AFRICA FIELDWORK & TECHNOLOGY

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Reports on: 1. Swaziland fieldwork
2. Technology
3. Methods and approaches

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MAINTENANCE PLANNING & HAND PUMPS

The problem

Many projects in rural areas of Africa go wrong because the equipment on which they depend is not adequately maintained. Servicing, inspection and visits by technicians with the correct tools and spare parts are often too infrequent.

The people involved in devising appropriate technologies for rural development are well aware of this, but there is still a lack of clear thinking about the problem which leads to imprecise specifications for equipment. We have experienced this particularly in thinking about the choice of a simple pump for use at rural wells and catchment tanks. The purpose of this paper is to discuss maintenance planning in general, and to define the limitations this places on the use of factory-made pumps, such as those we discussed in the first report in this series (technology / report 1: HAND-PUMPS).

Types of maintenance system

A central principle in any appropriate technology project ought to be that the design of a maintenance system as an item of "software" always accompanies the design of hardware. It is quite as important that the maintenance system should be appropriate as that the hardware should be of low cost and suitable for local conditions. We wish to specify three main types of maintenance system:

(a) zero maintenance
(b) community maintenance
(c) professional maintenance

By zero maintenance we mean the attempt sometimes made to allow for the poor maintenance facilities in rural areas by using very robust equipment which is not likely to require servicing or repair for a very long time. Such equipment is then often treated as if it needed no maintenance at all.

This is nearly always a mistake. All structures and all machines need some maintenance. Our argument in this paper is that, at the design stage, one should make clear decisions as to which maintenance tasks are being left in the hands of the local rural community, and which will be the responsibility of professionals - either technicians or engineers. That is, the real choice does not include 'zero maintenance' at all, but only the alternatives of 'community' and 'professional' maintenance, with various combinations of these two.

In all cases, choices must be based on knowledge of the skills of local people, the availability of tools and materials, and the extent of professional back-up that is possible. In some situations, professional maintenance will be excluded by shortages of skilled technicians, or by the great distances they would need to travel to reach scattered rural communities. Professional maintenance may also be excluded in some instances because the aim in an appropriate technology project will be low-cost maintenance, in proportion as capital costs are kept low. Even so, there will be many cases where professional maintenance is possible, and a choice has to be made about the extent to which it is used.

The illusion of zero maintenance

Two examples will serve to illustrate the shortcomings of treating simple and robust equipment as if it needed no maintenance at all.

The ox-drawn farm implements used widely in Africa are often thought of in this way. They are strongly made in steel and rarely break. But with use, the optimum shape of tines and plough-shares is gradually lost - angles and edges are distorted by wear and sometimes by slight bending. The result is that more and more effort is needed by the oxen to draw the implements through the soil, and they do a less efficient job.

Small dams and reservoirs in rural areas of Africa are also often treated as if zero maintenance practices were applicable. Sometimes one gets away with this and a dam lasts twenty years without attention. But really there is a lot that can go wrong - cracks can appear in embankments, spillways can erode, cattle can damage earthworks, vegetation can block spillways - and all these things can lead to the ultimate breakdown of the dam. A handbook on small dams in Rhodesia suggests that they should be inspected at least once every two weeks. This may be a cautious ruling, but the complete lack of any inspection and maintenance is an opposite extreme, and where it is the situation in Swaziland, we found several dams in need of repair, one of which had suffered serious damage.

Professional maintenance

Where the maintenance of a machine or structure depends on the supply of spare parts or on a relatively high level of technical expertise, as is the case with the pumps used at bore-holes, there is no alternative but to arrange for a technician to visit the site on a regular basis for servicing, and to be available if there are breakdowns at other times.

It is generally advisable to plan the maintenance programme before the project is embarked on - the geographical distribution of installations in the rural areas may need to be related to a route which the maintenance men can follow, and in some areas, construction of the installations may need to be linked to the building of access roads.

Taking bore-hole pumps as an example, the maintenance schedule would typically ensure that pumps were serviced, say, every two months. The technicians responsible would not only carry tools and spare parts in their vehicle, but would also need lifting gear for the odd occasion when pump rods and pump cylinders have to be lifted from the well.

In some projects, the risk of breakdowns occurring between servicing trips has been covered by supplying somebody in each local community with pre-printed and pre-stamped post cards which can be used to summon help when necessary. By using pre-printed cards, the system can be used by people who are not literate.

Community maintenance

In many projects using simple technology, there is an intention that local people should be entirely responsible for maintenance. In other cases, where there is a shortage of technicians, or where maintenance planning has been neglected, it may just turn out that the community is left to look after a piece of equipment, with only occasional visits from any technically qualified person.

What may happen in practice with, say, a hand-pump used for raising water from a shallow well is that it is seen as too small an item for a technician to be sent many miles for routine servicing. So it is used by the people for as long as it works, but when the inevitable happens and the pump breaks down, the cover of the well is opened and buckets are let down, to raise water. This circumvents the purpose for which the pump was installed, that of sealing the well against the intrusion of objects carrying pollution from the surface.

Too much is left to chance on the maintenance side of many such projects. By introducing the term 'community maintenance', we hope to stimulate clearer thinking as to what are the precise responsibilities being laid on the local people. Proper planning of community maintenance would take account of the following:

(a) the attitudes of the people; have they been able to influence the planning of the project, and have they participated in its construction, so that they identify the installation as truly theirs? Or do they regard it as belonging to some outside, alien agency, such as the government?

(b) the allocation of individual responsibilities for day-to-day operation of the equipment; for purchase of materials needed in repairs; and for actually carrying out repairs.

(c) the means of calling for help from outside, if any element of professional maintenance is to be involved.

(d) the resources of the community; tools and equipment possessed by local people; their skills; and the availability of materials needed for repairs.

It is the latter point which is most critical for the choice of hardware for use in community maintenance projects. People we met in rural areas of Swaziland and Botswana frequently possessed some wood-working tools which they used to make ox-yokes, ox-sledges, fences and houses; they had some blacksmiths' skills which enabled them to turn old car springs into simple tools; they were very skilful at making mechanical toys (model cars) for their children out of heavy gauge wire and tin lids. But the mechanical equipment they owned - farm implements and hand-driven maize mills - was mostly used on a zero maintenance basis, with the disadvantages noted above. A few people also have bicycles, and presumably carry out the basic maintenance of these with adequate success.

Some very simple pumps have been designed which can be made from readily available materials. The one illustrated here has been used in East Africa for raising water through very low heads. The circumstances in which this design originated are not known to the authors, but clearly, the pump could be made in a workshop with fairly basic equipment. Unless very carefully made, the pump would probably not be much use for heads greater than 2 metres. So it would be adequate for some of the catchment tanks recently constructed in Swaziland, but not for the Tanzania well programme which we have had in mind.

The only maintenance likely to be required would be the removal of occasional blockages, and the periodic replacement of the valve rubber. Both these tasks could be performed on a community maintenance basis in Swaziland or Tanzania, but we would suggest that maintenance is only likely to be effective if:

(a) the persons responsible fully understand the working principle of the pump. They should not be expected to follow a maintenance routine while remaining in the dark about what may be an unfamiliar principle.

(b) if dimensions are adjusted so that the spanners in a bicycle repair outfit will fit the nuts - rural people will not normally have any other sort of spanner.

(c) instruction in maintenance of the pump could well be related to bicycle maintenance. The pump's valve rubber is made from old bicycle inner tube, and the principle of bicycle pumps and of the valves on pneumatic tyres could be explained partly by comparison with the valves in the water pump. In this way, the maintenance of the pump could be made more interesting and more widely useful.

Turning to wells of around 5 metres depth, we tend to think that no comparable pump exists. Thus a community maintenance system rooted entirely in local resources and totally independent of professional help would have to abandon the advantages in well hygiene offered by pumps, and revert to using buckets for drawing water. We are supported in this conclusion by a project in Ghana where the use of pumps at shallow wells was deliberately excluded, despite the pollution problems which might ensue, because it was felt that pumps would not in practice be maintained. The hazards of using buckets can be offset by permanently attaching them to the well, so that people cannot take them home, and cannot use their own, possibly dirtier buckets.

Two kinds of "appropriate" technology

Within the range of techniques which are conventionally regarded as "appropriate" within the context of this paper - simple techniques, keeping below a certain cost level, and serving the needs of rural communities - there is often a choice between a community maintenance technology and a professional maintenance one.

Choosing between these two kinds of "appropriate" technology depends on the answers to questions with which we are not concerned here. The point we wish to stress is simply that one should be clear about the kind of technology being used from the outset in any project - to plan for professional maintenance, and then find that it is provided only on a patchy or occasional basis is to court failure. With the problem of raising water from catchment tanks in Swaziland, and from shallow wells in Tanzania, the kinds of appropriate technology equipment which currently seem viable are as follows:

1. TECHNOLOGY BASED ON PROFESSIONAL MAINTENANCE

For wells, use pitcher spout pumps with routine maintenance perhaps every two months, and with provision for an emergency breakdown service. For catchment tanks, use diaphragm pumps, with routine maintenance every four months; keep spare diaphragms available. For details of both types of pump, see the previous paper in this series - technology / report 1.

2. TECHNOLOGY BASED ON COMMUNITY MAINTENANCE

For wells, use a bucket on a chain or rope, perhaps with a windlass or pulley system. Attach the bucket permanently to the well and fence the site against animals to reduce the danger of pollution. For catchment tanks, adapt the pump illustrated in figure 1, adjusting component sizes to suit tools available to the community.

Extending the scope of community maintenance

It might be argued that reverting to the use of buckets at wells is defeatist, and that with sufficient ingenuity, one could design a pump for community maintenance. But we felt that rather than aiming at extreme simplicity in pump maintenance, it might often be preferable to enlarge the technical capabilities of the people and leave them to replace buckets by pumps when they judge for themselves that they can cope with the maintenance.

In Swaziland we observed a community centre (Nkundla) being built in the Mpolonjeni Rural Development Area. It contained a large hall for meetings with room for a clinic. One way of enlarging technical capabilities in that community would be to furnish this centre with a good work bench with a vice, and perhaps with tools (hacksaws, etc) available for loan from a caretaker or other responsible person.

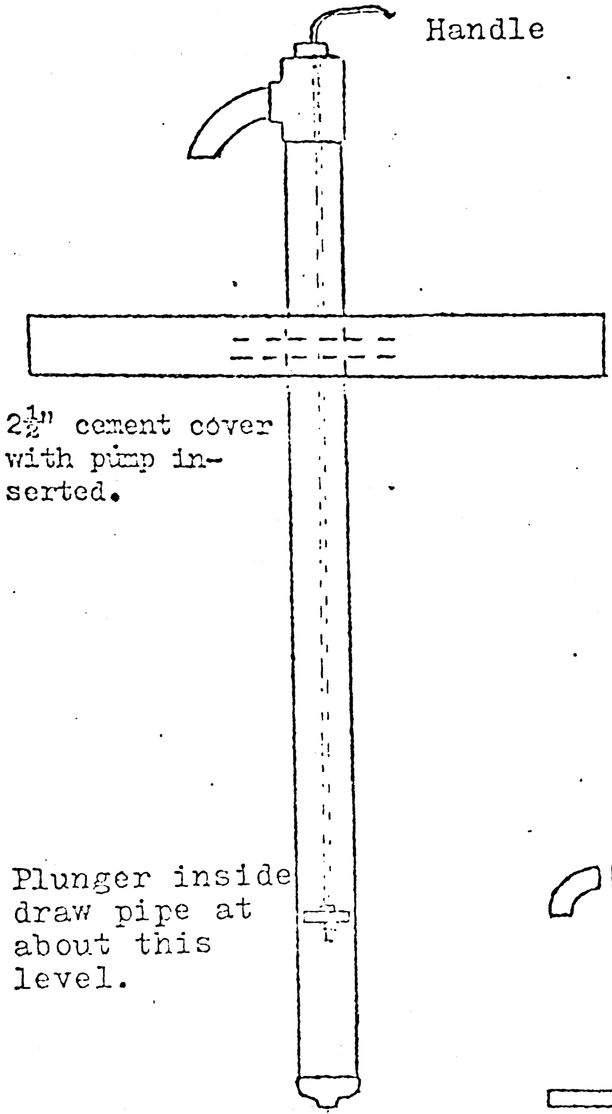
A second approach would be to give a few people from every rural community some technical training relevant to the equipment and building techniques currently being used in the locality where they live. Such training might typically include the following:

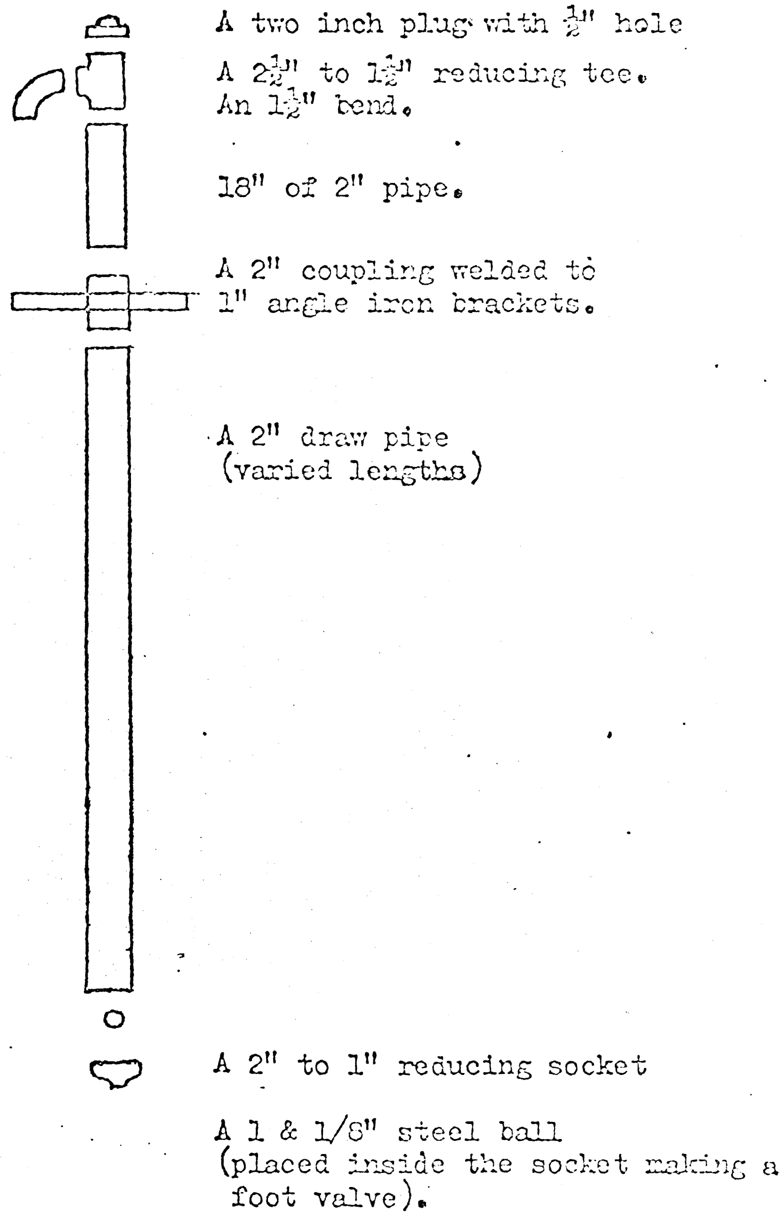
- maintenance and use of ploughs and cultivators (see page 2 above);
- making improved types of ox-harness;
- construction of ox-carts;
- making bricks and concrete blocks;
- improved wood-working techniques;
- installing guttering and tanks for collecting water from roofs;
- bicycle maintenance;
- working principles and maintenance of relevant types of water pump.

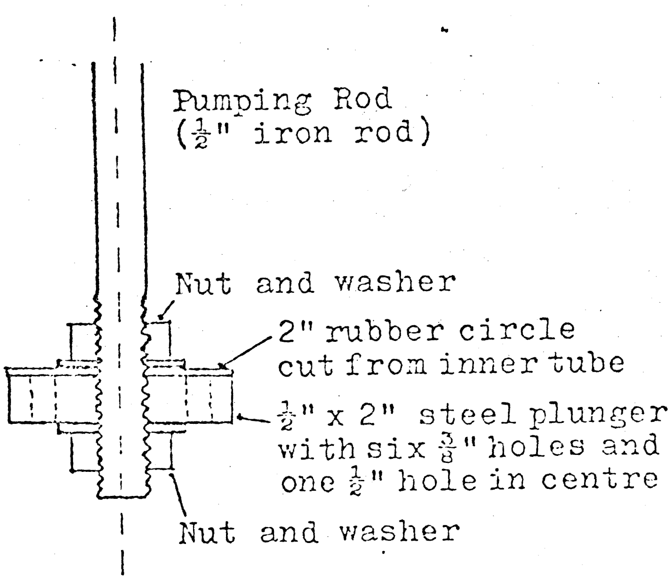
One or two Rural Training Centres already offer a little technical training of this kind alongside the more conventional agricultural training, and the Kenyan idea of "village polytechnics" ought to involve the same approach. It would be highly appropriate to develop more training of this kind in conjunction with existing agricultural extension or farmer training schemes, and also in the primary schools in rural areas.

Figure 1.

SIMPLE PUMP FOR HEADS OF LESS THAN 2 METRES







DETAIL OF PLUNGER ASSEMBLY