Community gardens using limited groundwater resources

Development of crystalline basement aquifers in semi-arid areas

Lack of water is the main constraint on agricultural production in south-east Zimbabwe

This booklet provides a brief overview of an ODA-funded programme in south-east Zimbabwe which has the wider objective of reducing environmental degradation and improving agricultural sustainability in semi-arid areas. The programme comprises several research and technical cooperation projects carried out by the Institute of Hydrology, the British Geological Survey and several different departments of the Zimbabwean Ministry of Lands, Agriculture and Water Development.

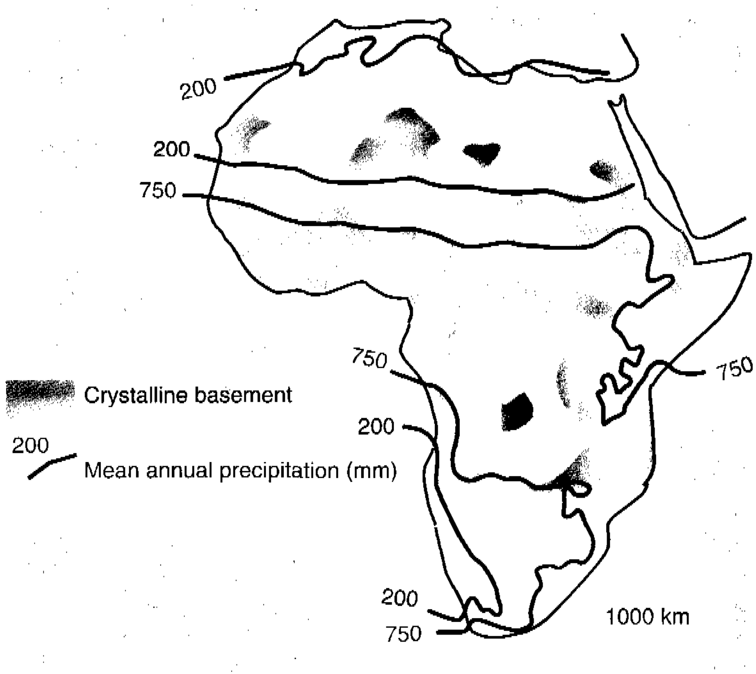
Gardening is a key agricultural activity traditionally practised by women in much of Africa. In semi-arid areas vegetables are grown both for sale and for home consumption if sufficient water is available.

Background

Many conventions and initiatives that resulted from the UN Conference on the Environment and Development in Rio de Janeiro in 1992 recognised that the links between poverty, high population growth and environmental degradation are circular and mutually reinforcing. Consequently, targeting projects to benefit poor rural communities, and women in particular, has become an accepted strategy for reducing poverty, protecting the environment and promoting sustainable development.

The programme of research and technology transfer described here is evaluating innovative ways of providing rural communities in semi-arid areas with more reliable and safer water supplies. These improved water supplies can be used for domestic purposes and for garden-scale production of vegetables for home consumption and sale. The programme, which is being carried out with the participation of local institutions and communities, is also evaluating the feasibility of using community or allotment-type gardens as an initial step towards improved environmental management at the village and catchment levels.

The rationale behind the programme is that access to more reliable water supplies for domestic and garden use can lead to improvements in health, household incomes and a reduction in poverty. As part of a strategy of integrated resource management, gardening may also reduce the need of rural communities to rely on unsustainable agricultural practices such as the cultivation of marginal areas. Furthermore, organisational experience and the confidence gained from implementing and managing community gardens can be used effectively in other community-based activities aimed at reducing environmental degradation and promoting sustainable development.



Location and extent of crystalline basement geologies in Africa

Basement aquifers

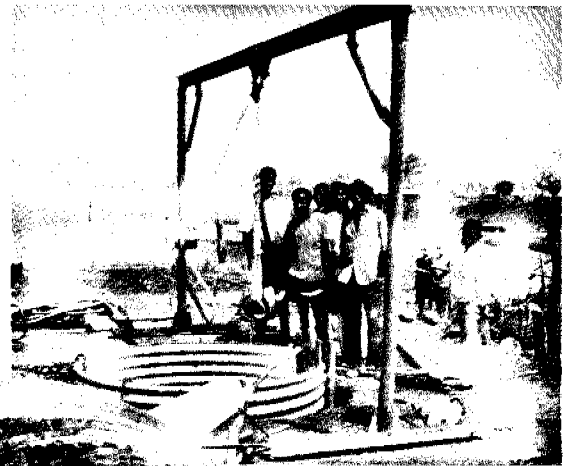
Widespread implementation of garden irrigation in semi-arid areas is constrained by the availability of water resources. The weathered surface zone of hardrock (or basement) areas, which are present over much of Africa, provide a limited but very extensive water resource which has the potential for greater use.

Development of these crystalline basement aquifers is normally carried out either by digging traditional wells in the weathered overburden or regolith, or by drilling deeper boreholes into the fractured rock beneath.

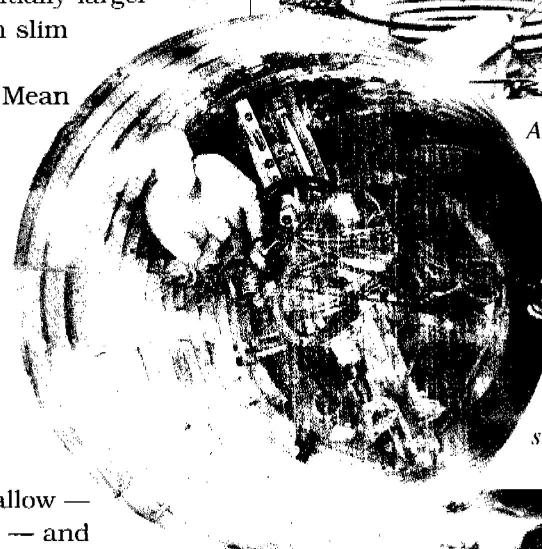
Collector wells

A collector well is a shallow hand-dug well of large diameter with horizontal boreholes drilled radially from the base to a distance of approximately 30 m, typically in four directions. Research during the last twelve years has shown that collector wells can be used to maximise and optimise groundwater abstraction from basement aquifers. This work has demonstrated the feasibility of obtaining substantially larger yields from collector wells than slim boreholes and with the added advantage of low drawdowns. Mean safe yields from eight collector wells in Zimbabwe and 20 in Sri Lanka have been calculated at 2.7 ls-1 with draw downs of 2-3m. These can be compared with typical yields in the range 0.1 - 0.7 ls^{1} for slim boreholes with drawdowns in excess of 30m.

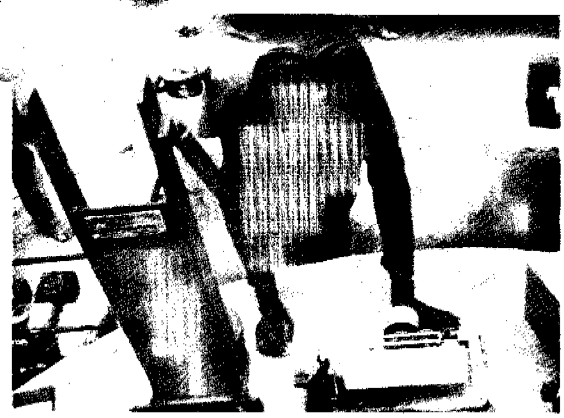
As collector wells are shallow — typically 5-15m depth to water — and have a low drawdown, handpumping water from the wells is less arduous than is the case for boreholes. The wide diameter vertical shaft of collector wells also provides increased volume of storage and allows two or more handpumps to be installed. This ensures that the required pumping capacity can be met and reduces the risks of water shortages when a pump breaks down and repairs are being carried out.



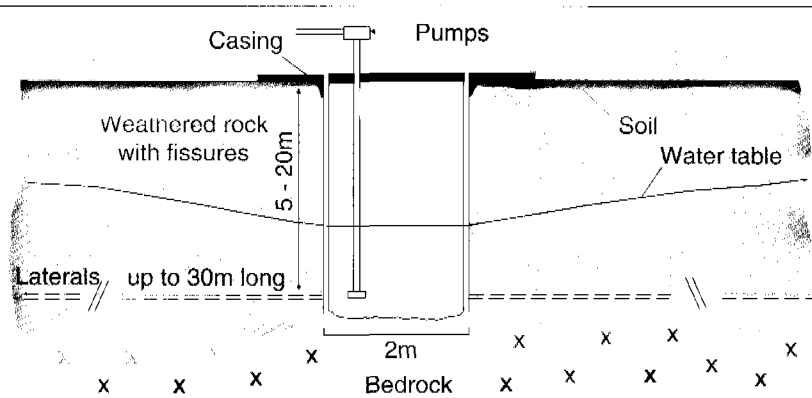
A vertical shaft for a collector well being dug by members of the local community under the guidance and supervision of a project foreman



Horizontal drilling rig being lowered down a well shaft



Using a chart recorder to monitor depth to water in a project collect well



Schematic diagram of a collector well

"the garden puts life into people and promotes self-reliance during drought"
– *Siphelani Dhobani*

Programme objectives

1 To assess the feasibility of using shallow aquifers as a source of water for irrigated gardens of up to one hectare in area. In particular, the project is assessing the potential of using collector wells to abstract sufficient water from shallow basement aquifers for both domestic and stock water requirements and yet still provide enough water to meet the requirements of an irrigated garden.

2 To compare and develop methods of low-cost, high-efficiency irrigation which are suitable for use on irrigated gardens. Limited water supplies and availability of labour are the principal constraints on the size of irrigated gardens in most semi-arid areas. There is merit, therefore, in adopting irrigation practices that increase irrigation efficiency and lead to a combination of reduced labour requirements, expansion in garden size, increased yields and/or improved crop quality.

3 To study the effects of land management on groundwater recharge and to improve the criteria used for siting wells and for selecting the most appropriate well design for a given location. The environmental consequences of increased exploitation of groundwater in semi-arid areas are also being assessed.

4 To assess the physical, socio-economic and institutional feasibility of using integrated catchment resource management (ICRM) to halt and, possibly, reverse land degradation in semi-arid areas. The long-term aim is to demonstrate that agricultural sustainability can be achieved by adoption of community gardening as part of a package of improved resource management practices which include improved livestock and forestry management.

Ploughing in one of the instrumented subcatchments of the Romwe catchment

Romwe Collector Well Garden during the 1991/92 drought

Project staffing

Extensive collaboration between agriculturalists, hydrologists, hydrogeologists, economists and social scientists has been a key component of the programme. With the exception of the irrigation trials, the work has been carried out away from the research station at locations representing a number of different physical, institutional and social settings. The emphasis has also been on working with and encouraging the participation of local people in evaluating research recommendations at the village level. It was recognised from the outset that the many human, institutional and economic factors that influence adoption of research recommendations would be as important as the viability of the recommendations themselves.

Programme chronology

In 1989 a collector well and associated irrigated garden were installed at the Chiredzi Research Station. These were used for demonstration purposes and also as the location for a series of replicated irrigation trials. Recommendations from these trials have been disseminated actively by Agritex extension workers and by field staff of the Intermediate Technology Development Group.

In 1990, the first off-station collector well garden was constructed in the Romwe Catchment with the participation of members of Tamwa, Sihambe and Dhobani Kraals. Since construction, around 98 families have used the well as a primary source of drinking water and 46 families have grown vegetables on allotments on the 0.5ha garden. After initial social and institutional "teething" problems this garden has flourished, most notably through the 1991/92 drought when all irrigation schemes using dam water failed and when the garden was the only source of vegetables in the area.

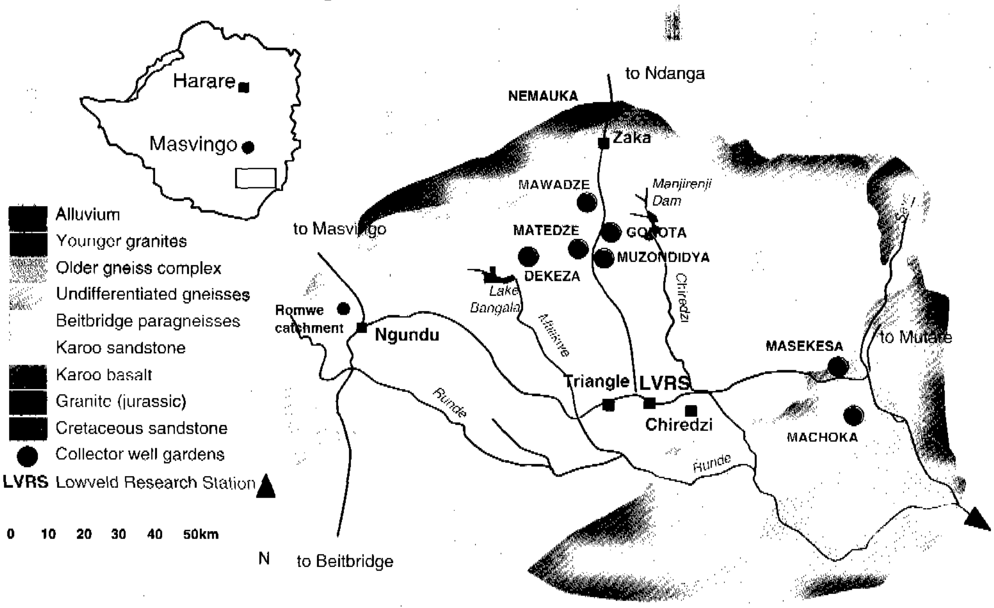
The success of this first off-station scheme led to an ODA-funded Pilot Project that constructed a further six collector well gardens that are providing domestic water for around 1319 families and allotments for 577 families. Valuable lessons were learnt during the siting and implementation of earlier schemes which led to significant improvements in community involvement and sense of ownership on later schemes.

In 1992 work started in the Romwe Catchment on a project studying the processes and mechanisms that control groundwater recharge. In 1994, additional monitoring equipment was installed to monitor the effects of land use and management on groundwater recharge. At the time of writing this pamphlet, efforts are being made to secure funding so that this project can become a long term assessment of the physical and socio-economic benefits of taking an integrated approach to community management of resources in semi arid areas.

In 1994, two community gardens were funded by and constructed in collaboration with Plan International in south-east Zimbabwe in an area underlain by basalt geology. Several NGOs in Zimbabwe have now indicated a willingness to fund further community gardens in their programme areas. Preparations are also well advanced for a second phase of the ongoing ODA-funded programme. There is considerable interest in the programme by NGOs and research groups working in other parts of the SADC region.

Romwe catchment's main flume and sediment sampling station

"The project is sustainable because the local community and researchers have worked together as a team"
– Mai Stoko Ziwawa.



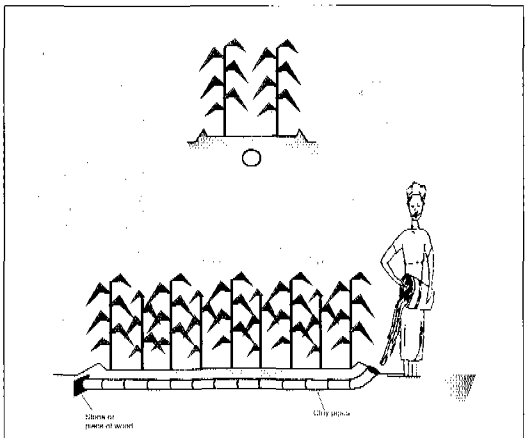
Geology of area round Chiredzi and location of collector well gardens

Low-cost, high-efficiency irrigation

Experimental Design

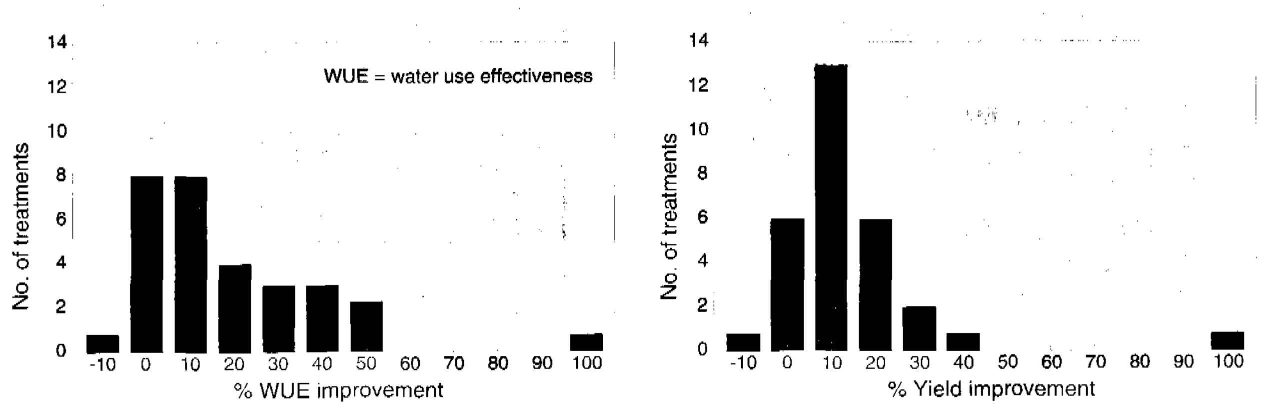
A series of replicated trials were carried out on the collector well garden at the Lowveld Research Station during the period 1989 to 1994. The trials were designed to compare and quantify the benefits of several simple low-cost irrigation methods that included: pitcher irrigation, improved flood irrigation, low-head drip irrigation, subsurface irrigation using slotted PVC or bamboo pipes and subsurface irrigation using clay pipes. The monitoring equipment used included: tensiometers, neutron probes and small and large lysimeters. Crops grown in the trials included maize, beans, tomato, okra, covo, cabbage and rape.

The principal findings from the trials were:



Subsurface irrigation using clay pipes

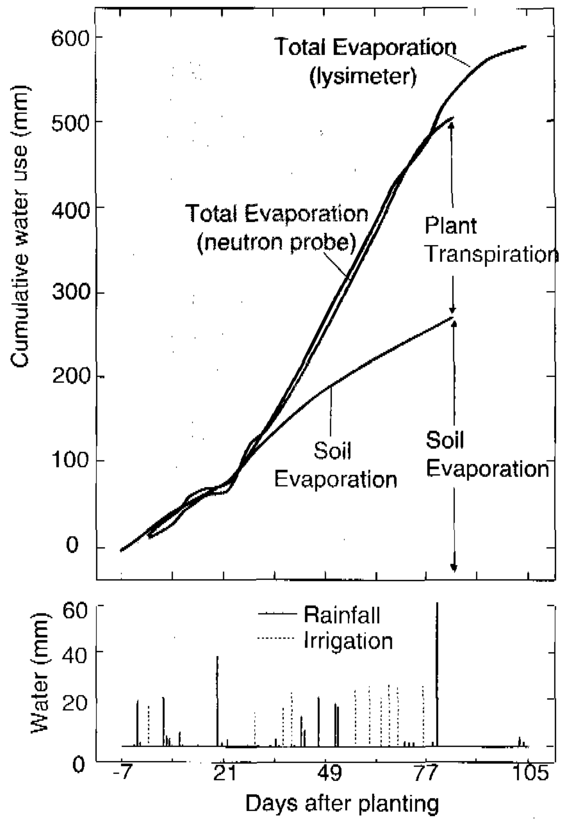
- There is enormous scope for improving water use effectiveness on irrigated gardens. For example, measurements during a flood-irrigated maize crop showed that 54% of irrigation water and rainfall was lost as soil evaporation;
- Subsurface irrigation using clay pipes had advantages over the other improved irrigation methods in terms of irrigation efficiency, ease of use and cost;
- Compared with traditional flood irrigation, subsurface irrigation led to improvements in yield, water use effectiveness and crop quality. However, these advantages are most apparent when irrigation regimes are matched to crop water requirements;
- It was shown that there is a low risk in adopting subsurface irrigation in that this method does not require particular management skills nor does it increase pest and disease problems;
- Large yield advantages were recorded in favour of subsurface irrigation as compared with traditional flood irrigation under summer drought conditions when evaporative demands were very high;
- Subsurface irrigation gave good results with relatively saline groundwater. This can be explained by soil water movement and distribution being similar under subsurface pipe irrigation to that achieved under subsurface drip irrigation;



Comparison of analogous subsurface and flood irrigated treatments (1989-1994)

- Clay pipes for subsurface irrigation can be made with a simple mould by villagers with skills in pot or brick making;
- Subsurface irrigation should be adopted by gardeners as part of a package of measures to improve water use efficiency and reduce risk of crop failure. Other measures should include landforming to improve effective use of rainfall and improved irrigation scheduling, varietal selection, crop husbandry and pest management.

Aerial view of experimental collector well garden at Chiredzi Research Station



Cumulative water use of a flood-irrigated maize crop

Developing community gardens using groundwater

Experience gained to date in Zimbabwe has led to guidelines being drawn up that distinguish key steps in identifying groundwater resources and ensuring active participation of all stakeholders. The critical considerations during the development phase include:

- Close liaison with district councils is vital in identifying ongoing and proposed water development projects and thereby avoiding duplication or conflicts of interest.
- Although there can be no substitute for genuine community interest, undertaking schemes on a ward-by-ward basis improves logistics and enables communities to learn from each other more effectively.
- The importance of community meetings cannot be overstated. No work should be done in an area until local leaders have been consulted. Meetings provide opportunities for detailed discussion, for clarifying misconceptions, confirming community commitment and agreeing community action.

Discussions taking place at a typical community meeting

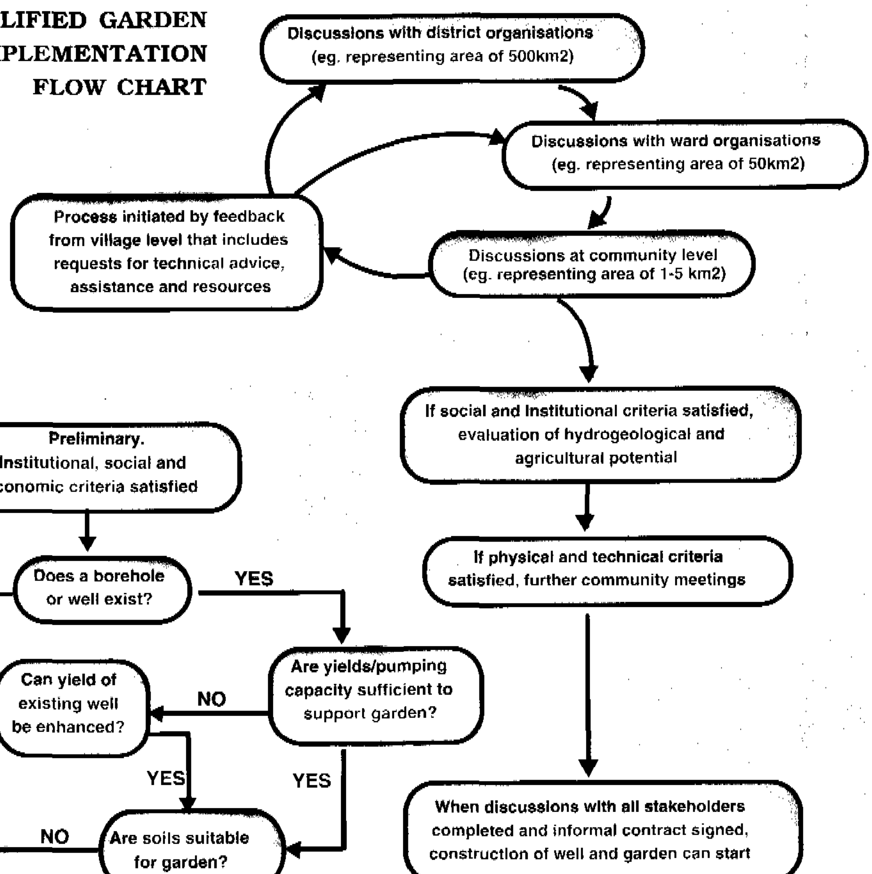
- When possible, hydrogeological evaluations of potential sites should be carried out during dry seasons when groundwater levels are likely to be at their lowest, using a range of techniques including local knowledge.

- In most semi-arid areas it is rare that a community will not have a need for or express an interest in a community garden particularly as this will also offer a source of clean drinking water. Thus at the first community meeting it is important not to raise hopes too high. It should be explained from the outset that the scheme will only be possible if all the physical, technical and economic criteria are satisfied.

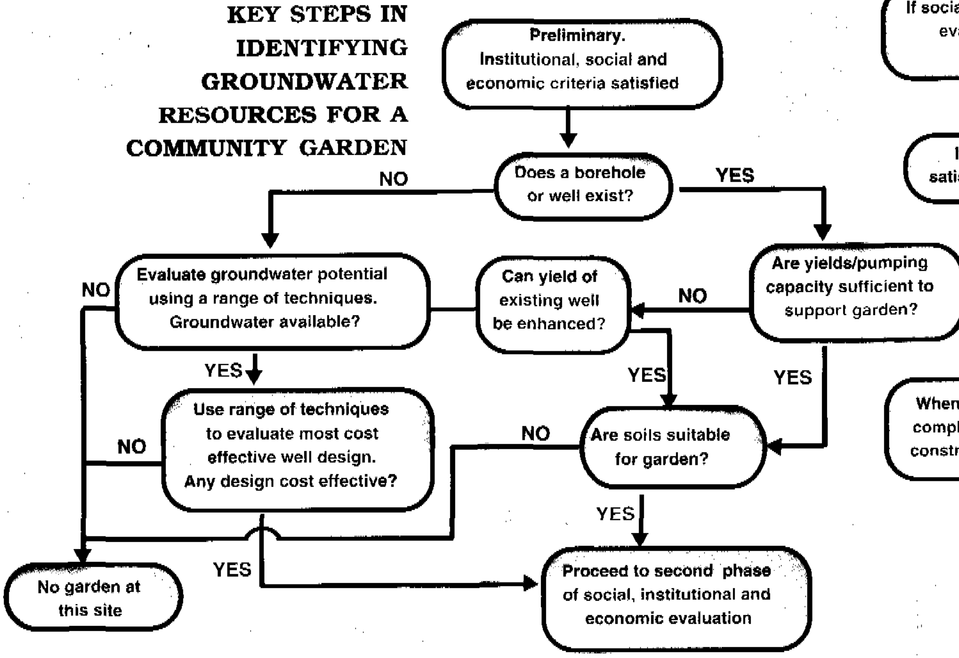
- The consideration, signing and distribution of copies of an informal contract (translated into the local language) before scheme construction is a potent means of ensuring that communities know their obligations. This is also an important stage in promoting participation and creating a sense of community ownership of the scheme.

"The project scheme is now the centre of the community"
– Mr Patrick Manhiwe.

SIMPLIFIED GARDEN IMPLEMENTATION FLOW CHART



KEY STEPS IN IDENTIFYING GROUNDWATER RESOURCES FOR A COMMUNITY GARDEN



Constructing wells and gardens

Once an informal contract has been agreed and signed there are a number of important points that should be recognised during the construction phase. These include:

- Experience has shown that monetary payment for work done should be avoided whether this be payment by project staff or by other community members. In the former case, payment promotes neither sense of ownership nor good progress. In the latter case payment causes difficulties because the problems poor communities have in finding cash. Automatic membership of the project for those who do work is to be preferred, others paying a cash joining fee at a later date.

- In terms of community participation and sense of ownership, collector wells have an advantage over other well designs in that the communities are directly involved in digging the wells.

- Both women and men from the community should be given training in pump maintenance and repair. A set of tools should be supplied with pumps and be kept by a reliable scheme member.

- Official openings of schemes are enjoyed by all as well as providing another important opportunity for the community ownership of schemes to be confirmed by all the outside agencies that might have assisted during scheme development and construction.

Garden Management

Regardless of the level of community participation during scheme development and construction, it seems that most gardens experience a number of institutional and social problems during the first cropping seasons. However, production figures from the programme gardens show that once these are overcome garden output stabilises at an acceptably high level. Some points worth noting are:

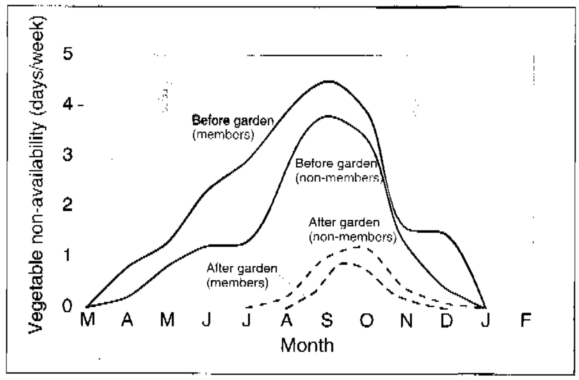
- Trained facilitators can help enormously in resolving difficulties if a scheme is experiencing social and institutional "teething" problems.

- Garden committees experience a rapid change of personnel during the first cropping seasons.

- Members of new gardens benefit enormously from visiting long established gardens and discussing garden management and crop husbandry with more experienced gardeners.

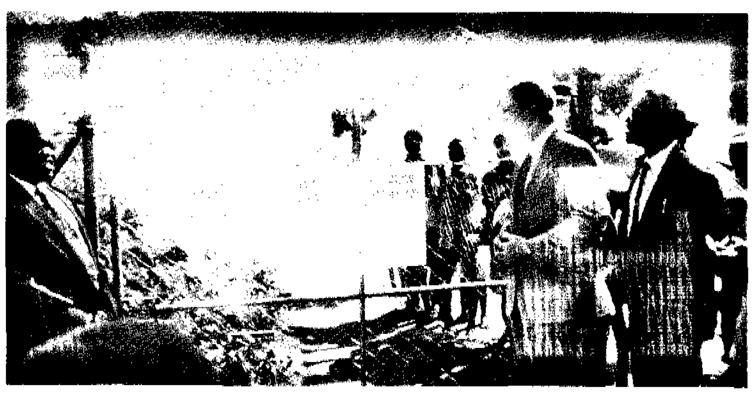
- Good extension advice is vital for inexperienced gardeners as is the availability of seeds, fertilisers, sprays and sprayers.

- It takes time for new gardeners to become aware of the market requirements and value of different vegetables.



Average non-availability of vegetables before and after implementation of ODA-funded collector well gardens

"The collector well is life for us and our children"
– Mai Never Mhlanga



Official opening of the Mawadze Collector Well Garden

Socio-economic research findings

The socio-economic aspects of the schemes funded by ODA have received considerable attention. Baseline surveys and routine monitoring show that:

- The schemes are economically viable, with an average IRR of 19% and total gross margins per ha per year averaging at Z$ 25 000 per scheme.
- Price increases for plots within the garden indicate the degree of welfare improvement the scheme is bringing its members. Many people, originally disinterested in the scheme now wish to join, to the extent that at one site there is a willingness to forfeit 16% of a year's income from rainfed crops as a joining fee.
- The schemes provide extensive marketing opportunities for the sale of dry season vegetables to surrounding communities and townships. Schemes also offer opportunity for wealth creation and income diversification.
- The wells and gardens play an important role in improving the welfare of women and children in the community, by making more efficient use of time and labour given to horticultural practices, improving nutrition in the household and providing an important source of disposable income for household items, education fees, etc.

Routine monitoring and feedback from local institutions have also indicated that specific environmental benefits of the schemes include:

- A reduction in pressure on the cultivation of marginal lands, particularly stream banks.
- Decreased soil erosion due to a reduction in the cutting of nearby trees and bushes, used to build and repair garden fences.
- The promotion of "long term" land management strategies, due to the decreased risk and improved security of tenure the scheme supplies.
- Experience and confidence gained implementing and managing the community garden can help the implementation of further community-focused projects that promote sustainable environmental management practices.

Financial costs of the collector wells compared to boreholes

A framework for analysing the capital cost of collector wells compared to boreholes has been developed. It calculates the equipment, staff and material costs for a hypothetical programme to develop 25 collector well schemes per year for ten years (discount rate of 13%).

Using this framework, the total financial cost per collector well, that is installed by a multidisciplinary team following the approach outlined is Z$80,584. This approach ensures a success rate of 100% (for collector wells yielding greater than 0.6 l s^{-1} and the costs compare favourably with the alternative of installing boreholes. For example, if two boreholes yielding 0.3 l s^{-1} each were drilled to allow two handpumps to be fitted, the real cost of each (considering a national drilling success rate figure of 51%) would be Z$60,784. If a single borehole yielding 0.6 l s^{-1} were drilled (at a national drilling success rate of 35%) and were fitted with a motorised pump, the real cost would be Z$108,000. These figures translate to average costs per m^3 of water of Z$3.36 for a collector well, Z$3.61 for a motorised-pump borehole and Z$4.06 for two handpump boreholes.

Community members keeping a record of garden production and water use

"During the 1991-92 drought we relied on the water and the garden to survive"
– Mr Tamwa, Headman of Tamwa village.

Conclusions

Although there is still much work to do, the programme of work in Zimbabwe is an excellent example of the transfer of technical research findings from the research station to the real world. It has demonstrated, yet again, that technical solutions alone rarely solve practical problems. Attention must be given to the needs and aspirations of the end users and to the institutional, socio-economic and environmental adjustments necessary for any innovation to be successful.

The programme described here shows that there are technologies that can be developed and used to substantially reduce poverty and improve the quality of life for poor rural communities living in semi-arid areas. There are large areas of the drier regions of Africa that are underlain by basement rocks that could benefit from the approaches that are being adopted in south-east Zimbabwe.

Perhaps most exciting of all, a first water development project such as a collector well garden has the added benefit that it provides an ideal initial step to other community-based activities that are aimed at improving resource management, reducing environmental degradation and promoting sustainable development.

Members of a collector well garden taking their excess produce to a local market.

Further Information

[illegible] reports are available on [illegible] the following [illegible]

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