22nd WEDC Conference New Delhi, India, 1996
REACHING THE UNREACHED: CHALLENGES FOR THE 21ST CENTURY

Development of collector well gardens

Charles Batchelor, Chris Lovell, John Chilton, UK and Isiah Mharapara, Zimbabwe

COMMUNAL AREAS OF southern Zimbabwe illustrate the problems now facing people and the environment in many semi-arid parts of Africa. Prime constraints on sustainable development are the low and erratic rainfall and the limited availability of ground and surface water resources. Rainfed crop production provides the main source of staple foodstuffs. However, increasing population densities, all too frequent droughts and declining productivity of existing croplands have led to cultivation of more marginal terrain which is better suited to other, less intensive forms of land use. In areas where sufficient water resources are available, large irrigation schemes have been constructed. However, such schemes have been beset by a wide range of technical, institutional and social problems. It has also been difficult to reconcile such schemes with traditional farming practices. In contrast, experience in the region has shown that informal or garden irrigation can be economically viable and appropriate to households, especially for women farmers, for whom it is already a traditional component of the farming system.

In 1988, a programme of research was started in southern Zimbabwe, the main objectives of which were to study the feasibility of using shallow crystalline basement aquifers as a source of water for small-scale irrigation and to compare and develop methods of low-cost, high efficiency irrigation which would be suitable for use on small irrigated gardens. This paper gives a brief description of some elements of this programme. More information can be found in Lovell *et al* (1996) and Murata *et al* (1995).

Crystalline basement aquifers

Crystalline basement aquifers, which are present over much of Africa (Figure 1), provide a limited but extensive resource which has the potential for greater use (Wright, 1992). Lovell *et al* (1996) estimated, on a regional long-term basis, that groundwater use in communal areas of south-east Zimbabwe is only around 4 per cent of average annual recharge. Although extremely variable in space and time, recharge is estimated to be in the range 2-5 per cent of annual rainfall (Houston, 1988).

In general, water in basement aquifers occurs within the weathered residual overburden (or regolith) and the fractured bedrock. In Zimbabwe, current development is generally by digging wells within the regolith or drilling boreholes to intercept fractures in the bedrock. Research during the last twelve years has demonstrated that collector wells can be used to increase groundwater abstraction from the regolith (Wright, 1992). Figure 2 is a schematic diagram of a collector well.

Results of research studies in Zimbabwe, Malawi and Sri Lanka have shown that collector wells can be used to maximise and optimise groundwater abstraction from basement aquifers that are not suited to slim boreholes. This work demonstrated that, in these areas, higher average yields can be obtained from collector wells than from slim boreholes with the added advantage of small drawdowns. Mean safe yield from 8 collector wells in Zimbabwe and Malawi and 20 in Sri Lanka has been calculated at 2.7 L s-1 (ranges of 1.1 - 6.6 and 0.5 - 8.0 L s-1 respectively) with drawdowns of 2-3 m. These results can be compared with typical yields in the range 0.1 - 0.7

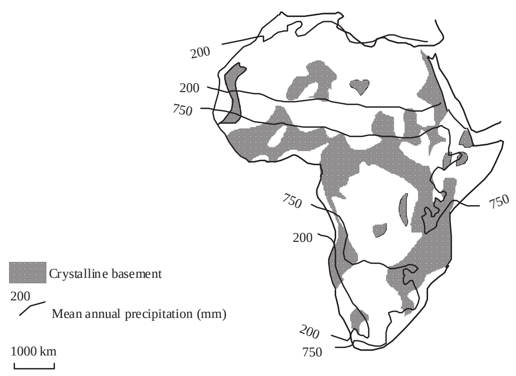

Figure 1. Distribution of basement aquifers in Africa

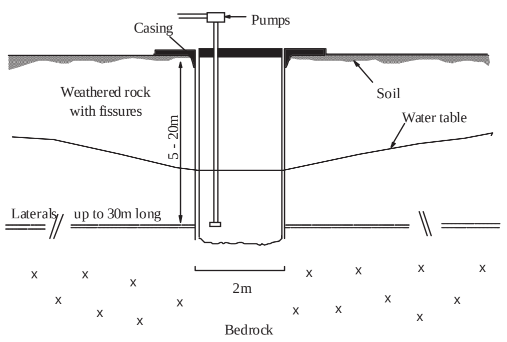

Figure 2. Schematic diagram of a collector well

L s-1 for slim boreholes at pumping drawdowns in excess of 30 m (Wright, 1992).

Implementation of collector garden well project

In 1989, a first collector well and associated irrigated garden were installed at the Chiredzi Research Station, Zimbabwe. The well and garden, which had an area of 1 ha, were used for demonstration purposes and also for a series of replicated irrigation trials. One important finding from these trials was that, when compared to traditional flood irrigation, subsurface irrigation using buried clay pipes can be a simple and effective means of improving crop yields, water use efficiency and crop quality on small vegetable gardens (Murata *et al*, 1995). For a range of vegetable crops, average yield and water use effectiveness increases were of the order of 15 per cent and 20 per cent respectively.

The good performance of the collector well garden at the research station led to construction of the first off-station collector well garden in 1990. This scheme was implemented in the Romwe Catchment with the participation of members of the Tamwa, Sihambe and Dhobani Kraals. Around 98 households have been using the well as a primary source of drinking water and 46 households have been growing vegetables on 100 m2 allotments on the garden. The success of this garden, particularly during the 1991/92 drought, prompted the implementation of a further eight schemes during the period 1992-95. These schemes were implemented as part of a pilot project that studied the technical, socio-economic and institutional aspects of locating, implementing and managing gardens and water points. Many valuable lessons were learnt with regard to well design and siting and with regard to ensuring the participation of the communities and local institutions (Lovell *et al*, 1996). These lessons were used as a basis for developing a series of decision trees that are to be used as guidelines in the execution of a project that will implement a further 100 gardens and water points in southern Zimbabwe during the next five years. One innovative approach that was used to minimise confusion over scheme ownership and community participation was the use of an informal contract. This contract was drawn up and discussed by communities and project staff prior to the commencement of groundwater exploration. The main benefit of the contracts has been that they clarify at the outset responsibilities for scheme implementation, operation and maintenance.

Performance of collector well gardens

Data collected by scheme members and surveys before and after the schemes were implemented gave an indication of the wide range of economic benefits for both scheme members and non-members (Waughray *et al*, 1996). The key benefits were improved availability of vegetables, access to a reliable and clean source of drinking water and a means of generating income. Internal rates of return for gardens range from 11-15 per cent, with an overall average gross margin for 1994/95 of Z$67,433 ha-1, Z$310 per member and Z$10.8 per labour day1. Of those who took up allotments on the garden, 80 per cent were women and 49 per cent on average were among the very poorest in the communities. The schemes supply fresh vegetables that are consumed as a relish by both garden members and non-members. Whilst some gardening continues during the rainy season when rainfed cropping is taking place, garden production is highest and returns greatest during dry seasons and during periods of droughts. Figure 3 shows the non-availability of vegetables before and after the implementation of gardens. This figure shows that scarcity of vegetables during normal dry seasons is much reduced for both members and non-members.

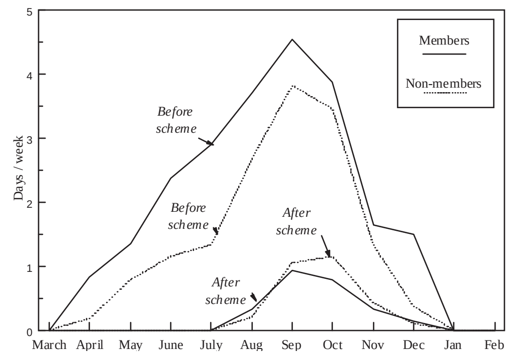

Figure 3. Before and after vegetable non-consumption

The schemes possess considerable potential for income generation and income diversification for garden members. The average income per member obtained by selling excess produce during 1994/95 was Z$225, in an area where 50 per cent of households have an income of less than Z$400 per year (Corbett, 1994). Women are controlling the saving and investment of cash generated. At least 50 per cent of all garden members were found to be involved in savings clubs and revolving funds. Only one fund was said to have existed before the collector well gardens existed and this has expanded. Savings from these funds are being spent on education, household necessities or on initiating other income generating activities.

To date, routine monitoring of schemes has led to the identification of a number of environmental benefits. These include: a reduction on pressure to cultivate marginal lands, particularly stream banks; decreased soil erosion due to a reduction in the cutting of brushwood for the fencing of small private gardens; and the promotion of long term land management strategies due to the decreased risk and improved security of tenure the scheme provides.

An important component of the programme is an evaluation of the factors that influence groundwater recharge and hence the long-term sustainability of the water points and gardens. In 1992, work started in the Romwe catchment on a project that is studying the processes and mechanisms that control groundwater recharge. Subsequently, this study has 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.

Conclusions

Although there is still much work to do, the programme 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 has shown that there are innovative technologies that can be developed and used to substantially reduce poverty and improve the quality of life of poor rural communities living in semi-arid areas. There are large areas of Africa that are underlain by crystalline basement rocks that could benefit from the approaches that are being adopted in Zimbabwe.

Perhaps the most exciting of all, a first water development project, implemented with the interactive participation of the community and local institutions, 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.

Acknowledgements

Funding for this research was provided primarily by the British Overseas Development Administration.

References

Corbett, J. 1994. Livelihoods, food security and nutrition in a drought prone part of Zimbabwe. Final report to UK ODA, ESCOR - Centre for the Study of African Economics, Oxford, and CSERGE, University College, London.

Lovell,C.J., Batchelor,C.H., Waughray,D.K., Semple,A.J., Mazhangara,E., Mtetwa,G., Murata,M., Brown,M.W., Dube,T., Thompson,D.T., Chilton,P.J., Macdonald, D.M.J., Conyers,D. and Mugweni,O. 1996. Small scale irrigation using collector wells pilot project - Zimbabwe: Final Report. IH Report ODA 95/14, Institute of Hydrology, Wallingford, Oxon, UK, pp 106.

Houston, J.F.T. 1988. Rainfall-runoff-recharge relationships in the basement rocks of Zimbabwe. In Simmers,I. (Ed.): Estimation of Natural Groundwater Recharge. D. Reidel Publishing Company, The Netherlands, 349-365.

Murata,M., Batchelor,C.H., Lovell,C.J., Brown,M.W., Semple,A.J., Mazhangara,E., Haria,A., McGrath,S.P. and Williams,R.J. 1995. Development of small-scale irrigation using limited groundwater resources: Fourth Interim Report. IH Report ODA 95/5, Institute of Hydrology, Wallingford, UK.

Waughray, D.K., Mazhangara, E. and Lovell, C.J. 1996. Generating economic benefits in dryland areas: Exploiting basement aquifers for small-scale irrigation schemes. Submitted to World Development.

Wright, E.P. 1992. The hydrogeology of crystalline basement aquifers in Africa. In Wright,E.P. and Burgess,W.G. (Eds.): The Hydrogeology of Crystalline Basement Aquifers in Africa. Geol. Soc., London, No. 66, 1-28.

[1] In February 1995, Z$ 13 = £1 (where Z$ = Zimbabwe dollars, and £ = pounds sterling)