

# Wood: A local option for handpump bearings

## by Nienke Danhof and Mathieu Gielen

**Experiments using wood to make bearings for pumps has shown that there is some potential for replacing costly imported bearings with bearings that have been produced locally.**

ONE PART OF a handpump that often causes problems is the bearing. An AMREF project in Kibwezi, Kenya, which was using the SWN 80 handpump, carried out research into the possibilities of using wood as a bearing material. It should be cheaper than imported fibre plastic bearings, and able to be produced locally. The field study at Kibwezi proved that there were problems with using wood, but there were also possibilities.

### History and problems

Since the SWN 80 handpump was designed in 1980, various bearings have been designed for and used with it. The bearing housing is designed for ball-bearings, which can last for many years but which are very expensive for rural communities: they cost US\$12.40 each and four are needed for a complete set.

Plastic bearings, called LFX and Arnite, were made as a cheaper alternative (but they are no longer available). These make a journal bearing, with the plastic turning on a stainless steel shaft (Figure 1). The communities in Kibwezi preferred these to the ball bearings because they were cheaper, only \$5. More durable bearings were later introduced, called Tufnol. They are made of a high-tech fibre plastic and cost \$4.50 each, but field observations showed that they wore out the pump shafts. The pump was redesigned (and renamed the SWN 90) to include major improvements to the bearings, but these cannot be used with SWN 80 handpumps. The bearings made of Tufnol and other synthetic plastics cannot be produced within Kenya, so they have to be imported at considerable cost.

Eucalyptus wood has already been used successfully in other parts of Kenya, but it is not available in Kibwezi, and our research was to find out if local artisans could make bearings with local woods. The eucalyptus bearings are also not very good for pumps with water coming in the pump-head: they are soft and swell easily. The minimum requirements were that the bearings be produced locally, be cheaper than imported ones,

last for about nine months, and fit into the SWN 80 handle. (Figure 1 shows such a handle with bearings.)

The research investigated both the design and the production process of the bearing, beginning with the former. Various local woodcarvers and furniture manufacturers were given sample bearings and asked to make copies in wood. In addition a fully equipped workshop in Nairobi also made and tested prototype bearings from wood.

- The village woodcarver used itula (*Commiphora baluensis*), which is a softwood, and with his chisel and sandpaper made bearings that were ready to be installed for \$0.80 each.
- The woodcarvers' factory 33km away used African blackwood (*Dalbergia melanoxylon*) and olive (*Olea africana*), both of which are hardwoods. The woodcarvers could not get the bearings quite orthogonal, and had particular problems making the holes round and centring them, so they could not be used in a pump. They were also the most expensive option, as it took a lot of time to make them. Blackwood bearings cost \$1.80 and olive \$1.40.
- A carpenter 32km away had a simple electric lathe which he used to make chair legs. He was shown how to make the bearings using a measuring calliper, but he was not able to make good holes with the equipment he had. The hardest wood he used was mukau (*Melia*

*volkensii*), which is rougher and not as hard as olive. He charged only \$0.25, but again the poor holes in the bearings meant they could not be used.

- In Nairobi, 228km away, the most high-tech solution was found: a pump rehabilitation workshop with a professional lathe and precision measuring instruments had suitable wood. They could make dimensionally perfect bearings, but the price was still being negotiated.

Care was taken that the producers used the wood they normally used in their business, so the choice of wood and the producer were linked.

The woodcarvers were not able to make a bearing of sufficient precision, and the carpenter would need some tools and training, so if local producers are used, someone would have to be responsible for control of quality and production. This would mean additional management responsibilities for the project.

Even though local production of bearings means they are more easily accessible to local consumers, the bulk of other spare parts come either from Nairobi or overseas. Therefore local production of bearings appears to require the community to establish new systems for supply. From a production point of view, the most suitable choice for a producer would be the workshop in Nairobi which is able to make a whole range of spare parts for hand pumps.

### Design aspects

The three most important variables were found to be: the type of wood, the direction of the wood grain, and the treatment against water.

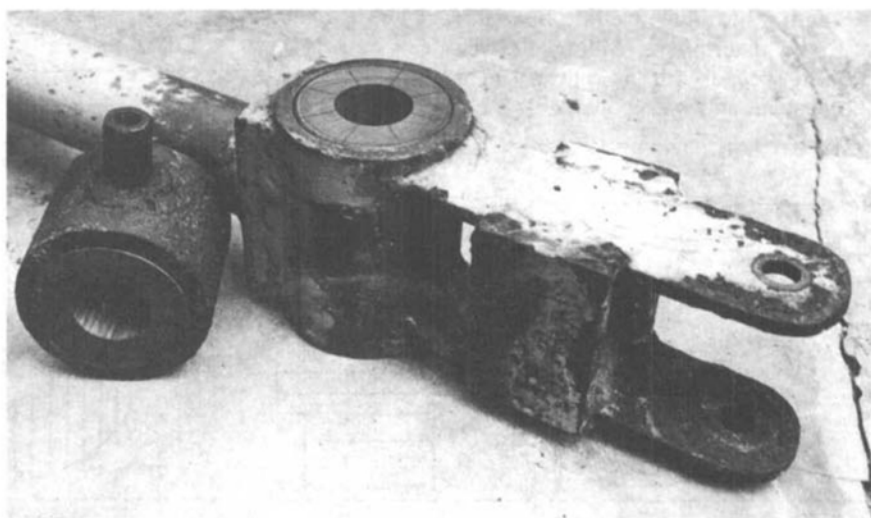


Figure 1. The handle of an SWN 80 handpump with wooden bearings.

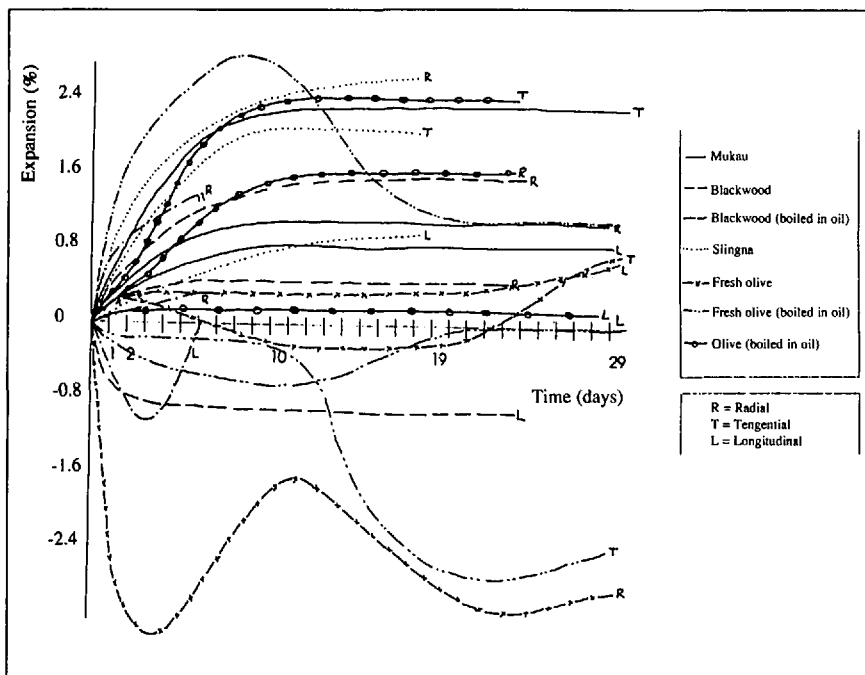


Figure 2. Expansion of wood in water (R = radial, T = tangential, L = longitudinal).

- **Type of wood** The hardness, density, and structure of the wood all influence the usefulness of wood as a bearing.
- **Direction of the wood grains in the bearing** There are two ways to cut the bearing: the axis can be parallel with or perpendicular to the grain. The direction of the wood will be different for each option. Some literature was available on these aspects, but further field trials were carried out.
- **Treatment against water** When a bearing is located inside the pump-head there is always a risk that it will get wet, which will cause swelling in a wooden bearing. This risk is increased when the pump outlet is blocked or inadequate for the flow of water. In this study pieces of plain and oil-treated wood were soaked in water to observe their expansion. This enabled the usefulness of oil treatment in preventing bearings swelling by water to be determined. Motor oil was used because it is cheap, heat resistant, and widely available.

### Results

Figure 2 shows the results of soaking the wood. All types of wood reacted to the water, and boiling or soaking

them in oil did not lead to less expansion. The wood expanded or shrank least in the direction of the grain. Blackwood expanded least, but even it expanded by 0.4 to 1.6 per cent.

Many of the woods changed their properties after being boiled in oil. Blackwood formed powder on its surface, indicating disintegration, while a series of small radial cracks appeared in the olive.

These results were confirmed by field trials. The bearings that were installed in pumps on shallow wells, where water was able to reach the bearings, got stuck because of swelling. The bearings did not expand when installed in pumps where the housing remained dry (see box).

Field trials also showed that oil can seriously hamper the functioning of the bearing. Debris from corrosion can stick in the oil, forming a crust on the working surface of the bearing. The lubricating effect of oil is also very limited when there is no full rotation and the speed is low.

Because so many bearings got stuck in the field trials, only limited

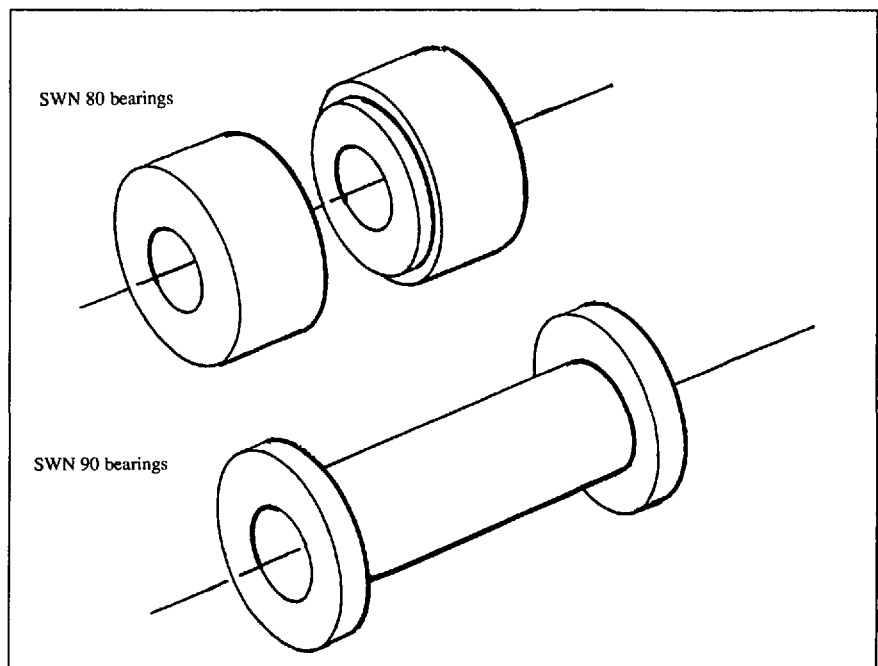


Figure 3. The redesigned bearing for the SWN 90 handpump.

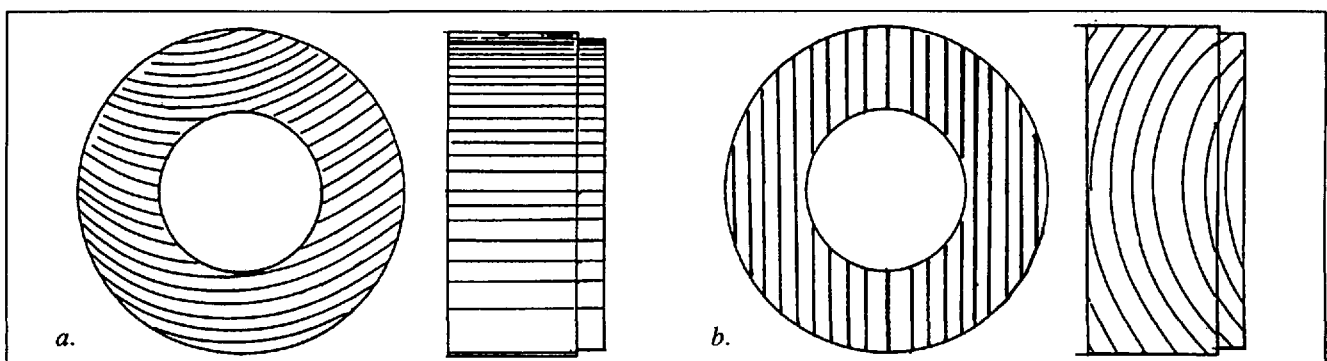


Figure 4. The grain in the bearing can be parallel to the axis of the bearing (a), or perpendicular to it (b).

### Why itula failed

Bearings made of the softwood itula were installed in a pump with a dry head and did not swell. The grain in these bearings was perpendicular to the axis of the bearings. As the wood dried out it lost its flexibility, however, and the load on it then caused cracks along the grain, as is shown in Figure 5.

This shows that the direction of the wood was poorly chosen, and it appears that the same bearing, only installed in the pump slightly rotated, could have made a stronger bearing. There is a big difference in the strength depending on to which side of the wood grains it applies. It is however very difficult to make sure that in every well the bearings are thus positioned that the strongest side is loaded.

If the bearing is made with the wood grain going in the other direction, with the axis of the bearing parallel to the wood grains, the wood does not show so much difference in strength.

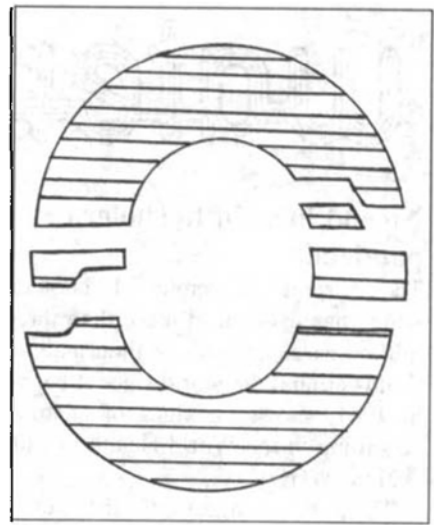


Figure 5. Itula bearings, cracked in the direction of the grain.

information was obtained about the wear. Itula, the softest of all woods, showed considerable wear after only five weeks. It is estimated that these bearings would only last for three months.

### Conclusions

- All types of wood which were tested expand when wet and boiling or soaking in oil does not prevent this.
- Oil has unwanted side-effects, such as weakening the wood and making

debris stick to the bearing. Oil is not an effective lubricator in a handpump bearing.

- The direction of the grain in a wooden bearing should be parallel to the axis of the bearing.
- Of all the researched woods blackwood expanded least in water (radial expansion 0.4-1.6 per cent, longitudinal shrinkage 0.9 per cent). The following alternatives should be considered when wood is used for handpump bearings and when there is a risk of water reaching the bearings:

- *Bearing with a bigger hole*  
If the hole in the bearing is bigger, the bearing can swell without getting stuck to the shaft. If blackwood, the wood which swells least, is used, the hole needs to be 31.4mm in diameter instead of the usual 30.2mm. If the wood does not swell, the bearing will be worn out much earlier! The life span of this larger diameter bearing still needs to be field-tested.

- *Design changes to the pump-stand*  
Changes to the pump-stand can be made to prevent water from reaching the bearings. This alternative is only possible for new pump-stands, and does not solve the problem of existing wells. Operators should also ensure that the correct size cylinder has been chosen.

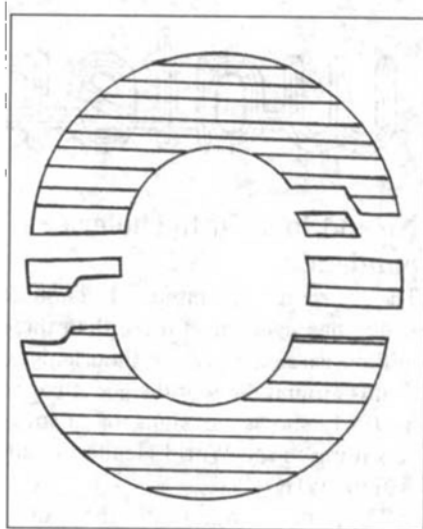
- *Better waterproofing of wood*  
Other methods of protecting wood, for example paint, coating, or impregnation, might be better than soaking in oil. More research is necessary to find out if other methods protect the wood better and prevent it from soaking up water.

If after trying these suggestions the wooden bearings are still not working satisfactorily, synthetic materials will have to be used.

So the best option for now for a wooden bearing is to have it made in a workshop with a professional lathe out of blackwood, and with a bigger hole. Field tests must demonstrate its life span. ●

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