which may block the water flow.

- With pipelines that run dry frequently, scale, which has accumulated on the pipeline wall will peel off and clog the pipeline at some point (with black pipe, which uses inner connectors, mostly at the connector).
- Buried pipelines, especially black plastic pipelines, may be chewed by mole rats or porcupines. Both are attracted by small leaks in the pipeline.

Air valves in a pipeline serve the purpose of letting out accumulated air without allowing water to leak out. As air always accumulates at the highest points of a pipeline, air valves will always be installed at little heights which will be passed by the pipeline. It is very important to have air valves at these places, as captured air may block water flow completely.

The easiest form of air valve is a standpipe, but this obviously can only be used on fairly level terrain where the tip of the standpipe can be higher than the highest point of delivery and point of discharge.

Air valves must be checked regularly for functionality. Scale might build up and insects tend to build their nests in the outlet which block air and water flow.

An air vessel is normally installed directly behind a pump (this is absolutely necessary with a piston pump (cylinder type) at the starting point of a pipeline). It serves the purpose of converting the fluctuating flow of a pump to an even flow in the pipeline. Fluctuating flow in a pipeline may cause a pipeline to burst or connectors to be pushed apart.

An air vessel basically consists of a pipe with a big diameter with a sealed top which is connected vertically above the delivery pipe. The captured air in this chamber will be compressed with each upward stroke of the pump and decompressed with each downward stroke and will thus cause an even flow in the pipeline.

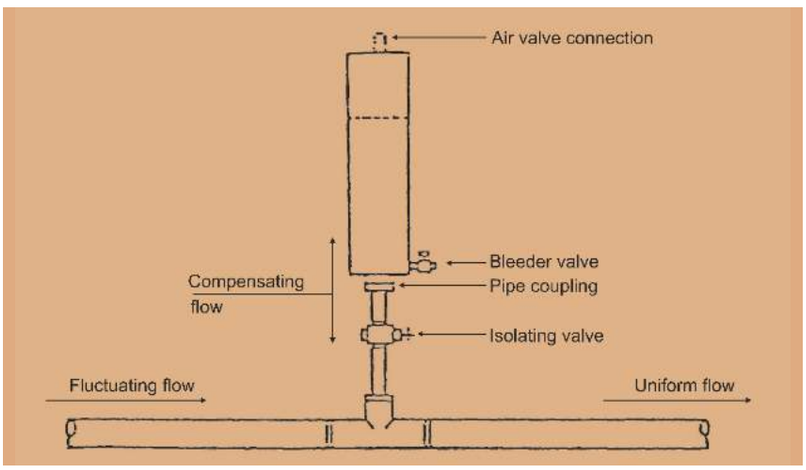


Figure 18: Air vessel *(© Neudamm notes)*

To serve its purpose, the air vessel must always be full of air. To ensure this it is necessary to occasionally close the connection to the flow line and bleed all the accumulated water out of the air vessel.

The size of a suitable air vessel depends on the diameter of the piston in the pump, the length of the stroke, the atmospheric pressure (height above sea level) and the absolute working pressure of the pipeline. The extension technician should make these calculations and advise the farmer accordingly.

## 9.4 Taps and ball valves

Taps and ball valves serve the purpose of cutting off water flow temporarily.

Various types of taps are available. The most commonly used taps are the spindle type (mostly brass) taps which have a washer at the bottom of a spindle, which is turned downward to stop the water flow. Other taps work with a ball or wedge which allows thoroughfare of water in one position and blocks the water off in the other.

The spindle type tap needs regular replacement of the washer. Closing the tap with force regularly often damages washers. Scale may also deposit in the spindle which will make the tap close and open with difficulty and will eventually lead to the stripping of the spindle.

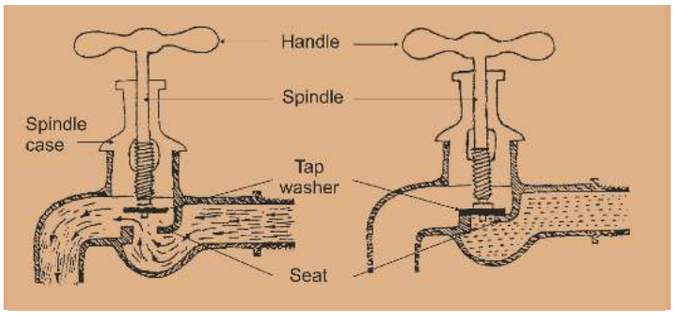


Figure 19: Spindle type tap *(© Agrifutura)*

The ball or wedge type tap always captures a little water in the ball when closed. When this water freezes, the tap will burst. This can be prevented by drilling a little hole in the side of the tap to release captured water when closed.

Ball valves close the water flow automatically when a certain level (in the trough or reservoir) is reached. Various types are available. All of them work well, but they all tend to accumulate scale over time and should be regularly descaled (chemically) to ensure proper functioning.

When purchasing a ball valve, be sure to purchase one that is designed to withstand the pressure on the delivery pipe when closed. Low- and high-pressure ball valves are available and each serves its own purpose. (A high-pressure ball valve works in places where only a low-pressure ball valve is needed, but limits the flow rate.)

## 9.5 Water catchment structures

As natural fountains are very rare in Namibia, the most common water catchment structures are wells, boreholes, earth dams or sand storage dams. All of them need maintenance from time to time. They should be cleaned out and repaired when necessary to ensure proper functioning and an extended lifespan.

### 9.5.1 Earth dams

It must be emphasised that every structure/dam that is built in a river will have an influence downstream. Every farmer must familiarise himself with the legal aspects and the correct procedures to build a dam. There are laws that regulate the capacity and location of a dam. Every river, no matter how small, is part of a larger catchment system and contributes to the ecology further downstream.

Farm dams are usually constructed of earth. With these, the most important feature is the spillway or overflow. It must be designed in such a way that any expected flood can safely bypass the dam once it is full without endangering the actual dam wall. Many structures like houses, cattle pens and bridges might be built downstream next to or over the same river and these might be in serious trouble with breaking dam walls!

It is very important to do regular maintenance on earth dams. The dam should be fenced off so that no animals can trample on the wall. Any trees should be removed as roots penetrate and damage the structure. Regular inspections should be carried out to ensure that no rodents, ant bears, meerkats or porcupines dig holes in the dam wall. Furthermore, no farm animals should be allowed to drink from an earth dam, as heavy parasite infestations will be encountered. By allowing livestock around the water source, dung will also build up in the dam at a much higher rate.

It must be realised that dams have a limited lifespan due to siltation from further upstream. Maintenance is once again important here. When dry, the filled up dam basin should be cleaned out mechanically in order to regain some capacity.

In the mountains of the Khomas Hochland, dams have a very important role to play. Because of the high runoff due to the topography and geological underground structure water is often scarce and farmers rely on earth dams for supplying livestock with water and for replenishing the underground water table.

On the flats, excavation dams (*gatdamme*) are more common. Because no definite rivers occur, the general flow direction of water is determined and then a big hole is excavated in order to be filled up with rainwater. Depending on the size and soil configuration, these dams can keep water for up to one year for livestock watering purposes. Maintenance and cleaning are required on such a structure as well.

### 9.5.2 Sand storage dams

Sand storage dams are the most effective structures to store rainwater. Virtually no water is lost to evaporation and the impact on the downstream environment is minimised. The principle here is that a strong concrete wall is built through a narrow gorge in a solid rock formation. Initially the wall should not be higher than 0,5 m to 1 m. When the river flows, sand is deposited in the sand storage dam, while the lighter silt particles are suspended in the running water which flows over the low wall. Once the storage dam is filled up with sand, the concrete wall is raised by another ± 50 cm and the same process is repeated until the wanted height is reached after several rainy seasons.

The advantage of these structures lies in their ability to store plenty of water in the porous sand that can either be used for livestock watering or for replenishing the underground water table. A pipeline through the dam wall with a tap on the down-stream side will make it possible to get hold of the clean drinking water. As no evaporation takes place the water can last for several seasons, while open earth dams are only 11–15 % effective!

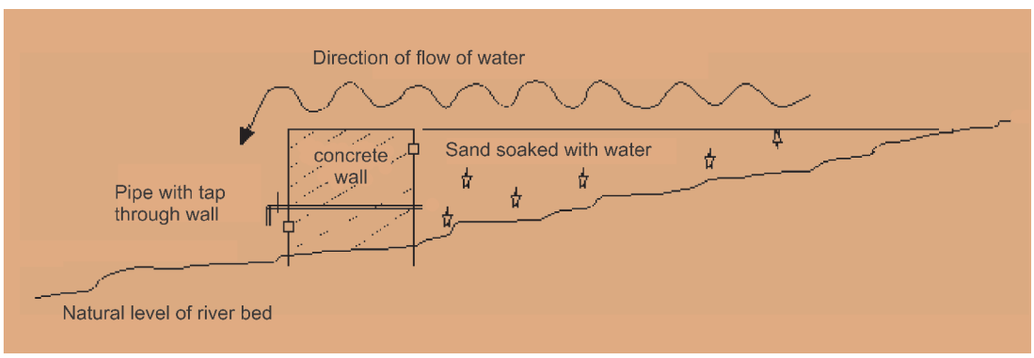


Figure 20: Cross-section of sand storage dam *(Illustration by Ingo Jacobi)*

# CHAPTER 2
# Fences, Gates and Stock Pens

This chapter aims to teach the reader:

- how to erect a fence to control cattle, small stock and predators (jackals)
- where gates should be fitted and why
- arrangements regarding border fences and survey beacons
- a few thoughts about home-made droppers and poles.

## 1. Fences

Fences serve the purpose to control humans, farm animals, game and predators and must obviously be designed in such a way as to serve their purpose.

Figure 21 shows various suggested spacings of steel strains of wire to control stock. Large stock and mixed stock should be controlled by a fence at least 1,20 m high, while sheep can be controlled by a fence 90 cm in height.

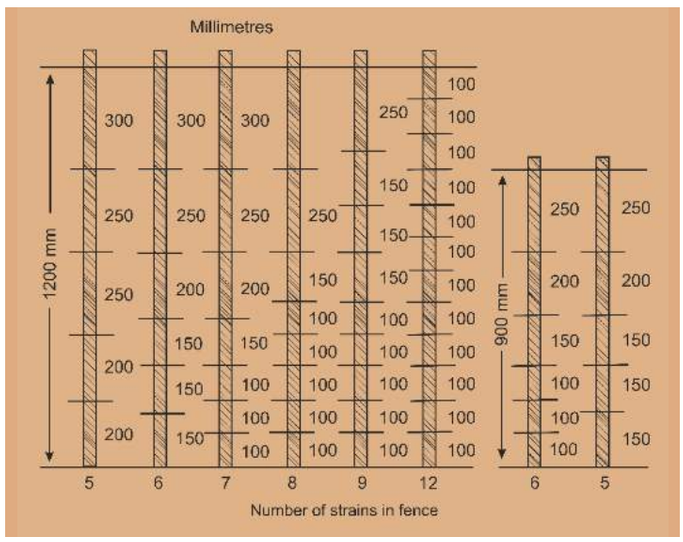


Figure 21: Spacing between wire strains for 1,2 m and 900 mm high livestock fences
*(© Staatsdrukkery, RSA)*

In Namibia, fences are normally erected by using lightly galvanised, high-tensile steel wire (oval or round) as strains. The oval wire is most commonly used, but the round (less strong) wire works well away from pressure points.

Soft wire is used to fasten the strains to poles and droppers and to fasten jackal-proof fencing to the strains:

2,5 mm to fasten poles
2,0 mm to fasten droppers
1,6 mm to fasten jackal-proof

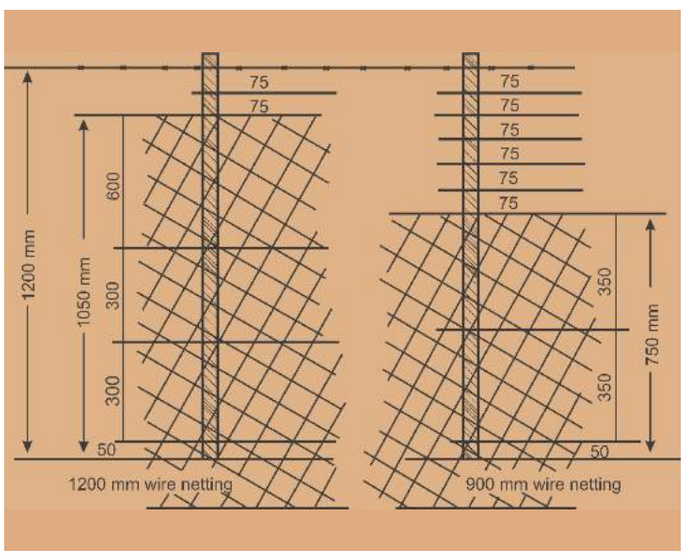


Figure 22: Jackal-proof fencing – spacing of wire strains
*(© Staatsdrukkery, RSA)*

In practice, posts are normally placed 20 m apart with 5 droppers in between. Some farmers prefer fences that are stronger (posts 16 m apart, 4 droppers in between). This is good and advisable close to water points, but expensive.

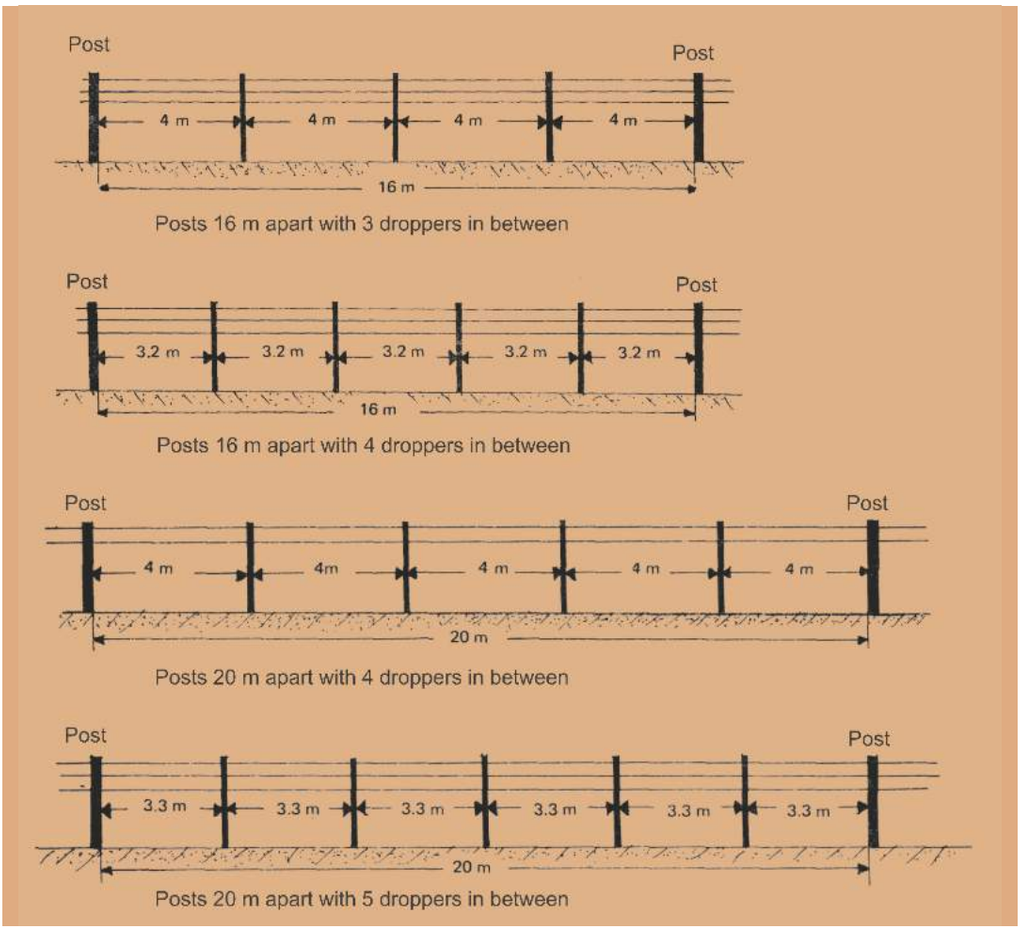


Figure 23: Spacing of posts and droppers *(© Landbou-tegniese Dienste, Pretoria. 1978)*

For normal stock fences, line posts of 1,80 m in length are sufficient. Steel posts (Y type and I type) are available with notches and/or holes to be able to fasten strains in such a way that they are unable to move up and down the post. Wooden posts (creosoted posts or hardwood posts sawn on the farm) need to be notched as well.

Droppers serve the purpose of holding the spacing of steel wires constant between posts and preventing wires to be pushed apart to allow thoroughfare.

Steel droppers are available. They work well, but tend to bend, especially when game passes through stock fences. Wooden droppers (creosoted or sawn on the farm) need to be notched to avoid wires from moving up and down. Do not let wooden droppers stand on the ground. Then they will not be reachable for termites, particularly untreated droppers.

Straining posts are placed not further than 500 m apart. Any fence must always run straight between two straining posts. Wooden posts or steel posts can be used. The principle to be followed is that any fence is just as good as the straining posts. These posts must stand firmly, thus, the longer, the better (depending on the type of soil). Straining posts are also always anchored, either by an outside anchor or an inside stay or a second post with a wire anchor and stay between the two posts.

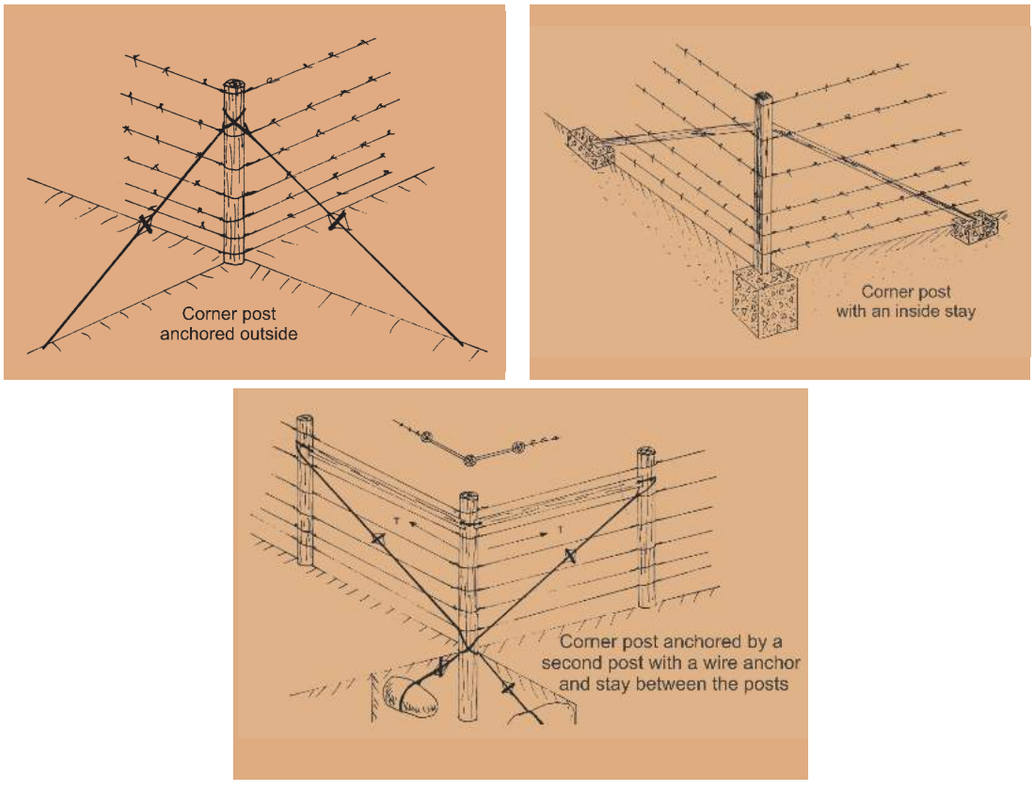


Figure 24: Straining posts for camp and kraal corners *(© Landbou-tegniese Dienste, Pretoria. 1978)*

Corner posts or gateposts are erected in exactly the same way. They are nothing more than straining posts as well.

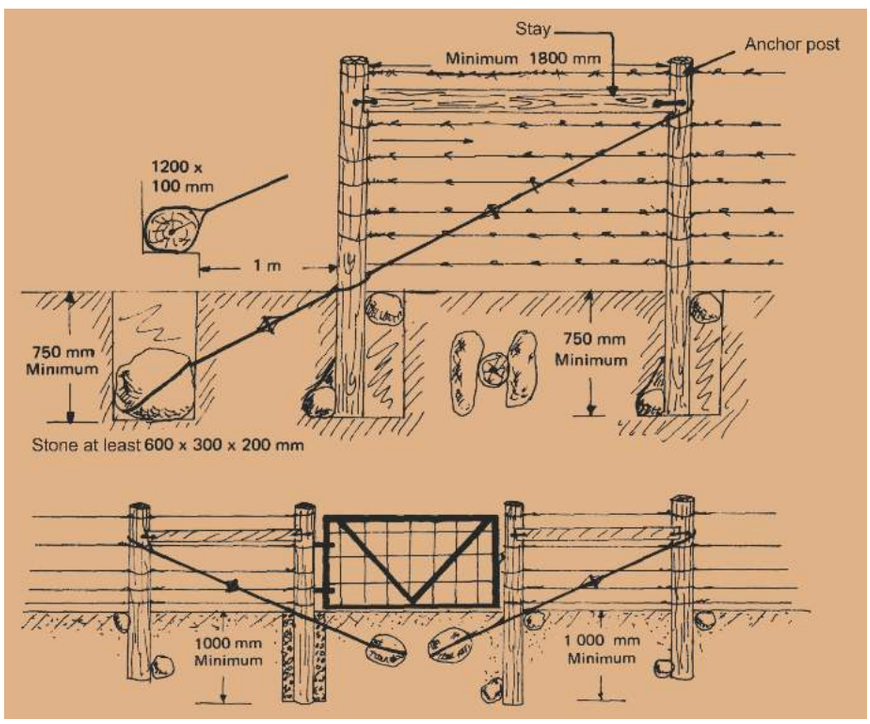


Figure 25: Straining posts for (top) corners and (bottom) gates
*(© Landbou-tegniese Dienste, Pretoria. 1978)*

## 2. Gates

Gates should always be placed in the corner of a camp or stock pen. This makes the moving of animals through the gate much easier than when they are placed in the middle of a fence line. It is convenient to instal a gate in such a way that it is able to open to both sides. If in a corner, hinge the gate in such a way that it can lean against a fence when open. The gate is out of the way when animals move through the opening.

The size of a gate depends on its use. For stock only a 2,5 m gate is sufficient. Single animals can even move through a 1 m gate, but for the thoroughfare of vehicles, gates of 3 m to 4,20 m should be considered.

A properly installed gate opens to both sides, does not drag on the ground and closes the opening in such a way that the whole fence still serves its purpose (control of stock or predators).

## 3. Stock pens

Much thought should go into the design of a suitable system of stock pens. The design will largely depend on the needs of each individual farmer.

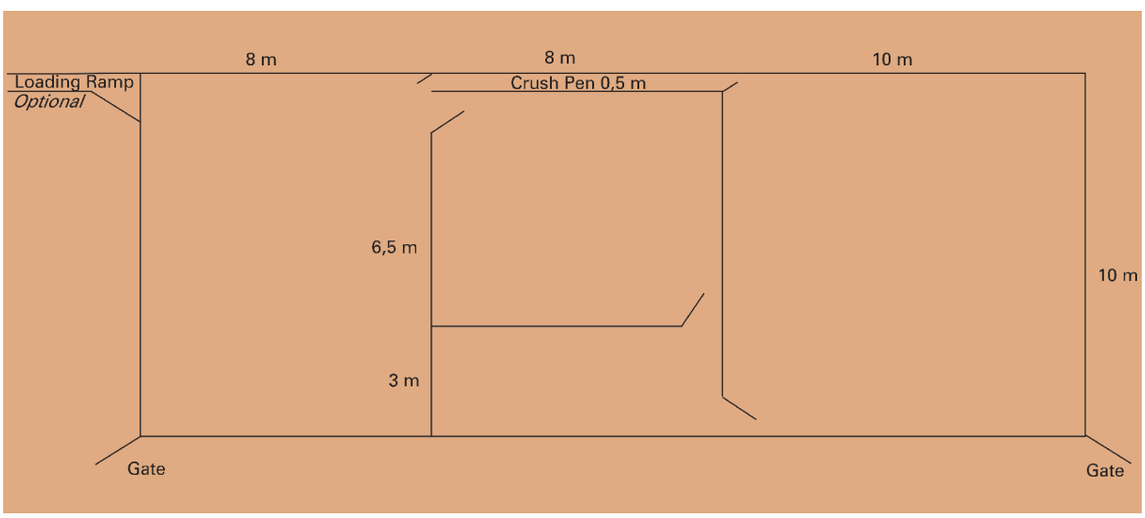


Figure 26: Simple small stock handling pens accommodating 200 ewes
*(Illustration by Danie de Lange)*

## 4. Border fences and survey beacons

Responsibility regarding border fences is regulated by law. Normally, neighbours agree among each other who is responsible for what part of the common border, usually on a 50/50 basis of the length of the border.

In a proclaimed jackal-proof area a farmer can be forced to erect jackal-proof fencing on his border, even if he himself does not gain any advantage from this improvement.

Game fences on a common border are normally the responsibility of the game farmer alone. Special rules apply when wildebeest are kept on a game farm and veterinary services should

be contacted for details. Any border fence will run straight between survey beacons. These beacons should not be disturbed and fences must be constructed around these points.

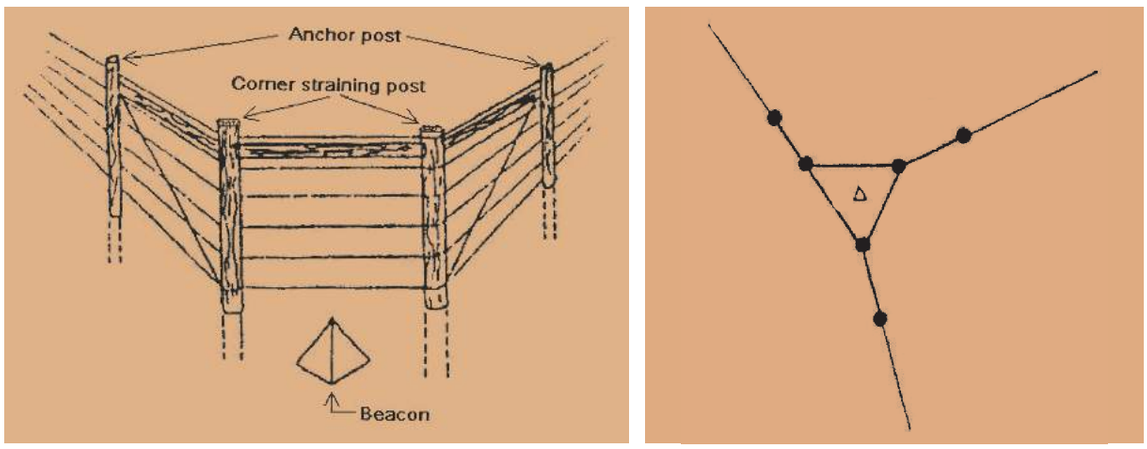


Figure 27: Fencing off of a beacon *(© Staatsdrukkery, RSA)*

## 5. Game fences

The erection of a game fence is a very costly business. While the basic principles which were discussed beforehand apply here as well, it will be understood that not only the additional material involved, but also all efforts which will be put into the erection of a stable, good-looking fence double the height of a normal fence to control species which are used to roam freely, will have to be considered.

Obviously, the species to be controlled will determine the type of fence to be erected. While a normal 1,20 m jackal-proof fence will control creeping game like duiker, steenbok, springbuck and oryx, raising it to a height of 1,80 m (4 additional wires) might be necessary to control hartebeest, wildebeest and zebra as well. Jumping game like kudu and eland need to be controlled by a 2,40 m high fence.

It has been mentioned that, in order to have a strong game fence, extra effort has to be put in. This mainly involves that poles are placed closer to each other

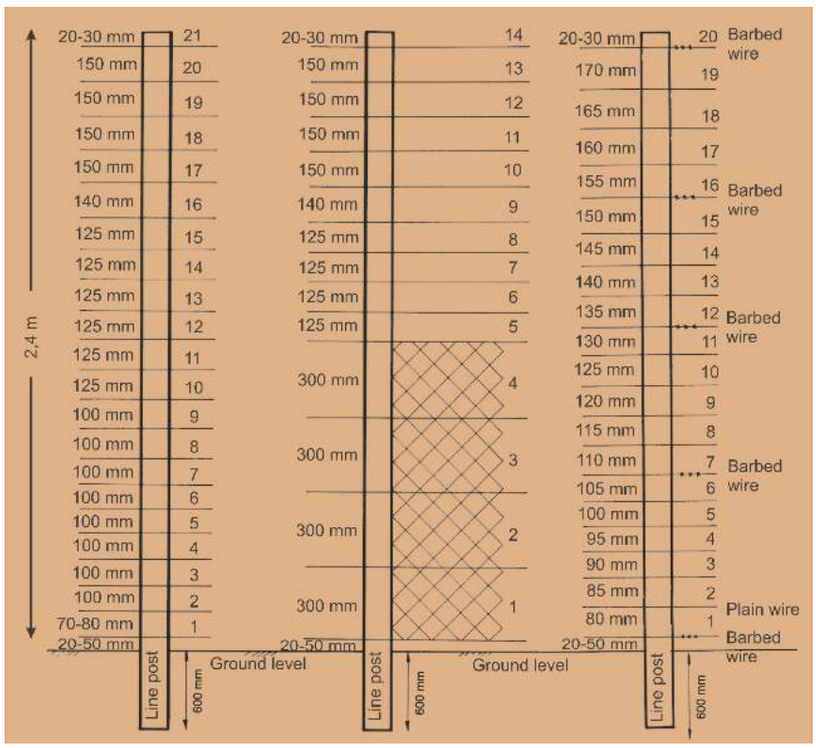


Figure 28: Spacing between wire strains for 2,4 m high game fences *(© Staatsdrukkery, RSA)*

(8 to 15 m apart) whilst droppers are placed 1 to 3 m apart.

Take into consideration that easy thoroughfare through the game fence should be possible in cases of emergency (e.g. veld fires). This can be best achieved by making provision for places that can be clipped without damage to the fence. For example, at each straining post (500 m apart), place two independent straining posts 3 to 4 m apart (as with a gate). The opening is closed with separate wires that do not form part of the 500 m strain. If neighbours are aware of these places, they will not damage the game fence and will be more willing to assist during a veld fire by gaining access through these places.

Be aware that an additional fence 30 m before a border fence is prescribed if wildebeest are to be kept to avoid the spreading of malignant catarrhal fever to cattle or sheep of neighbours.

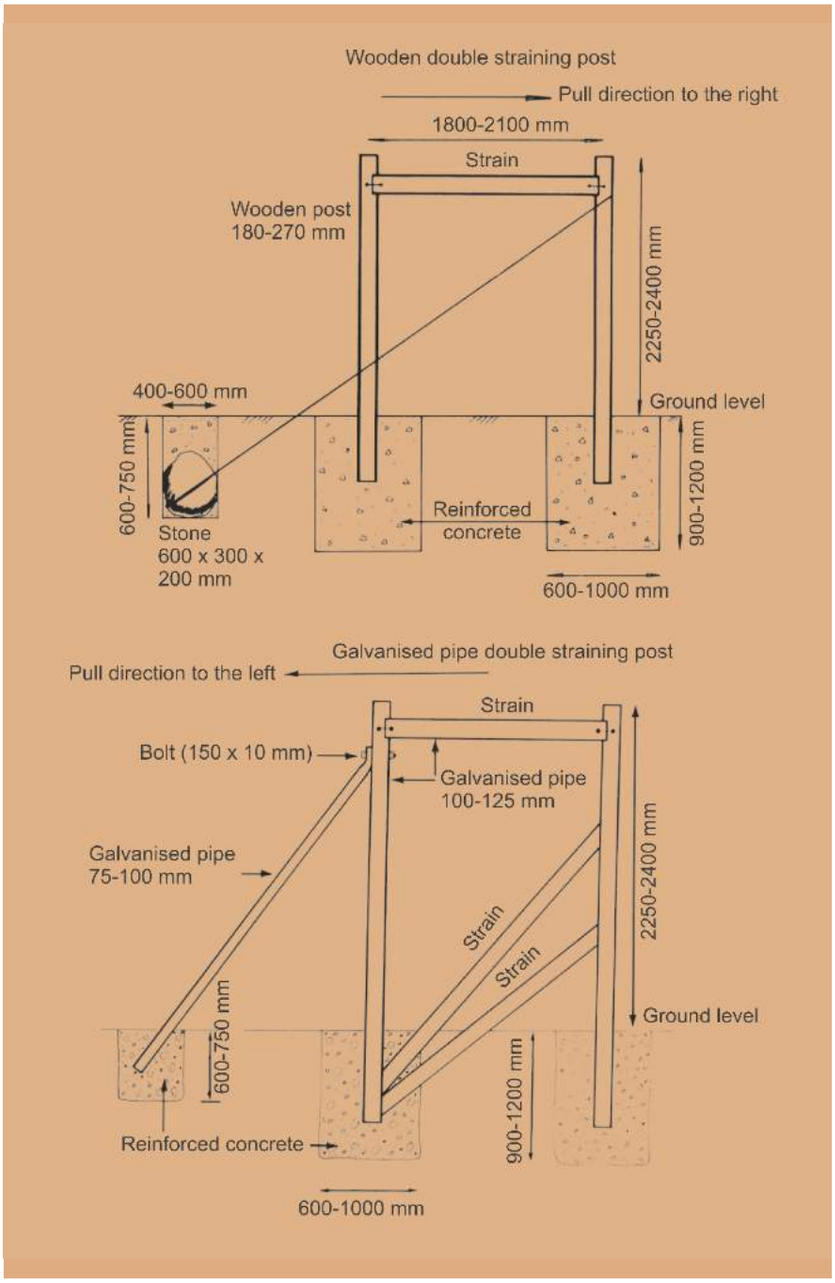


Figure 29: Straining posts for game fences *(© Staatsdrukkery, RSA)*

## 6. Electric fences

Electric fences consist of one or more wires (even netting for small stock) which are connected to an electric current (via a special energiser) which will shock animals when they touch the wire and thus scare them off.

The electric current is created by an energiser which is powered by grid electricity, a battery charged by means of photovoltaic energy, a wind charger, etc.

Electric fences to control stock are not commonly used in Namibia, the main reason being that low rainfall, dry soil and long distances of wire make the commonly known system of a single electrified wire with earth return inefficient.

A system of multiple wires where every alternate wire serves as a return (earth) wire can, however, overcome this limitation.

Such a system might be attractive from a cost-effective point of view as it can be moved fairly easily and no permanent structures are therefore needed.

Very good earthing (particularly with earth return systems), good connections and minimum leakages by means of vegetation, etc. are prerequisites for an effective electric fencing system. Furthermore, stock that must be controlled should be "trained" to respect an electric fence. This can be done by confining animals to a stock pen where an electric fence has been erected for a period of time. Pieces of tinfoil attached to the electric fence can help to train cattle. Because they are inquisitive, the cattle will want to smell at the tinfoil pieces and will be shocked on the nose, the most sensitive part of the body.

Electric fencing is sometimes used by small stock farmers in combination with jackal-proof fencing to control predators. In this case, the jackal-proof serves as earth whilst a live wire runs approximately 25 to 45 cm along the fence on the outside of the camp. Depending on the construction, such a system can scare off diggers or climbers (or both) that want to cross the jackal-proof fence.

Obviously, the same method can be used to confine game to a game camp or a game park as well.

When considering electric fencing, professional advice should be obtained. Many technical and legal aspects have to be considered to design a tailor-made system that will measure up to its expectations and be legally acceptable at the same time.

## 7. Manufacturing of home-made droppers and posts

Many woody plants in Namibia are suitable for the manufacturing of posts and droppers on the farm. This can save a fair amount of cash layout when erecting a new fence or refurbishing an existing fence.

Commonly used species for posts are:

- camel thorn
- silver clusterleaf (*geelhout*)
- tamboti
- prosopis
- mopane

For droppers, some commonly uses species are:

- blackthorn (*swarthaak*)
- silver clusterleaf (*geelhout*)
- prosopis
- tamboti
- sicklebush (*omatjette*)
- mopane

It should be considered that some species (e.g. camel thorn) are protected and only dead wood may be sawn.

When sawing poles, a few basic guidelines should be followed:

- When sawing green wood, proper dry-out (at least 1 year) is necessary before the post can be planted.
- Remove the bark before planting.
- Treatment with old motor oil and insecticide may be advantageous.
- Keep conservation in mind when sawing. Saving money cannot be the sole motive.

Regarding droppers, the following can be said:

- Droppers from blackthorn and silver clusterleaf are chopped when green and put into a fire to enable the bark to come loose.
- Prosopis droppers are sold bark-on. (Why?)
- The bark peels off later which makes a fence look very unneat.
- Tamboti droppers are often made of old tamboti poles which are cleaved.
- It is advantageous to treat blackthorn and prosopis droppers with old motor oil and insecticide to lengthen their lifespan. Tamboti and silver clusterleaf droppers are very seldom attacked by termites.
- Allow for proper dry-out before attaching to a fence.
- Home-made droppers should be fitted upside down (thick end up) in order to avoid them from slipping down as they may get thinner with advanced dry-out after some time.

# CHAPTER 3
# Machinery and Equipment

This chapter should give the user an idea of:

- the importance of engine, tractor and motor vehicle services and the right oils to be used;
- how to ensure good cooling of an engine;
- battery maintenance.

Each modern farm with the aim of producing for the market involves a certain amount of machinery. It is true that any crop production enterprise needs more machinery than an extensive sheep or cattle farm, but even the latter will most probably have at least a light truck, a power head and a water engine involved. All these machines need maintenance to ensure good functioning and a long life.

## 1. Engines, tractors and motor vehicles

### 1.1 Safety

Obviously every machine has its own safety hazards and operators' manuals should be studied to be aware of these. On the other hand, some basic rules apply to all machines.

- Become familiar with all the controls, indicators, warning lights and warning plates before operating a machine.
- Make sure that all the safety guards, shields, etc. supplied with the machine are in place.
- Beware of inhalation of exhaust fumes when operating an engine in a confined place.
- Maintain the brakes of a vehicle in an excellent condition.
- Do not wear loose clothing close to moving parts.
- Do not work on or adjust a running machine.
- Beware of open-running belts of mainly water engines. Ideally, all belts should be caged.
- Stop an engine before refuelling, be on the lookout for leaks, clean off spilled fuel and avoid any form of open flame while refuelling.
- Never open the radiator cap while an engine is hot. The coolant is under high pressure.
- Wrong tyre pressure is a major safety hazard with vehicles.
- A slower operating speed always goes hand in hand with more safety with any vehicle.

## 1.2 Service

### 1.2.1 Oil changes and type of oil to be used

Refer to the operators' manual of machinery to find details on the frequency and service procedures. The manual will also give an indication of the oil quality and the viscosity to be used. A few general guidelines can be given, however.

- Most stationary engines should have an oil and filter change every 250 hours. With older vehicles, a service every 5 000 km is recommended, although many modern car manufacturers claim that a service every 10 000 km is sufficient. Take working conditions (dust, heavy work, etc.) into consideration. It might make sense to shorten the service interval.
- Be sure the right oil is used. Petrol engines need different oil than diesel engines, although some oils are registered for petrol and diesel engines. Classifications for petrol engines are SA, SB, SC, SD and SE (S = spark ignition) and for diesel engines CB and CC (C = compression ignition). The second symbol describes the quality within the class. An SA oil is suited only for light petrol engines run under ideal conditions while an SE oil is a heavy-duty petrol engine oil. CD oil is suited for extremely difficult circumstances for turbo charged diesel engines (caterpillars, etc.) and is harmful for petrol engines.
- The viscosity of oil is indicated by SAE followed by a number. Thinner oil (e.g. SAE 10) is normally recommended for very cold conditions while thicker oil (e.g. SAE 30 or SAE 40) is suited for hot climates. Modern multigrade oils (e.g. SAE 20 W 50) are suited for a wide range of climates. These oils will flow more easily under cold conditions but will still keep its lubrication ability under hot conditions.
- Transmissions (gearboxes and differentials) and hydraulics need different oils. Some oils, which can serve as engine oil, transmission oil and hydraulics oil for tractors are available. (Tractor universal oil.)

### 1.2.2 Cleaning and replacing filters

Clean filters are vitally important to extend the lifetime of an engine and to ensure good working. Whilst filters are normally changed with each oil change, it is obvious that intermediate changes or cleaning may be necessary under the difficult working conditions of an engine. Dust clogs air filters, while fuel from containers like drums or cans may contain dust, sand, water and rust.

Some older stationary engines still have oil-bath air filters. The oil should be replaced and the housing washed properly with petrol on a regular basis, depending on the working conditions of the engine.

Smaller petrol engines (fire pumps, welders, etc.) have a foam filter that can be washed in petrol to have it cleaned.

The most common modern air filters have a paper filter element, which needs to be changed. It is only recommendable in

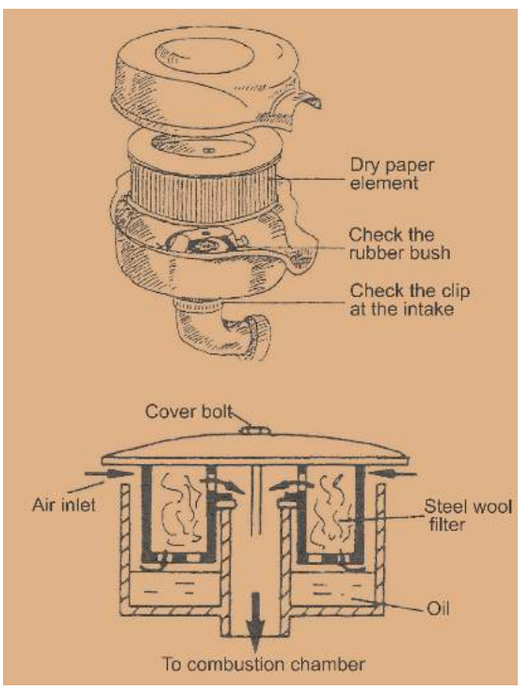


Figure 30: Paper element air filter (top) and oil-bath air filter (bottom) *(© Agrifutura)*

emergencies to try and clean these elements by means of compressed air. A new element is always the better option.

Fuel filters either have a paper element that needs to be changed or a filter cartridge, which is replaced. Again, cleaning attempts should be avoided; replacement is the right option.

The same applies to oil filters. Oil filters are seldom changed between oil changes, as may be the case with air and fuel filters, but they must definitely be changed with each oil change.

Be sure that any service of an engine is conducted in such a way that contamination of the environment is avoided. Furthermore, work under clean conditions as far as possible. It serves no purpose to change filters if, during the process, all open lines are contaminated with sand, dust, oil drippings, etc.

### 1.2.3 Maintenance of batteries

All modern vehicles, but also some stationary engines, are fitted with batteries to enable electric starting and avoid having to crank an engine by hand. On many farms, basic electricity is also supplied by means of batteries, which are charged by means of generator or solar power. Although fairly maintenance free, batteries need some attention. Pay special attention to the following aspects:

- See that the electrolyte in each cell is always at the right level, namely ± 13 cm above the plates. If water needs to be added, use only clean distilled water. Never use water with a high salt content or water treated with chlorine or water softener.
- Keep the casing and the pole connectors (terminals) clean and dry. Petroleum jelly applied to the poles avoids build-up of salts and ensures clean poles.
- See that the air vents (ventilation caps) in the battery are open.
- See to it that the battery is not shaken or knocked around. Proper mounting in a vehicle is essential.
- If the starter is used, the battery must be given a rest after each ± 15 seconds of cranking.
- Charge a battery once a month if it is not in regular use.
- Ensure good ventilation and avoid open flames and sparks near batteries, especially when charging.
- Battery acid is corrosive. Avoid contact of clothes with battery acid and expect metal parts in close vicinity of batteries to corrode.

### 1.2.4 Vehicle radiators and cooling systems

Engines (stationary and vehicle mounted) are either water- or air-cooled. While with an air-cooled engine heat exchange takes place directly from the engine to the air, in a water-cooled engine water circulating around the hot parts of an engine absorbs the heat which may be air-cooled again in a radiator.

With air-cooled engines, it is vitally important that all fins are clean, all air-conducting panels are in place and the fan (if fitted) runs properly.

A water-cooled engine has a number of special features which ensure the correct working temperature.

- Coolant is under pressure when the engine is hot. This increases the boiling point of the water which, in turn, facilitates more effective cooling (and a smaller cooling

system needed) as the difference in temperature between the air and the water is bigger, which leads to faster heat exchange. (Some stationary engines still have an open water-cooling system, which is not under pressure. Here, the amount of water available in the cooling tank (usually a drum) will be vital for engine cooling).

- Water cooling systems under pressure are fitted with a thermostat, which only opens when a certain temperature is reached. This enables the engine to reach the best working temperature faster after starting.

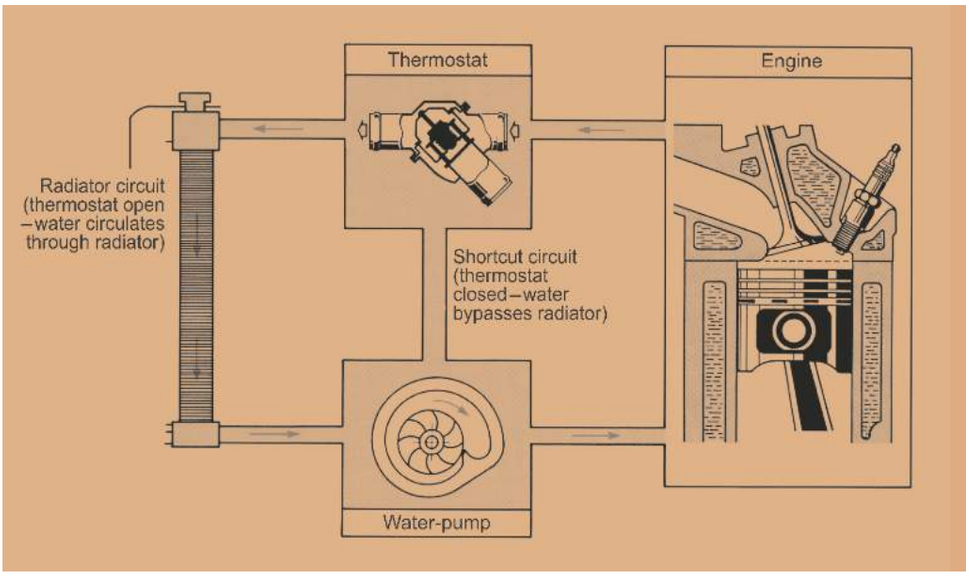


Figure 31: Water-cooled radiator system of a modern vehicle *(© Staudt W.)*

Water-cooling systems need the following maintenance:

- Check the water level in the radiator daily. Remember, a closed system is under pressure when hot and the water level should thus only be controlled when the engine is cold.
- Check regularly that the fan belt is tight and all hoses and connections are free from leaks.
- Rinse and replace the water in the cooling system once a year.
- With an open cooling system on stationary engines, much water is lost due to evaporation and has to be replaced regularly. This leads to scale build-up with hard water. A little oil on the water surface will, however, prevent evaporation from the water tank.
- Prevent the water from freezing by adding antifreeze. Freezing water in an engine can cause an engine block to burst.

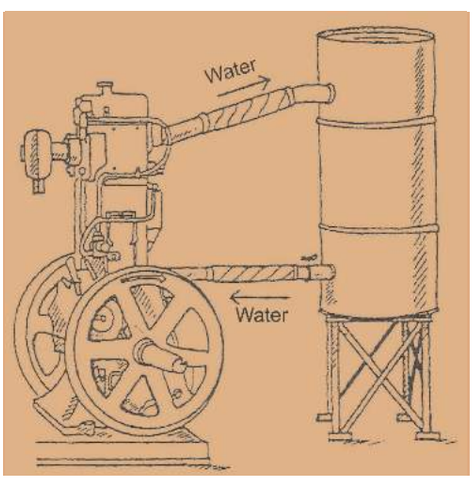


Figure 32: Water-cooled stationary engine *(© Agrifutura)*

On farms, severe problems are experienced with grass seed clogging vehicle radiators, resulting in overheating of engines. Here, prevention is much better than cure.

Regularly used farm roads should be cut clear of grass. A piece of fly netting in front of the radiator will prevent some of the seeds from

getting stuck in the fins of the radiator. Furthermore, regular cleaning of the radiator by means of compressed air or water may help. Ensure that the pressure used is not too high, otherwise the radiator fins may bend.

It might be wise to have the regulator cleaned (internally and externally) once in a while by a professional to ensure proper working at all times.

### 1.2.5 Tyre pressure

Tyre pressure is very important for road safety purposes. On the farm tyre pressure is often determined by the load to be hauled on a vehicle and the terrain (sand, sharp rocks, etc.), but ensure to have the correct (recommended) tyre pressure for the type of vehicle and tyre to avoid swimming (too flat tyres) or bumping (too hard tyres) on the open road. Light trucks which are driven without a load tend to bump severely. A bag or two filled with sand on the loading platform can ensure a much smoother ride.

In combination with tyre pressure, functioning shocks also contribute to a smooth and safe ride.

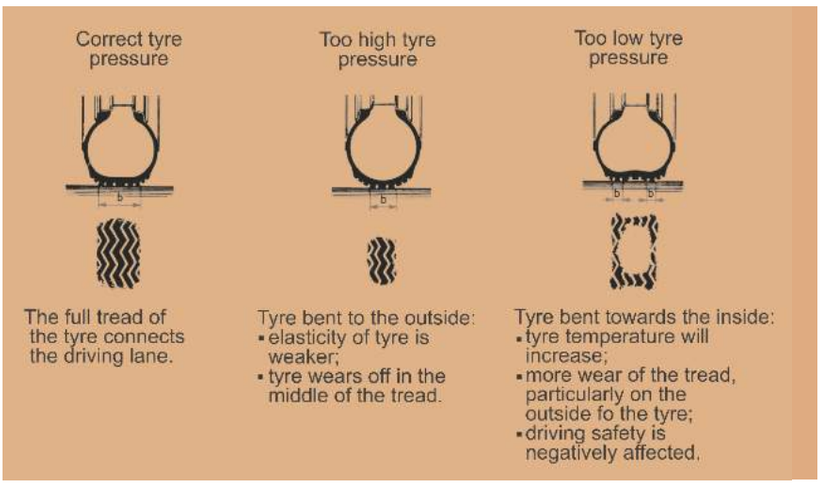


Figure 33: The effect of tyre pressure on wear of tread and road safety *(© Staudt W.)*

## 2. Record-keeping

With all types of machinery and equipment, some sort of record-keeping is recommended to keep track of what has been done when in terms of repairs and services to a specific piece of equipment. No fancy bookkeeping is necessary. Regarding services, for example, a tag fastened to the machine or equipment with the basic information of the last service conducted is for many a farmer more worthwhile than a book stored somewhere in his office.

### 2.1 Purchase information

Keep information of date of purchase, model, serial number (chassis number, engine number), etc. of all machinery. This will simplify the purchasing of spare parts and will be necessary in cases of theft.

## 2.2 Working hours

To be able to conduct services and inspections at the right intervals, working hours should be recorded. This can be done by keeping a logbook where hours worked are written down. It might, however, be more practical to instal an hour meter which registers the hours worked by means of the vibration of the machine.

## 2.3 Services (repairs conducted)

As mentioned above, some farmers might find it more practical to attach a tag to a machine, which contains the details of the last service (date, hour meter, reading and service details), whilst others prefer a record book in the office. Major repairs should be recorded in the office as well. As some machines will be used more often than others, the farmer might lose track of when what was done to what machine. In the case of selling a machine, these records can also be forwarded to the prospective buyer to emphasise the fact that the machine was properly cared for.

## 2.4 Next service due date

With many different machines on the farm, it might make sense to add on the last service tag of a machine the next service due date. While all manufacturers have their own ideas about when their machines should be serviced, some basic rules are mentioned in the manual:

- Windmills: Check oil and check bolts for tightness –
  bolts, twice a year (every 6 months)
  oil change, every 1½ to 2 years
- Power heads: Oil change, once a year
- Stationary engines: Oil and filter change, every 250 working hours
- Vehicles: Oil and filter change and greasing of joints every 5 000 km (older vehicles) or 10 000 km (modern vehicles)

# CHAPTER 4
# Fire Control

This chapter gives a few thoughts on modern firefighting equipment used on farms and a few basics regarding the technical side of combating veld fires.

Limited farmland available to a farmer makes it necessary to control veld fires as fast as possible. Firefighting must be a community action where neighbours assist each other. Whilst the procedure, dangers, safety precautions, etc. go far beyond the contents of a mechanical manual, a few technical points should be addressed.

## 1. Firebreaks

It makes sense to construct firebreaks after years of good rains when grass grows in abundance. While a graded, 100 % grass-free firebreak of 3 or 6 m wide can assist in a firefighting action, no illusions should exist that such a firebreak is a guarantee to stop a fire. A fair wind will blow a fire with ease over a national road. Graded farm roads and borders as well as roads cut free of grass will, however, enable firefighting teams to move quickly to where they are needed.

## 2. Equipment

Modern farmers make use of tanks or drums of water and pumping equipment to fight fires where the terrain allows access by vehicle. This works very well, but a few basic rules should be kept in mind regarding the technical side of the action:

Trailer-mounted firefighting unit equipped with 1 000 litre tank
(© *Industrial Building Supplies, Windhoek)*

- Do not overload your vehicle. While some heavier 4x4 trucks might be able to carry 1 000 litres of water plus equipment, a normal 1-ton bakkie should not carry more than 500 litres of water and equipment.
- Have all equipment tied down very securely. Loose equipment might harm passengers when unexpected holes, etc. are struck.
- Be sure to move on the already burned side (the black side) of a fire only. Fatal accidents happen annually to people and vehicles that get caught in the high grass by a raging fire.
- Know the limits of your vehicle. It serves no purpose to try and drive at places which will harm your vehicle, equipment and personnel.
- Be aware that petrol burns much more easily than diesel. Special care must thus be taken when moving in a petrol vehicle towards a fire. Furthermore, spare petrol (usually for the pump) should be carried in a tight metal container, not a plastic can.

- Pumps used are either centrifugal pumps or high-pressure piston pumps, driven by a little petrol engine. Centrifugal pumps have less pressure to cast water long distances, but are less sensitive for dirty water. Piston pumps spray very far, but special care by means of sieves and filters must be taken to avoid dirt reaching the pump.
- A proper inspection of your vehicle and pump equipment should be carried out after each operation. Defects will be noticed and can be repaired immediately as far as possible. Remember, your next firefighting action might be only a few hours away.

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- Toco lifting, lashing, loading, rigging and winching equipment
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