# Comparison Between Hand Dug and Hand Augered Wells



**Based on experiences in Zambia and Zimbabwe**

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February 1990

# COMPARISON BETWEEN HAND DUG AND HAND AUGERED WELLS BASED ON EXPERIENCES IN ZAMBIA AND ZIMBABWE

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## INTRODUCTION

In the context of this paper:

> **A PROTECTED DUG WELL** well consists of a hand dug hole, in excess of one metre in diameter The sides of the hole are lined with pre cast concrete rings. A protected well has a concrete cap, surround and drainage channel. Water is extracted from the well by means of a windlass and bucket.
>
> **A HAND AUGERED WELL** consists of a narrow hole about 175 millimetres in diameter which is drilled by hand using a special rig called the VONDER RIG. The hole is lined with 125 mm diameter plastic pipe. Water is extracted by means of a windlass and specially designed bucket.

## GENERAL OBSERVATIONS ON RURAL WATER PROJECTS

Large scale Rural Water Supply Projects, particularly those largely funded by Donor Agencies, must accommodate the legitimate objectives and aspirations of the following groups;

- the central Government of the country in which the project is located,
- the local politicians in the area of the project,
- the local authorities in the area,
- the traditional authorities,
- the actual communities (villages) being served by the project.

Failure to find a mechanism for balancing these, often conflicting, demands will have serious implications for the success of a project.

As a consequence of the general shortage of resources in developing countries it is almost certain that the local authorities will not be able to support an on-going preventative maintenance programme for a large number of wells scattered throughout their area.

This means that the local community in which a well is constructed will in fact be largely responsible for it's maintenance.

The above two paragraphs imply one of the important guidelines for the success of well projects namely;

> ***"If the well is to remain viable after the departure of the project then the community in whose village the well is constructed must consider it as their well."***

If the villagers believe that the well belongs to the Project or the Local Authority then they will legitimately expect that the owner should take care of the well.

There were numerous examples, in Kasama, of existing Local Authority wells falling into disrepair because the villagers believed that they were the responsibility of the "owner".

If the villagers are to accept a new facility as theirs then they must be involved in all aspects of that facility. This means that the village must be involved in the siting, the construction and in the operation and maintenance. This implies another guideline for successful well projects;

*"Rural well projects must be user centred."*

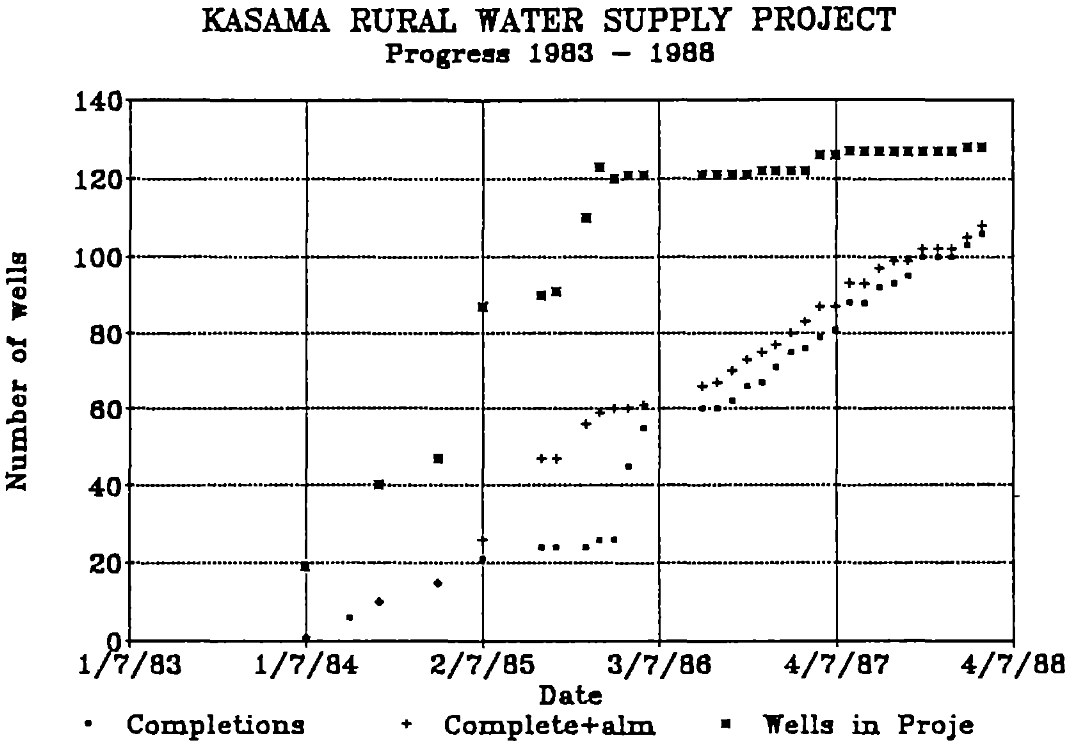
In an ideal system;

- the Central Government would decide the area in which the Project should take place in accordance with it's overall strategy for the water sector,
- the local politicians with the Local Authority (eg. District Council) acting as co-ordinator would draw up a priority list of villages to be served,
- the relevant local officials. (eg. Health Assistants) together with representatives of the Project would promote the Project to the priority villages and to the traditional authorities (eg. Chiefs. Headmen) in the villages,
- the villagers, informed as a result of the promotion would decide;
  (a) whether or not they wanted a well,
  (b) whether or not they were prepared to provide the self help required to construct the well and
  (c) if the answer is yes to (a) and (b) where the well should be generally located,
- the relevant technical experts (eg. Health officials, water engineers) would decide on technical grounds the optimum site for the well within the designated location. This site would be agreed with the village bearing in mind that it is better to accept a less than optimum site agreeable to the village than an optimum site with which the village disagrees.

Organising community centred projects results in a large amount of consultation and very slow progress in the early stages. However successful projects grow and take on a pace of their own. Remember that in many instances the communities have often in the past been promised projects that have not materialised. The villagers therefore have a natural reluctance to commit themselves to the efforts that self help requires until they are convinced that the Project will deliver it's side of the bargain. Building up this confidence takes time and may require the construction of demonstration wells at facilities such as Health Centres and schools.

The slow start up followed by subsequent rapid progress is clearly demonstrated in Figure 1 taken from the progress reports for Kasama Water Project in Zambia.

FIGURE 1




Complete+alm=complete plus almost 95% complete  Wells in Proje= Wells in Project

## WELL SITING

Well siting is potentially the most contentious aspect of rural well projects. Everybody naturally wants the well to be sited beside his or her house.

With regard to well siting there is one golden guideline;

> *"A new source of water must be significantly closer to the user than his or her traditional source before he or she will switch to the new source."*

As an example of just how important the user considers the question of distance examine the following tables (Table 1 and Table 2)(1).

TABLE 1

REASON FOR NOT USING TRADITIONAL WATER SUPPLY

| REASON FOR NOT USING | NUMBER | % |
|---|---|---|
| Distance | 103 | 85.1% |
| Distance and water dirty | 4 | 3.3% |
| Dist.& water not treated | 2 | 1.7% |
| Dries-up | 4 | 3.3% |
| Project well better | 4 | 3.3% |
| Contaminated | 2 | 1.7% |
| Bad taste | 2 | 1.7% |
| TOTAL | 121 | 100.0% |

## TABLE 2

REASON FOR FREQUENT USE OF PROJECT WELL WATER SUPPLY

| REASON | NUMBER | % |
|---|---|---|
| Protected and near | 2 | 1.2% |
| Treated and clean | 7 | 4.1% |
| Tastes good and near | 4 | 2.3% |
| Cleaner/not contaminated | 10 | 5.8% |
| Distance | 148 | 86.5% |
| TOTAL | 171 | 100.0% |

Number refers to the number of respondents in the survey.

The Kasama Project found the use of divining rods to locate the exact site of the well within the chosen location to be of advantage. Divining rods have the advantage that all present know the reason why the exact site was chosen.

## BACKGROUND

The information contained in this paper was acquired by the Author while working in Zambia and briefly in Zimbabwe. Most of the information comes from the Irish Government Bilateral Aid Project in Kasama Northern Zambia. The two technologies were used on this Project and this allows some detailed comparisons.

Kasama Water Supply Project is part of the Irish Government's Bilateral Aid programme. It started in 1983 with a target of 100 wells. The technology used was similar to a number of other Projects already in existence in Zambia at that time. The ground conditions are particularly suitable for dug well. The wells did not require shoring during digging. Some holes remained open unlined for over a year and showed no tendency to collapse.

In making comparisons for the purposes of this paper it is assumed that the wells are part of a scheme of around one hundred wells. Many of the comparisons would obviously not hold up for smaller schemes.

## PROTECTED DUG WELL

Constructing dug wells as practiced in Kasama consisted of three phases;

- MANUFACTURING concrete rings for lining the wells, concrete caps to top the wells and windlasses to raise the water from the wells,

- SELF HELP digging until the water table is reached by the villagers,

- COMPLETING digging by the Project below the water table, lining with rings, capping the well, constructing a surround and drain and installing a windlass and bucket.

The whole process consisted of twenty three separate operations. The process, for a one hundred well project, is heavily dependent on pumps to dewater the wells, trucks to deliver rings and broken stone to make concrete.

## HAND AUGERED WELL

A small number of wells, in the first phase of the Kasama Project, were hand augered using a special rig imported from Zimbabwe known as the Vonder Rig.

The VONDER RIG (VR) is a low cost (about ZIM$ 3,000) robust hand operated drilling rig which can drill a 175mm (7") diameter hole to a depth of around 20m (65 feet). The rig can be operated by as few as three people although the more people the better.

The tubewell drilled by the VR can be lined with any suitable lining material. The lining material used in the Project was 125mm (5") class 6 uPVC pipe. If the well is to be used with a handpump then slotted liners are used. For a Bucket Pump there is no need for slotted liners.

To raise the water from the well a special type of bucket known as a Bucket Pump was used.

The "ZIMBABWE BUCKET PUMP" consists of a windlass to which is attached, by chain, a long narrow bucket. This bucket made from light galvanized steel is about one metre long and about one hundred millimetres in diameter. At the bottom of the bucket is fitted a simple poppet valve which allows water into the bucket and then closes retaining the water as the bucket is lifted. The bucket has a capacity of about five litres.

It is somewhat of a misnomer to describe the "Zimbabwe Bucket Pump" as a pump, as it is more akin to a windlass and bucket system than it is to a traditional pump. It is the use of the poppet valve, in many ways similar to a foot valve in a pump, which results in the device being described as a pump.

## COMPARISON

Table 3 is a direct comparison between the two systems for completing a 100 well project over a five year period. The dug well figures are based on actual results while the augered figures are based on a mixture of actual results and estimates.

TABLE 3

COMPARSION BETWEEN SYSTEMS

| | Dug | Augered | |
|---|---|---|---|
| **SETTING UP** | | | |
| Office accomodation | Yes | Yes | |
| Storage shed | Yes | Yes | |
| Concreting yard | Yes | No | |
| Stone/sand storage | Yes | Yes | Ratio 2:1 |
| Ring cap storage | Yes | No | |
| Cement store | Yes | YES | Ratio 3:1 |
| Plastic pipe storage | No | Yes | |
| Workshop | Yes | Yes | |
| Water for concreting | Yes | No | |
| Laboratory space | Yes | Yes | |
| **STARTING UP EQUIPMENT** | | | |
| Concrete batch mixer | Yes | No | |
| Welding equipment | Yes | Yes | |
| Metal cutting/grinding | Yes | Yes | |
| Electrical repair | Yes | No | |
| Basic vehicle repair | Yes | Yes | |
| Painting | Yes | No | |
| Laboratory supplies | Yes | Yes | |

## COMPARSION BETWEEN SYSTEMS CONTINUED

| | Dug | Augered | |
|---|---|---|---|
| **WELL COMPLETING EQUIPMENT** | | | |
| Submersible pumps | 6 | No | |
| Generators | 5 | No | |
| Vonder Rigs | No | 3 | |
| **TRANSPORT** | | | |
| Management | 1 | 1 | St. wagon |
| Health Education | 1 | 1 | Pickup |
| Construction truck | 1 or 2 | 0 or 1 | |
| Construction pickups | 2 | 2 or 1 | |
| **COMPLETION UNITS** | | | |
| Number of teams | 4 | 2 | |
| **WORK FORCE** (Peak) | | | |
| Management | 2 | 2 | |
| Technicans | 2 | 2 | |
| Health Education | 1 | 1 | |
| Clerical/book keeping | 1 | 1 | |
| Foreman | 2 | 1 | |
| Driver | 3 | 3 | |
| Wells Capitao | 6 | 2 | |
| Bricklayer | 2 | 1 | |
| Watchmen | 6 | 6 | |
| Plumber/fitter | 1 | 1 | |
| Electrician | 1 | | |
| Mechanic | 1 | 1 | |
| Painter | 1 | | |
| General worker | 28 | 10 | |
| Total workforce | 57 | 31 | |

## TYPICAL WELL

| | Dug | Augered | |
|---|---|---|---|
| **COMPLETION TIMES** | | | |
| Self help to w.table | 14 - 300 | NA | days |
| Completion | 21 | 6 | days |
| Completion man days | *130 | 12 | man days |
| * excluding self help | | | |
| **TRANSPORT** | | | |
| Journeys | 11 | 4 | |
| **COMPLETION COST** (June '87) | Kwacha | Kwacha | |
| **BY TASK** | | | |
| Deepening | 1432.33 | 240.54 | |
| Lining | 3262.93 | 893.59 | |
| Surround | 846.69 | 891.82 | |
| Finishing | 1526.77 | 1104.4 | |
| Total | 7068.72 | 3130.35 | |
| **BY RESOURCE** | | | |
| Labour | 2653.45 | 314.16 | |
| Transport | 442.14 | 174.60 | |
| Materials | 3923.13 | 2591.59 | |
| Sundries | 50.00 | 50.00 | |
| Total | 7068.72 | 3130.35 | |

## COMPARSION BETWEEN SYSTEMS CONTINUED

| | Dug | Augered |
|---|---|---|
| **COMPLETION COST** (June '87) | Kwacha | Kwacha |
| **BY IMPORTED MATERIAL** | | |
| Estimated value | 394.66 | 1700.00 |
| % of total materials | 10% | 66% |
| **LIFTING SYSTEM** | | |
| Windlass & bucket | Yes | No |
| Capacity litres | 10 | |
| Bucket Pump | No | Yes |
| Capacity litres | | 5 |

## GENERAL INFORMATION FROM EXISTING PROJECT

| | | | |
|---|---|---|---|
| **AGRICULTURE** | | | |
| Subsistence farming | Yes | | |
| Animal husbandry | No | | |
| **RAINFALL** | | | |
| 30 year average mm | 1277 | | |
| Rainy season | Sep.- May | | |
| **POPULATION** | | | |
| Population per village | | 171 | Average |
| Range of village pop. | | 15 - 1363 | 86 vill. |
| Population per well | (87) 110 | (4) 178 | ()wells |

| | | |
|---|---|---|
| **WATER TABLE & WELL DEPTHS** | | |
| Average depth. metres | 10.52 | 10.78 |
| Range of depths. | 4.55-20.07 | |
| Average depth to water | 8.03 | 6.89 |
| Average depth of water | 2.44 | 3.89 |
| Average WT movement | 2.8 | |
| Range of WT movement | 0.39-8.15 | |
| **FAECAL COLIFORM** | | |
| Number of wells | 98 | 10 |
| Number of samples | 590 | 43 |
| % with FC/100ml=0 | 25.3% | 72.1% |
| % with FC range 1-10 | 36.3% | 25.6% |
| % with FC range 11-50 | 18.8% | 2.3% |
| % with FC > 50 | 19.7% | 0.0% |
| **pH** | | |
| Number of samples | 625 | |
| Average pH | 6.26 | |
| Range of pH values | 4.39-9.96 | |
| **CONDUCTIVITY** (micro siemens per cm) | | |
| Number of samples | 630 | |
| Average Conductivity | 95.26 | |
| Range of Cond. values | 1.22-466 | |
| **TURBIDITY** (NTU) | | |
| Number of samples | 626 | |
| Average Turbidity | 7.6 | |
| Range of Turb. values | 0.3-465 | |

COMPARSION BETWEEN SYSTEMS CONTINUED

| | Dug | Augered |
|---|---|---|
| **IRON** mg/l | | |
| Number of samples | 30 | |
| Average Iron | 0.44 | |
| Range of Iron values | 0-2 | |
| **SUSPENDED SOLIDS** | | |
| Number of samples | 13 | |
| Average S.S. | 15.4 | |
| Range of S.S values | 0-100 | |
| **USAGE PATTERN** | | |
| Number of wells | 94 | 6 |
| Number of visits | 1447 | 33 |
| In use during visit | 28.2% | 40.6% |
| Not in use at visit | 71.8% | 59.4% |
| Showed evidence of use | 91.6% | 93.9% |
| No evidence of use | 8.4% | 6.1% |

## SETTING UP

The ratios shown in Table 3 under this heading are an estimate of the relative requirements for the two systems. Because of the pre cast concrete work a dug well project will require more extensive facilities.

## STARTING UP EQUIPMENT

All of this equipment may not be required immediately but could be acquired on a phased basis. Also depending on the Project much of the equipment may be available in the Agency within whose ambit the project is operating.

## WELL COMPLETING EQUIPMENT

Breakdowns of pumps and generators seriously hampered progress in the Kasama Project. Operational pumps went from eight to three in less than a three month period with the result that the Project had to lay off 32% of it's work force for an extended period.

Things improved when the Project hired an electrician.

However experience indicates that it would be provident to carry at least 50% and preferably 100% spare capacity. Cannibalism of one broken piece of equipment to keep another going cannot be avoided because of the delays in obtaining externally sourced spare parts.

With the Vonder Rigs it would be advisable to have one spare rig but it would be necessary to carry over 100% capacity in the cutting tools.

## TRANSPORT

A one hundred well Project is not feasible without adequate transport.

Operating conditions on a dug well project are particularly punishing on transport.

It would appear from experiences on the Kasama Water Project that the useful lifetime of a vehicle is between two and three years.

While vehicles will last longer than two to three years down time will become a major problem.

One relatively new truck developed serious mechanical problems with the result that it was inoperable for 47 weeks. The other Truck was down for over 20 weeks of the project.

Other projects in Zambia have experienced similar down time with trucks.

A dug well project which requires to move concrete rings or large quantities of stone for concrete is totally dependent on having an operating truck.

Pickups can move personnel, pumps, generators, cement and small quantities of stone but they are not suitable for moving rings.

In at least one Project in Zimbabwe the Vonder Rig and it's associated equipment was moved locally by ox cart. This would not be feasible in Kasama as the ox cart is almost non existent.

## COMPLETION UNITS

In estimating the number of teams required to complete a one hundred well Project it was assumed that the same slow start due to community involvement and self help would occur.

In the case of a dug well project it is assumed that, as in Kasama, the villagers would dig at their own pace to reach the water and that there would always be wells at water waiting for the Project to complete.

This means that villagers who have completed their self help often have to wait significant periods for their well to be completed. This delay was a source of dissatisfaction for some people with the Kasama project.
This can be seen in the two tables Table 3 and Table 4 taken from the same study as tables 1 and 2

### TABLE 4

### HAPPY OR UNHAPPY WITH THE PROJECT

| HAPPY | NUMBER | % |
|---|---|---|
| Yes, to have water near | 158 | 71.8% |
| No, with Project so far | 62 | 28.2% |
| TOTAL | 220 | 100.0% |

## TABLE 5

### REASON FOR BEING UNHAPPY

| REASON | NUMBER | % |
|---|---|---|
| Late to complete | 16 | 25.8% |
| Promised spares* | 20 | 32.3% |
| Other unspecified | 26 | 41.9% |
| TOTAL | 62 | 100.0% |

* Spares promised steel cage or windlass

Assuming two auger teams is purely to make the systems comparable. In reality as it would be much better to operate with at least four teams in the field. This would mean that either the construction time would be halved or twice the amount of wells could be constructed.

As their is no waiting period between reaching water and completing the well with the augered system this should eliminate the problems indicated in Table 5.

## WORK FORCE

The exact work force will vary significantly depending on the conditions under which the Project is operating. The figures quoted are based on the actual work force for Kasama.

A dug well project can be a significant source of employment in an area. A dug well project because of the concrete work can also contribute to the provision of skilled and semi skilled labour in an area.

Doubling the number of teams from two to four for an augered well project would only increase the work force by four.

In one project in Zimbabwe no project staff were directly involved in the drilling. The drilling was carried out by the villagers supervised by local health workers who had received some basic training. However the water table was significantly closer to the surface than Kasama.

It is felt that the advantages of having a small trained team working with the villagers would greatly expedite the project and ensure a better quality well.

## COMPLETION TIMES

The time taken by self help teams working at their own pace to dig a well to water varies widely. It obviously depends on the depth but it is also influenced by local factors.

In Kasama the project would not complete a well until it reached water nor would they pressurise a village to dig any faster.

A few villages took as little as two to three weeks to reach water while others took two to three years.

In another project in Zambia which strove to reach a higher degree of self help with the villagers doing all the work under the supervision of a Capitao progress was very slow with the Capitao sitting around idle for extended periods. This had serious implications for the viability of that Project.

Six days to complete an augered well is based on experience with the few augered wells in Kasama.

## TRANSPORT FOR THE TYPICAL WELL

The extra journeys for the dug well are the direct result of moving different teams, transporting rings and material for concrete.

There would probably be a three to one fuel saving for an augered project over a dug project as the augered project would carry lighter loads.

## COSTS COMPARISON

Because of the currency fluctuations in underdeveloped countries cost comparisons can alter suddenly.

Kasama Water Project was almost exclusively funded by the Irish Government. This means that cost comparisons are made ultimately in Irish pounds.

During the initial investigations of the Vonder Rig for use in Kasama it was estimated that only a marginal direct cost saving would occur in favour of the Vonder Rig tubewell system.

However the Zambian Kwacha went from about 2.5 per US$ to about 17 per US$ and back to about 8 per US$ in the period of a year between July 1985 and May 1986. The Zimbabwean dollar remained relatively stable at about 2.5 Zim$ per IRpound throughout the same period. The fluctuations in the Kwacha resulted in the tube well becoming almost twice as cheap as a similar dug well.

However as already stated cost comparisons are particularly difficult in underdeveloped countries.

These comparisons take no account of the fact that a much larger proportion of the materials used in a hand augered well will have to be imported from Zimbabwe. Therefore although there appears from the view of an external funding agency to be a big saving in using the Tube well this saving may not be so obvious from the Zambian viewpoint if the imports have to be paid for with scarce foreign exchange.

Parts of the augered system could be manufactured in Zambia. In fact the Kasama Project build and tested a windlass system for a bucket pump which used only the Zimbabwean bucket. The plastic pipes used for liners could be manufactured in Zambia if their was enough demand.

## LIFTING SYSTEM

A reliable lifting system is essential for a successful well.

Handpumps without a proper maintenance system are totally unsuitable for a rural water project.

Handpumps have failed to such an extent in Kasama area that less than 6% of a sample of 220 people when asked would they prefer a handpump said yes.

The reason for such a big anti pump vote is obvious when one looks at the number of abandoned wells due to broken pumps. A sealed well with a broken pump is worse than useless. It is impossible to get the water from such a well no matter how good the quality is. In fact Kasama Project rehabilitated about thirty existing wells by removing broken pumps and installing windlasses.

Initially the Kasama project used a locally manufactured 15 litre bucket made of galvanised iron and manufactured in Zambia. These buckets did not standing up to the operating conditions. Many of the buckets failed after only a short time in service. The handle broke or pulled out with the result that the bucket ended up in the well. Because of the depth of water in the well the villagers were unable to retrieve the bucket. This situation forced the users to use their own containers with a resultant deterioration in water quality in the well.

Various options were tried to solve the bucket problem amongst which was holding a competition amongst the work force for suggestions, making buckets from sheet steel and using locally made light buckets in a frame. The final solution was to use a ten litre galvanized bucket enclosed in a specially constructed steel frame.

The steel cage manufactured by the Project proved a great improvement as can be seen in Table 6

## TABLE 6

**Maintenance 1986-1988**
**by quarter**

| | 3rd | 4th. | 1st. | 2nd. | 3rd. | 4th. | 1st. | 2nd |
|---|---|---|---|---|---|---|---|---|
| Bucket | | | | | | | | |
| Good | 10 | 11 | 7 | 3 | 7 | 2 | 2 | 1 |
| Bad | 31 | 33 | 28 | 17 | 11 | 12 | 4 | 3 |
| Missing | 5 | 11 | 9 | 19 | 22 | 22 | 9 | 11 |
| Num. of wells | | 42 | 43 | 39 | 40 | 35 | 14 | 14 |
| Bucket & cage | | | | | | | | |
| Good | | 15 | 20 | 30 | 37 | 49 | 54 | 72 |
| Bad | | | | 1 | | 1 | 1 | 7 |
| Missing | | | | | | 2 | 4 | 5 |
| Num. of wells | | 15 | 20 | 31 | 37 | 52 | 57 | 77 |
| Augered well | | | | | | | | |
| Good | | | | | 1 | 1 | 4 | 6 |
| Bad | | | | | | | | |
| Missing | | | | | | | | |
| Num. of wells | | | | | 1 | 1 | 4 | 6 |

However as well as being heavy the cage added a lot to the cost and almost all the materials used in the cage had to be imported into Zambia.

With regard to the question of weight an interesting result showed up in a survey of the project. Tables 8 and 9.

## TABLE 7

**THE WEIGHT OF THE WINDLASS SYSTEM**

| WEIGHT | NUMBER | % |
|---|---|---|
| Okay | 93 | 42.3% |
| Heavy | 127 | 57.7% |
| TOTAL | 220 | 100.0% |

TABLE 8

PERCEPTION OF STEEL CAGE RELATIVE TO OLD SYSTEM

| RELATIVE WEIGHT | NUMBER | % |
|---|---|---|
| Steel cage heavier | 220 | 100.0% |
| Steel cage lighter | 0 | 0.0% |
| TOTAL | 220 | 100.0% |

When actually weighed the new system full of water is marginally lighter than the original bucket only system. This is because the bucket was changed from 15 litres to 10 litres.

This points to a perception that the system is heavy.

The Bucket pump is much lighter and could be carried by hand easily to a local centre for maintenance whereas the windlass, bucket and cage require transport when repairs are necessary.

However if the bucket fails or is stolen in a dug well the users can improvise and draw water with there own containers. If the bucket of a bucket pump is damaged or stolen then the augured well is unusable. This problem with the bucket pump could be solved by carrying spares at some local centre like a health centre.

The small capacity of the Bucket Pump will also have an effect on the number of users that one well can supply. However the rate of extraction with a 5l Bucket pump would in reality be greater than half that of the 10l bucket because of the difference in weights.

A tube well is obviously not sufficient to supply water for any form of irrigation. However in Kasama this would not be a problem as practically nobody used a well for irrigation as can be seen in Table 9.

TABLE 9

USES OF WATER FROM THE PROJECT WELL

| USES | NUMBER | % |
|---|---|---|
| Gardening | 5 | 2.3% |
| Washing body | 189 | 85.9% |
| Washing clothes | 185 | 84.1% |
| Drinking | 179 | 81.4% |
| Other | 185 | 84.1% |

A member of the Blair Research Laboratory put the ideal number of people per well at around 50 but they have satisfactorally served twice that number in Zimbabwe.

## RAINFALL

Zambia has one rainy season extending from October/November to April/May. In Kasama the thirty year average is 1277mm per year.

However the amount of rainfall is subject to significant local variation. For example two stations less than ten kilometres apart reported an annual difference of 308mm (24%) in 1986/1987.

The rainfall can be intense with over 150mm recorded in less than twenty four hours on one occasion during 1987/1988.

## POPULATION

Measurement of population in the Project area was very difficult and subject to wide variance. The figures shown are based on the average of three different surveys carried out by three separate groups.

## WATER TABLE

Because of the long dry season considerable variation occurs in the water table. This variation can cause problems for wells finished when the water table is high. In Kasama a small number of wells went dry and had to be deepened using smaller rings.

The augered system is normally capable of deeper penetration of the water table than the had dug well and so should be less prone to going dry. However if an augered well goes dry it cannot be deepened.

## WATER QUALITY

The World Health Organization in it's "GUIDELINES FOR DRINKING-WATER QUALITY" gives Zero faecal Coliforms per one hundred millilitres as the guideline value for bacteriological quality for unpiped water supplies.

WHO reecognises that for sources such as wells there may be problems in attaining these results and states that for dug wells "Only when there is no contact between the person drawing the water and the water in the well, can the system be regarded as having any degree of sanitary protection."

This need to separate the user from the water in the well is the challenge and paradox of small scale rural water projects.

The traditional method for achieving separation is to totally seal the well and use a handpump to draw the water. This has failed to such an extent in Kasama area that as already shown less than 6% of users when asked would they prefer a handpump said yes.

The Blair Research Laboratory in Zimbabwe reecognised the difficulties if not actual impossibility in meeting the WHO Guidelines for the majority of wells and proposed instead the following tentative guidelines for Rural Water Supplies:

| FC or E.Coli/100ml | State of supply |
|---|---|
| 1 - 10 | Satisfactory |
| 11 - 50 | Needs further testing |
| > 50 | Needs investigation & improving |

Blair Research Bulletin No. W60

This guideline would appear to have a lot of merit as it reecognises the actual position rather than the desirable. Rigid application of the WHO guideline of Zero FC/100ml could result in many new sources being rejected and people forced to return to their existing sources which are often grossly contaminated.

In analysing Results from a number of surveys I have adopted the Blair Standard. These results can be seen in Tables 10 and Tables 11 below.

## TABLE 10

## KASAMA RURAL WATER SUPPLY (10/'85-6/'88)

### Analysis Results

| | Faecal Coliforms per 100mls. 0 (%) | 1-10 (%) | 11-50 (%) | >50 (%) | Wells (No.) | Samples (No.) |
|---|---|---|---|---|---|---|
| PROTECTED | 25.3 | 36.3 | 18.8 | 19.7 | 98 | 590 |
| SELECTED * | 32.8 | 53.1 | 10.9 | 3.1 | 2 | 64 |
| AUGERED | 72.1 | 25.6 | 2.3 | 0.0 | 10 | 43 |
| TRADITIONAL | 5.9 | 29.4 | 17.6 | 47.1 | 14 | 17 |

The two selected wells were wells 68 and 83. These selected wells are also part of 98 PROTECTED. All the augered wells in the sample were equipped with a bucket pump. The Protected wells were equipped with a mixture of buckets only and buckets in cages. The two selected wells were equipped with a bucket and cage and were monitored weekly over an extended period. Augered well results are for period 87/88.

## TABLE 11

## BACTERIOLOGY RESULTS

## BLAIR RESEARCH LABORATORY (Epworth 9/1/'84 - 11/3/'85)

| | Faecal Coliforms per 100mls. 0 (%) | 1-10 (%) | 11-50 (%) | >50 (%) | Wells (No.) | Samples (No.) |
|---|---|---|---|---|---|---|
| BLAIR PUMP | 55 | 33 | 9.0 | 3.0 | 7 | 174 |
| BUCKET PUMP | 50 | 35 | 7.5 | 7.5 | 11 | 230 |
| TRADITIONAL | 3 | 10 | 22.0 | 65.0 | 7 | 179 |

The Blair pump is a handpump and both the Blair pump and the Bucket pump were mounted on hand augered tube wells. These results were extracted from Blair Research Bulletin No. W24.

The results for Protected wells would appear to agreed broadly with other studies in Zambia. There is some evidence from Kasama and other Zambian results that there is a higher incidence of samples containing greater than 10 FC/100ml during the warm wet season when compared with the cooler dry season.

It is clear from the two tables that the hand augered tube well using the bucket pump and the protected dug wells with a cage are a vast improvement over the traditional unprotected dug well.

There is also evidence that the bucket pump on the hand augered well is significantly better than the protected dug well. This distinction is not so clear when compared with the two selected wells which had cages and were well mantained, operated and monitored. It is possible that the introduction of the cage to the protected well will have made an improvement as it reduces the contact between the user and the bucket. However no analysis of protected wells with cages versus protected wells with no cages was carried out.

It is also worth noting that, in Table 12, the results from a bucket pump are almost as good as a handpump. This is also confirmed from the two hand augered wells with handpumps in the Kasama Project.

## SUMMARY

### PROTECTED DUG WELL SYSTEM

ADVANTAGES

- Proven technology.
- Makes maximum use of local materials.
- Villagers can make a significant self help contribution.
- Should lifting system fail villagers can improvise.
- Provides significant training and local employment

DISADVANTAGES

- Significant start up costs because of requirements to manufacture rings.
- Is truck dependent.
- Is dependent on the availability of local broken stone
- Is dependent on externally sourced pumps and generators.
- Self help component because of the heavy labour involved is almost carried out exclusively by men.
- Windlass and cage are heavy and difficult to transport other than by vehicle which could mean difficulties in getting system repaired.

### HAND AUGERED WELLS WITH BUCKET PUMPS

ADVANTAGES

- Very fast.
- Very suitable for community involvement including women and children.
- Yields high quality water.
- Is much less transport dependent than a dug well Project.
- Bucket is light and easily transportable.

DISADVANTAGES

- Should lifting device fail then the villagers would be totally without water and forced to return to traditional sources.
- At the time of this comparison would require a high level of imports into Zambia.
- Low yield

## CONCLUSION

Unlike in 1982/1983 if an externally aided project was being set up in Kasama Zambia at the end of 1988 there would be a lot in favour of going exclusively for a Hand Augered Project. This is based on the assumption of providing two wells per village to offset problems of lifting device failure. The cost savings and speed would allow the provision of two wells. The Project would also have to set up a spare part distribution system through the Local Health Centres. Villagers would have to buy spares but this would also be the case for a dug well project. Zambia and Zimbabwe are both members of SADCC which allows a certain degree of freedom of trade. The Project would have to set up a repair system and move to replace as much as possible of the imported parts by locally manufactured parts.

However in underdeveloped countries things can change very rapidly and what may be the most economic solution today may be totally uneconomic tomorrow.

At the end of the day it is hard to get away from the fact that at least with the dug well the people will always have some means of getting the water out whatever the quality.

## pH

As can be seen from the Table 3 the water in Kasama is generally acidic. This is because of the nature of the ground and soil.

## CONDUCTIVITY/TURBIDITY/IRON/SUSPENDED SOLIDS

The average for these figures is the simple average which means that it is significantly influenced by a small number of relatively high readings.

## USAGE PATTERN

No detailed study was carried out on the number of people drawing or the times when people were drawing.

The figures shown in Table 3 are derived from the results of two questions filled in during a monthly depth and condition survey of all completed wells.

These questions were;

Was the well being used when you arrived? and

Is there evidence that the well has been used recently?.

Table 12 which is drawn from the same report as tables 1 and 2 gives some indication of the number of times water is drawn. However as 220 is the total sample it is possible that some of the people who do not draw water have other members of their family drawing for them.
It is normally the women and children who draw water.

### TABLE 12

NUMBER OF TIMES PER DAY WATER IS DRAWN FROM PROJECT WELL

| TIMES | NUMBER | % |
|---|---|---|
| 0 | 27 | 12.3% |
| 1 | 19 | 8.6% |
| 2 | 39 | 17.7% |
| 3+ (3 or 4) | 135 | 61.4% |
| TOTAL | 220 | 100.0% |

(1) Tables 1, 2, 4, 5, 7, 8 and 9 were abstracted from an unpublished survey of Kasama Rural Water Supply Project undertaken at the request of Irish Department of Foreign Affairs. The survey was carried out by Dr. Mwape of the University of Zambia.

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