SMALL SCALE IRRIGATION USING COLLECTOR WELLS PILOT PROJECT - ZIMBABWE

FIFTH PROGRESS REPORT
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Summary

The ODA TC pilot project "Small scale irrigation using collector wells - Zimbabwe" began in October 1992. This report outlines progress made on all aspects during the fifth six months of work.

The six project schemes are installed and five have completed their first winter cropping season. Two additional schemes for Plan International (an NGO working in south-east Zimbabwe) are also complete. Together with the first collector well garden implemented in 1991, the total number of families now taking domestic water from the nine wells is 1515, and the total number of families with allotments on the associated community gardens is 731.

As planned, the schemes represent a range of physical, social, economic and institutional settings. Monitoring of garden performance is proceeding well. The first scheme continues to give high returns, recording a gross margin of Z$18903 per hectare in it's fourth winter season, and an average gross margin of Z$22932 per hectare per year during four years of operation. First results at the five pilot project schemes are similarly high, ranging from Z$2221 up to Z$47459 per hectare and averaging Z$23798. The average return per member at these schemes is Z$338 and per labour day Z$4.04. These figures are far higher than returns given by other land use options in this area, and are an indication of the excellent revenues possible from small, intensively cultivated areas when reliable water sources can be made available. They may increase further as social teething problems are overcome and members gain in experience and experiment with different growing and marketing strategies.

Valuable lessons have been learnt by project staff during this pilot phase, and further progress made to distil experiences and draft guidelines to assist future development. An expanded decision tree is included to show key steps required during both site identification and scheme implementation in order to achieve successful collaboration with communities and help ensure schemes more likely to be sustainable from a social point of view.

The guidelines include a decision tree that can be used to determine the most cost-effective well design for any area. Good progress has been made to compare alternative well types at each site, namely collector well, large diameter well, borehole and traditional well. Modelling of pump test results to project safe yields for one year indicate that: a) at no site did a traditional well satisfy the required target of 15m^3 of water per day; b) at each site the collector well satisfied or exceeded this target and at four sites could support a garden larger than 0.5ha if required; c) at two of the nine sites only a collector well would suffice; d) at two of the nine sites a large diameter well without radials would suffice; e) at five of the nine sites a shallow borehole at a site of exploratory drilling would have sufficed if screened in the regolith.

The results highlight the role to be played by each well type in any future development. Yields of large diameter wells, collector wells and shallow boreholes screened in the regolith, although lower than deep borehole yields at some sites, are shown to be far more consistent in value and quite adequate for small scale vegetable production. Final choice at any site will also depend on geology, size of garden and pumping capacity required, and should consider community maintenance and sense of ownership.

At two of the nine sites, existing deep boreholes were found to be under utilised at present.

This is because the steel casing will accept only one Zimbabwe bushpump. Boreholes such as these could be developed for future programmes simply by increasing pumping capacity using an alternative design of pump, but community maintenance of the pump and the long-term yield of such boreholes as opposed to other well types particularly during drought will remain important issues to consider. The economic viability of purposely siting high yielding deep boreholes to support community gardens is shown to depend very much on the success rate of drilling. The use of shallow exploratory drilling in the regolith to site deep boreholes appears to improve success rate and further study of this aspect is recommended.

Much interest continues to be expressed by communities and organisations in the region now wishing to develop community gardens using groundwater. After the second annual project review in November 1994, a steering committee of senior Government staff and project staff was formed to develop a framework for the next phase of work in Zimbabwe. The aim of this phase will principally be to develop capacity in Government to implement this type of development, and to provide an interim or transitional period to allow monitoring of all aspects of scheme performance and sustainability prior to full-scale replication. Details are included of progress towards a transitional project proposal. Much interest is also being shown in the potential of using groundwater-based community gardens as a first step in programmes aimed at halting environmental degradation and promoting sustainable agricultural development.

Contents

1 Introduction

The pilot project "Small scale irrigation using collector wells -Zimbabwe" contains the following main elements:

i) selection of suitable sites and the installation of six small irrigation schemes using water from collector wells in south-east Zimbabwe;

ii) the assembly and collection of adequate baseline data and design of a monitoring system to facilitate the assessment required at iv below;

iii) the regular collection of data through the monitoring system;

iv) production of a final integrated report on the scheme's technical, economic, financial, institutional, social and environmental viability, with recommendations for future development.

The main objectives of the project are:

i) to field test the validity of small scale irrigation and collector well research results obtained at the Lowveld Research Stations (LVRS);

ii) to identify ways of improving the operation of the schemes, for example by identifying and overcoming constraints;

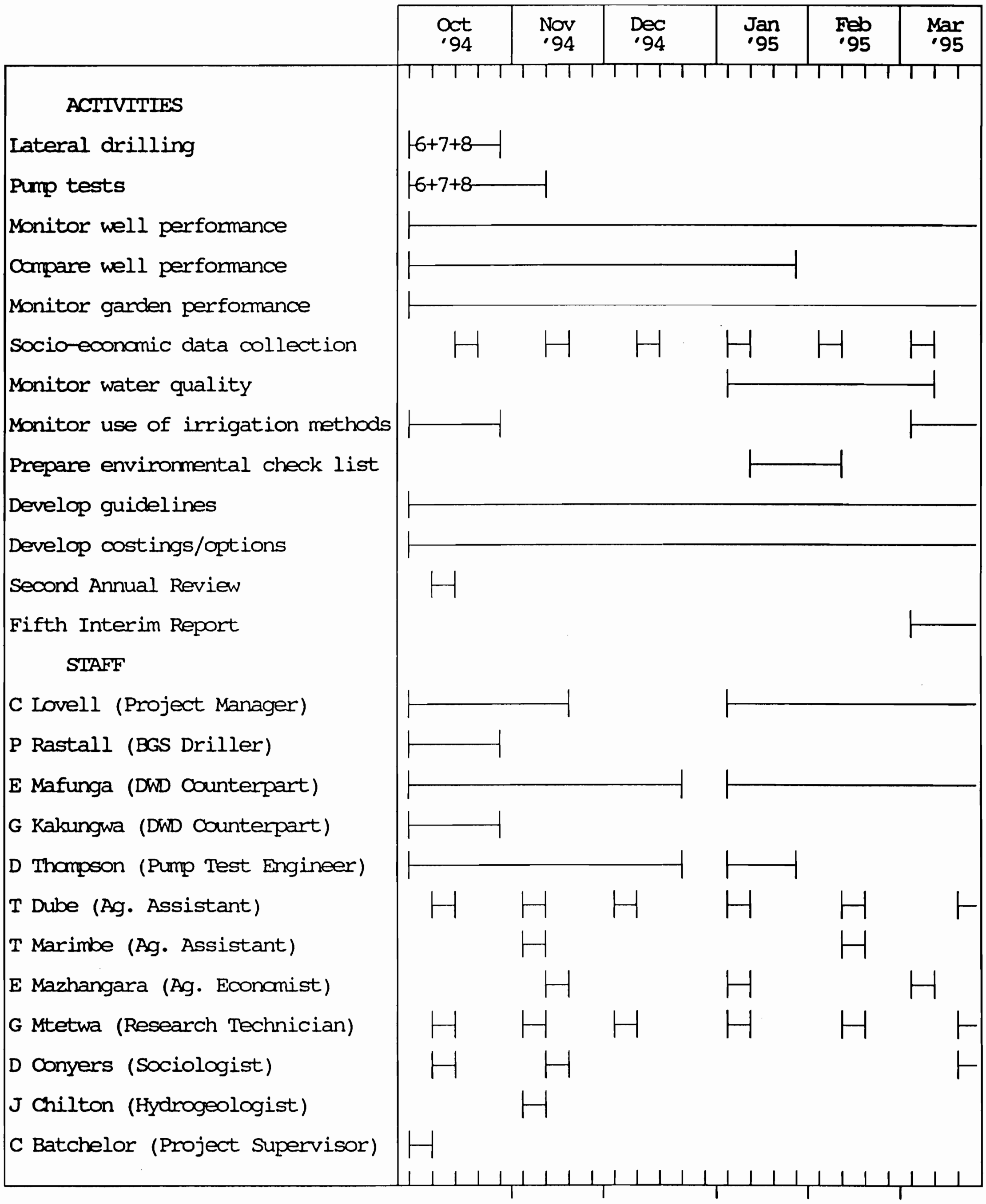
iii) to identify a basis for replicating the schemes on a wider scale.

(Ref. Project Data Sheet, BDDSA March 1992)

The project started on the 1st October 1992. This report outlines progress made during the fifth six months of work, subsequent to that described in the fourth progress report published in November 1994.

2 Work completed during fifth six months

A provisional programme of work for the fifth six months proposed at the time of the fourth progress report was:



In the event, good progress has been made to complete the sixth scheme plus the two additional schemes for Plan International. Good progress has also been made to monitor garden and well performance during the first crop season at five of the six ODA sites, and to compare alternative well designs at each site.

2.1 WELL CONSTRUCTION

2.1.1 Matedze (#6)

As reported in the fourth progress report, digging began at the beginning of May and was completed to 11 metres by the end of July. An informal contract was again signed with the community and all work performed by them on a voluntary basis, teams of five men working for five days each under supervision of a project foreman. Radial drilling was completed in September.

2.1.2 Machoka (Plan International)

Slow progress continued at this site due to poor community involvement and hard rock conditions. Digging was finally completed to 11 metres in December after a total of seven months. Pump tests confirmed that the large diameter well could satisfy the target yield of 15 m^3 of water per day. Radial drilling was not required and was not performed at this site. Two handpumps were installed in February, and a training day held at which eight members of the community were trained in all aspects of pump maintenance and repair.

2.1.3 Masekesa (Plan International)

Slow progress continued at this site again due to poor community involvement. Digging was completed to 17 metres in October. Four radials were drilled and well yield improved by 13 per cent (see sections 2.3.1 and 2.4.3). Handpumps were installed and members of the community training in pump maintenance as per the site at Machoka.

2.2 MONITORING OF COMMUNITY GARDENS

Monitoring of garden performance is proceeding well. Economic appraisals for each site are given in Appendix 1. The following table provides a summary of gross margins recorded at the five pilot project schemes to complete their first winter season, and at the original scheme at Tamwa/Sihambe/Dhobani (Romwe catchment) during it's fourth winter season 1994.

Site	Z$/ha	Z$/member	Z$/labour day
#1 Muzondidya	(27673)	(100)	(4.52)
#2 Gokota	35348	316	3.42
#3 Dekeza	47459	989	5.90
#4 Nemauka	2221	9	0.42
#5 Mawadze	11183	233	4.18
Romwe	18903	378	5.77
Average	23798	338	4.04

Figures in parenthesis are estimated due to gross under-reporting at this site (Appendix A1.1)

The original scheme in Romwe catchment continues to give high returns, recording a gross margin of Z$18903 per hectare in it's fourth winter season and an average gross margin of Z$22932 per hectare per year during four years of operation. First results at the pilot project schemes are similarly high. They are far higher than returns given by other land use options in this area, and are an indication of the excellent returns possible from small, intensively cultivated areas when water can reliably be made available.

One senses however that even greater things are still possible. Social teething problems remain to be overcome at site #4. Gross under-reporting occurred at site #1, and under-reporting to some degree is suspected at all sites where members have free access to the gardens and harvest vegetables at any time of day. It is also becoming clear that members in general are somewhat reluctant to reveal the true extent of their success for fear of being disadvantaged in some way in the future. Markets are not being fully exploited at present, and members at some schemes are clearly being constrained by the present authoritarian system of management that relies upon decisions to be made by a committee and certain activities to be undertaken as a group.

There appears to be no good reason why members so inclined could not operate in a more independent way and tend to their own allotments within a communal fence. Indeed, it will be exciting to observe what is achieved as members at some schemes try these different growing and marketing strategies. Increased extension advice on pest control and on irrigation schedules would also greatly improve production levels if this could be given.

2.2.1 Analysis of garden soils

The following table provides results of soil analyses performed by the Chemistry and Soil Research Institute, Department of Research and Specialist Services, for each pilot project site.

Site	Depth	Colour	Texture	pH	N (ppm)		P_2O_5	K	Ca	Mg	Tot
	(cm)				init	inc	ppm		(mEq/100g)		
#1	0-30	GB	MG/SL	4.7	19	25	16	.10	1.5	0.85	2.4
#1	30-60	GB	MG/SL	5.0	17	29	8	.07	1.6	0.94	2.6
#2	0-30	GB	MG/SL	6.3	37	61	16	.19	5.7	1.06	7.0
#2	30-60	GB	MG/SL	5.5	32	45	8	.09	3.2	0.90	4.1
#3	0-30	GB	MG/SL	4.9	19	41	3	.14	5.4	3.88	9.4
#3	30-60	GB	MG/SL	5.3	14	22	2	.08	5.7	4.21	10.0
#4	0-30	L/YB	MG/SL	6.0	34	46	3	.09	2.7	0.75	3.5
#4	30-60	YB	MG/SL	5.7	34	34	3	.08	2.2	0.80	3.1
#5	0-30	GB	MG/SL	5.4	13	27	3	.14	2.3	0.88	3.3
#5	30-60	GB	MG/SC	5.8	14	17	2	.08	6.9	1.74	8.7
#6	0-30	GB	MG/SC	5.1	12	37	3	.11	5.4	2.99	8.5
#6	30-60	GB	MG/SC	5.7	14	20	3	.09	10.9	8.03	19.0

Notes:
1) pH determined in 0.01M calcium chloride
2) N init = initial mineral nitrogen (ammonium plus nitrate)
3) N inc = mineral nitrogen after incubation (ammonium plus nitrate)
4) P2O5 = available phosphorous by resin extract
5) GB = grey brown; L/YB = light yellow brown
6) MG/SL = medium grained sandy loam; MG/SC = medium grained sandy clay

Summary:

Site #1:	soil very acidic, requires liming to raise pH, low in potassium and nitrogen, need to improve phosphate, calcium and magnesium.
Site #2:	satisfactory although phosphates are a bit low.
Site #3:	acidic, requires lime, low nitrogen, phosphates and potassium.
Site #4:	satisfactory, although potassium needs a push.
Site #5:	slightly acidic, low in nitrogen, potassium and phosphate.
Site #6:	Acidic, requires lime, low in potassium and phosphate.

2.3 MONITORING OF COLLECTOR WELLS

2.3.1 The effect of lateral drilling

Figure 1 shows improved well recovery rates measured following lateral drilling at eight of nine sites completed during this pilot phase. At the ninth site (Machoka), pump tests showed that the large diameter well could satisfy the required target of 15 m^3 of water per day and laterals were not drilled. Little improvement in well yield by lateral drilling is seen at Gokota and at Tamwa/Sihambe/Dhobani. However, the large diameter wells at these two sites have proved able to support viable community gardens (sections A1.2 & A1.7). At all other sites, lateral drilling improved well yield significantly. When successful, lateral drilling has the effect of reducing drawdown and increasing rate of recovery after abstraction from the well. In real terms, this improvement increased relatively low yields of large diameter wells at sites #1 and #6 to yields above 15m^3/day, and at sites #3, #4 and #5, converted large diameter wells that satisfied this target into relatively high yielding collector wells that can now support irrigated gardens larger than 0.5ha if required. Further details of collector well yields and comparison with alternative well designs at each site are given in Section 2.4.

2.3.2 Well performance to date

Figure 2 shows performance of the six pilot project collector wells to date. Monitoring confirms that the water required to irrigate a 0.5 ha garden and satisfy local domestic need is typically 14-15 m^3/day. However, the initial scheme at Tamwa/ Sihambe/Dhobani demonstrates that a viable (if somewhat smaller) community garden is also entirely possible using 10-11 m^3/day. Monitoring of well performance will continue in order to assess the impact of prolonged use and periods of low rainfall.

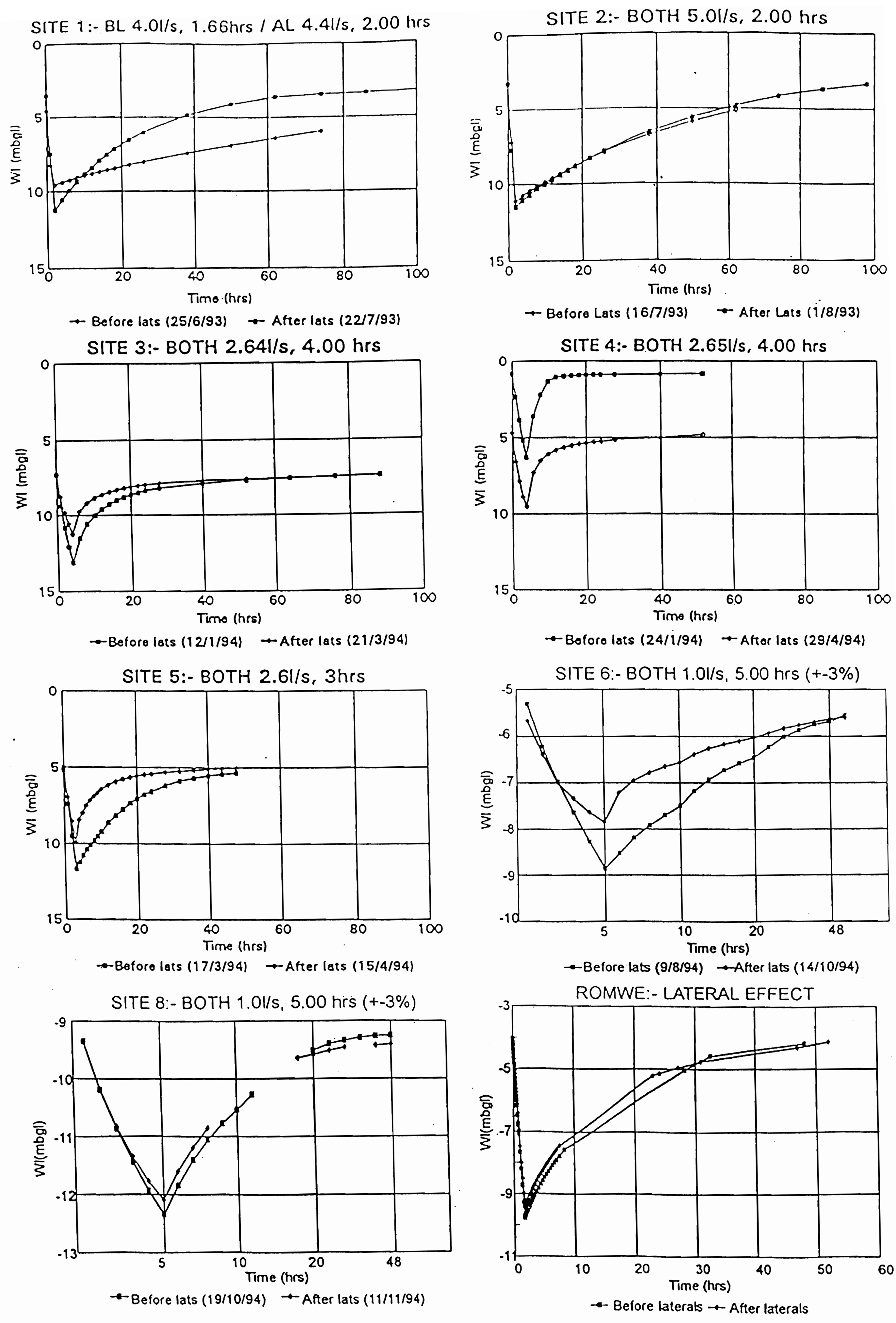


Figure 1 *The effect of lateral drilling at eight sites drilled*

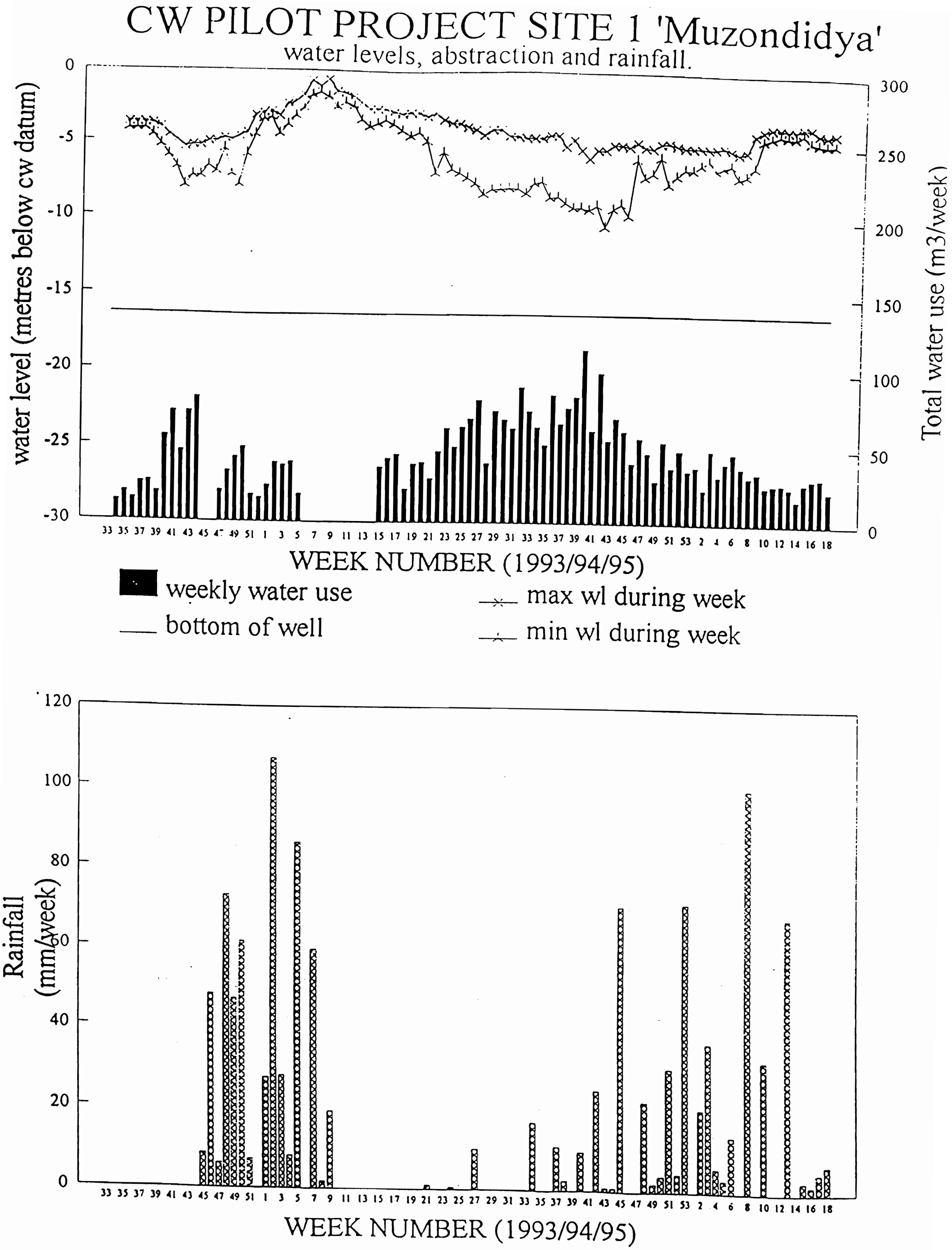
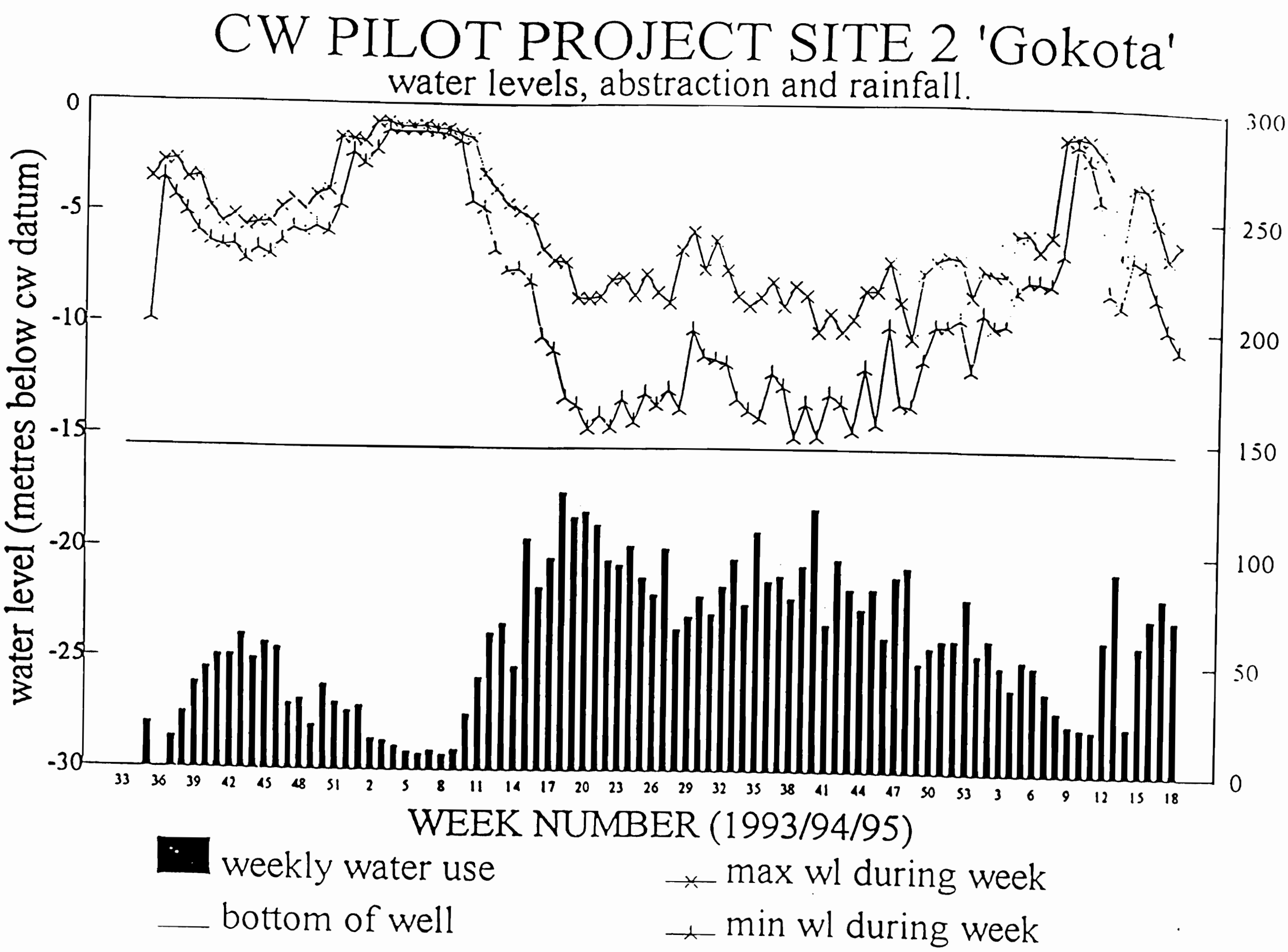
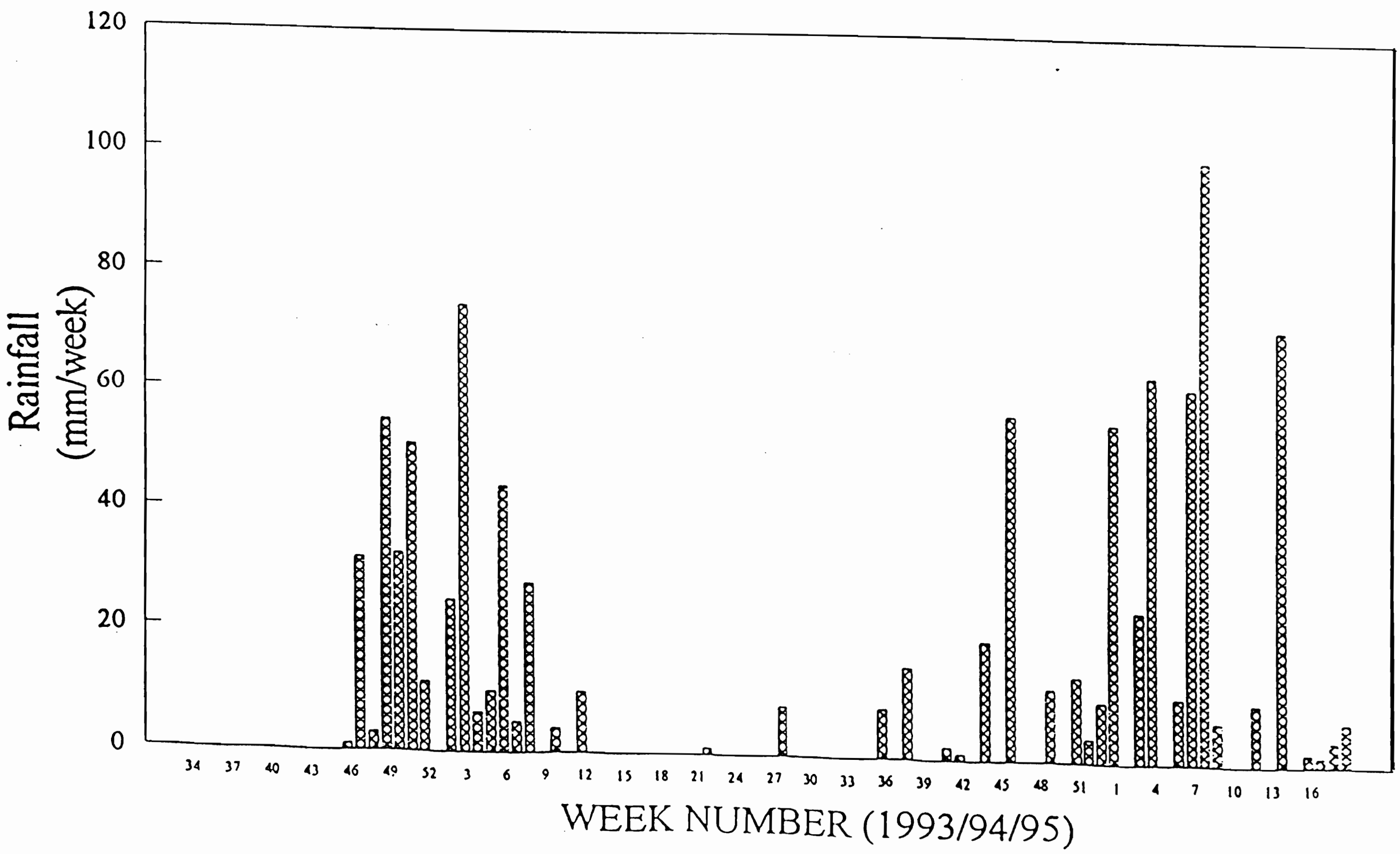


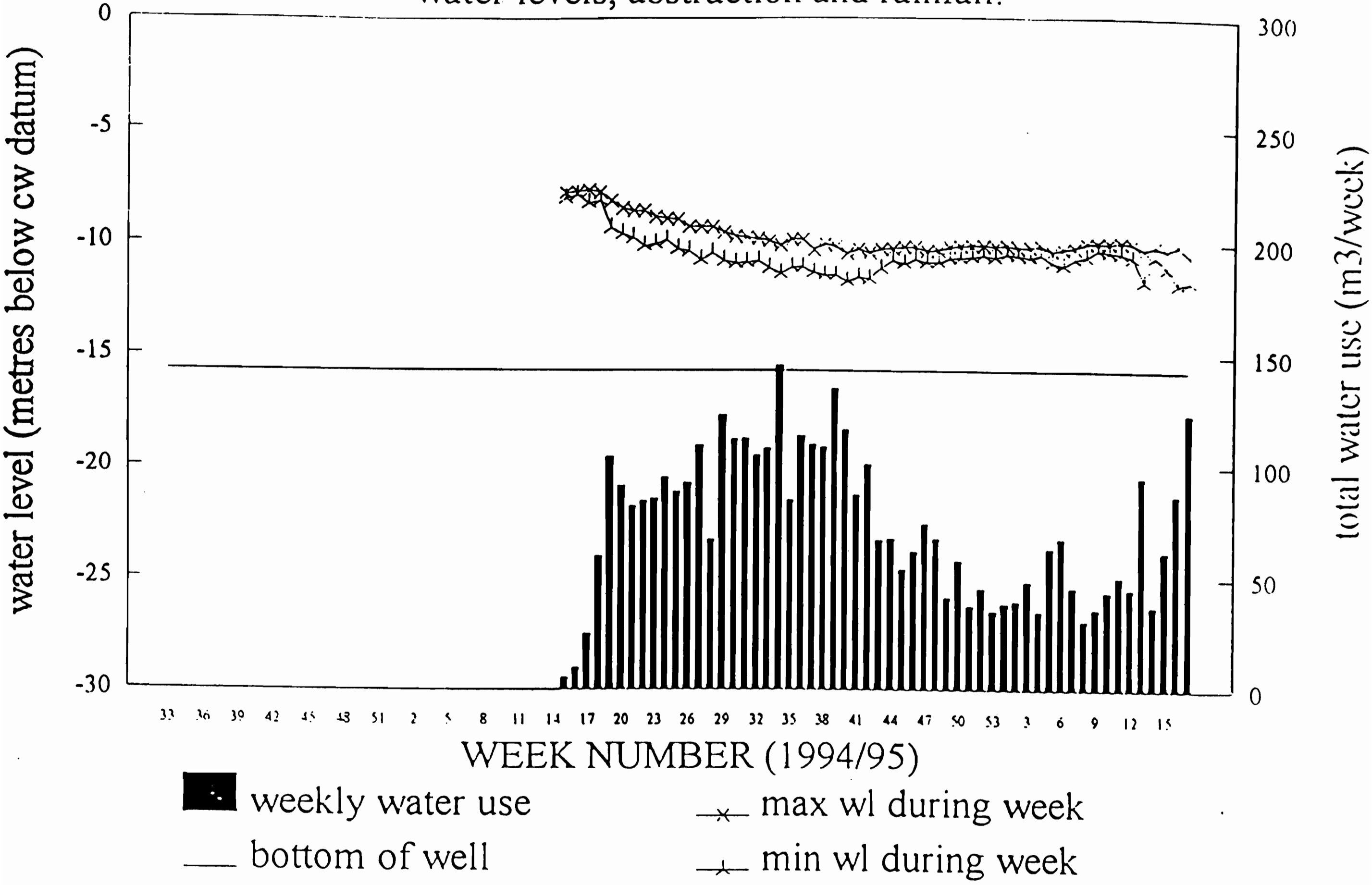
Figure 2 *Collector well performance to date*

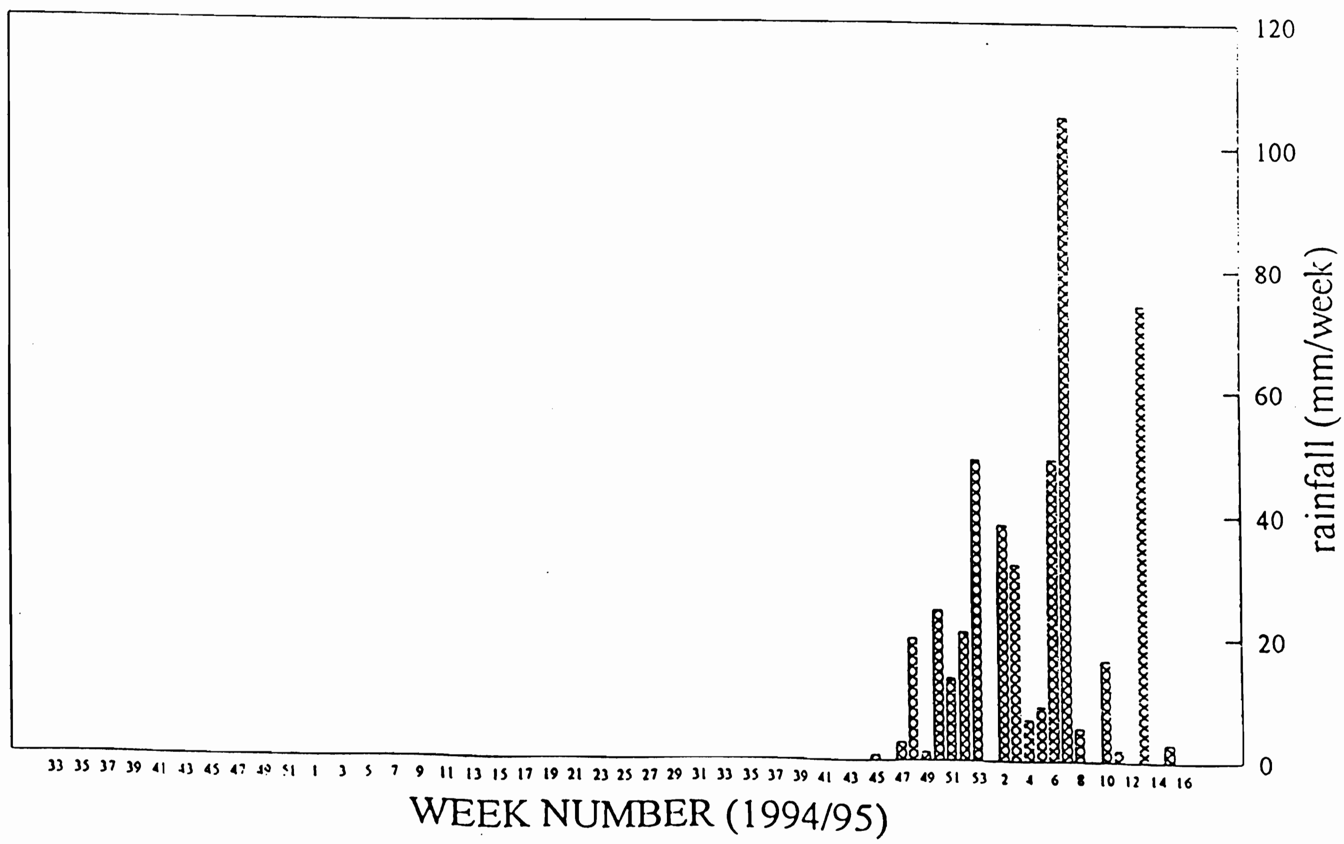

CW PILOT PROJECT SITE 2 'Gokota'
water levels, abstraction and rainfall.
water level (metres below cw datum)
0
-5
-10
-15
-20
-25
-30
300
250
200
150
100
50
0
33 36 39 42 45 48 51 2 5 8 11 14 17 20 23 26 29 32 35 38 41 44 47 50 53 3 6 9 12 15 18
WEEK NUMBER (1993/94/95)
weekly water use
bottom of well
max wl during week
min wl during week


Rainfall
(mm/week)
120
100
80
60
40
20
0
34 37 40 43 46 49 52 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 1 4 7 10 13 16
WEEK NUMBER (1993/94/95)

CW PILOT PROJECT SITE 3 'Dekeza'

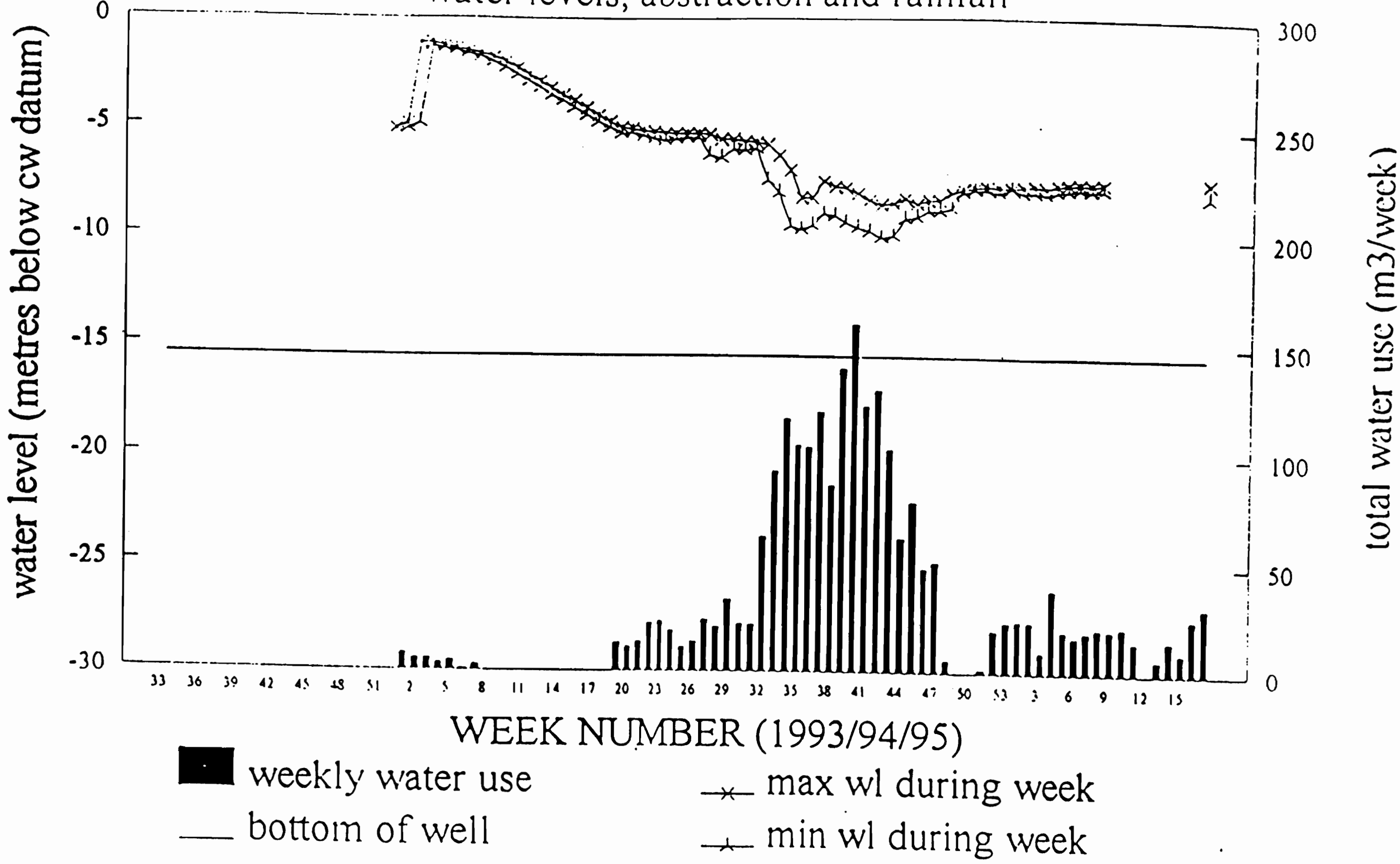
water levels, abstraction and rainfall.

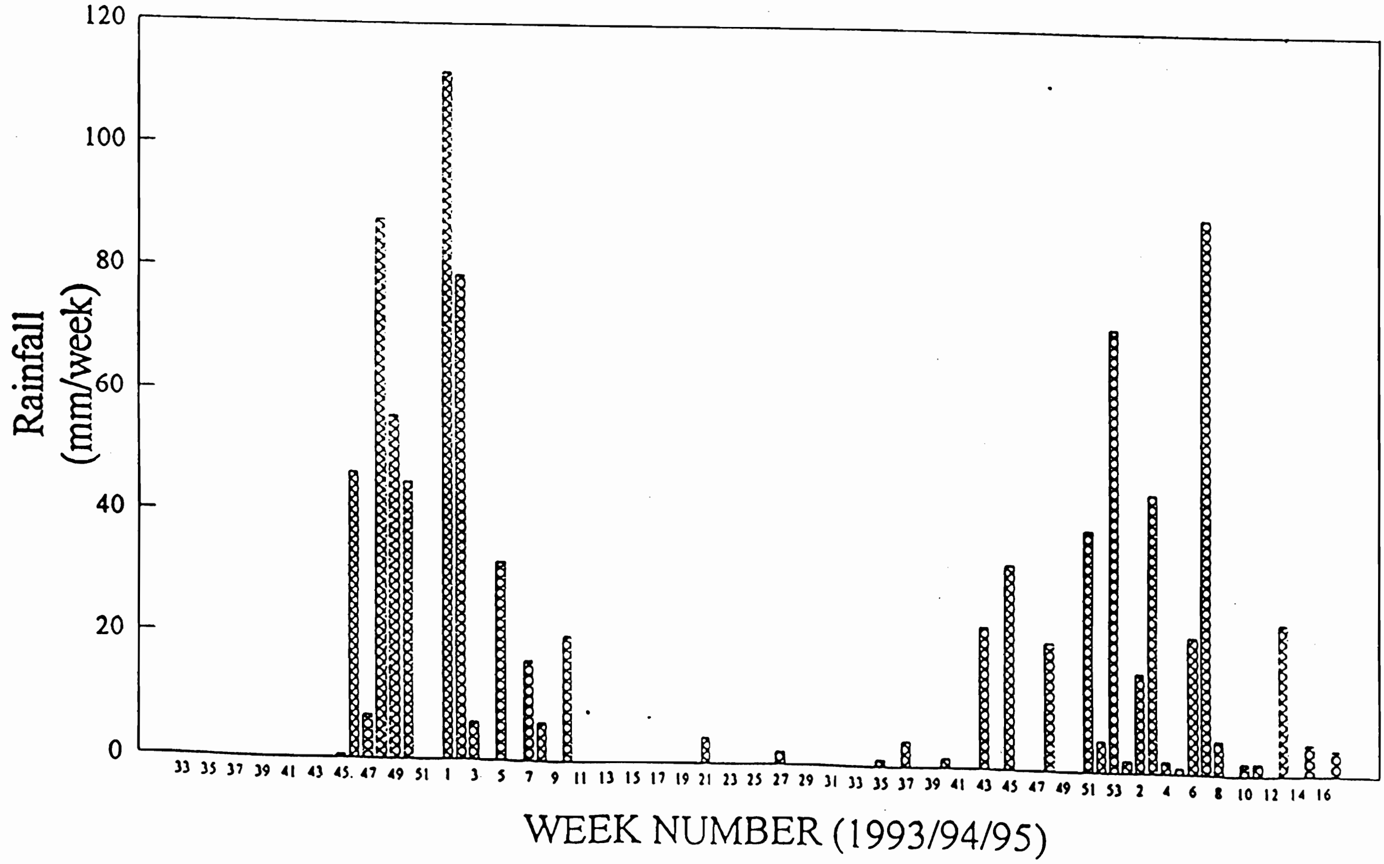




CW PILOT PROJECT SITE 4 'Nemauka'

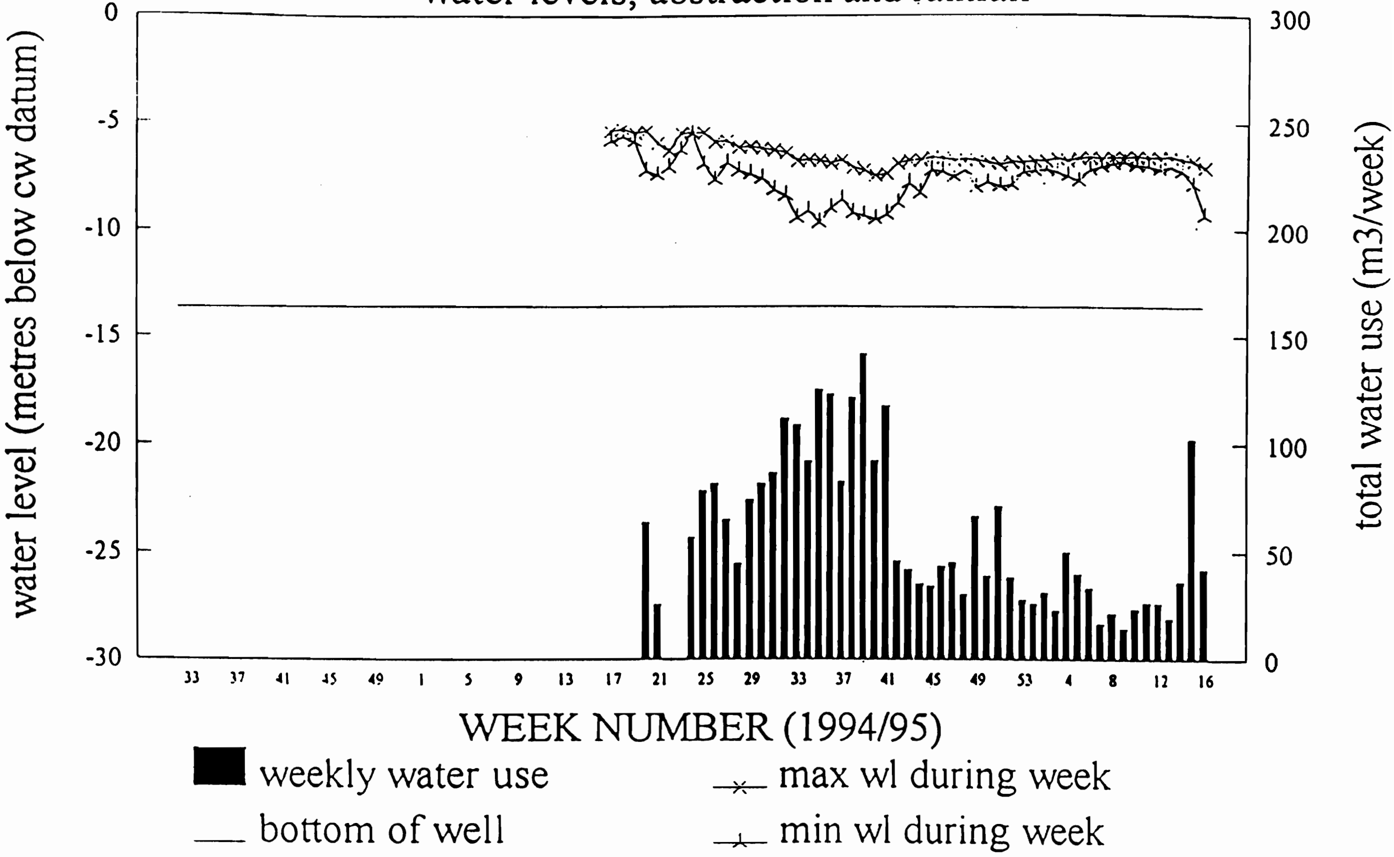
water levels, abstraction and rainfall



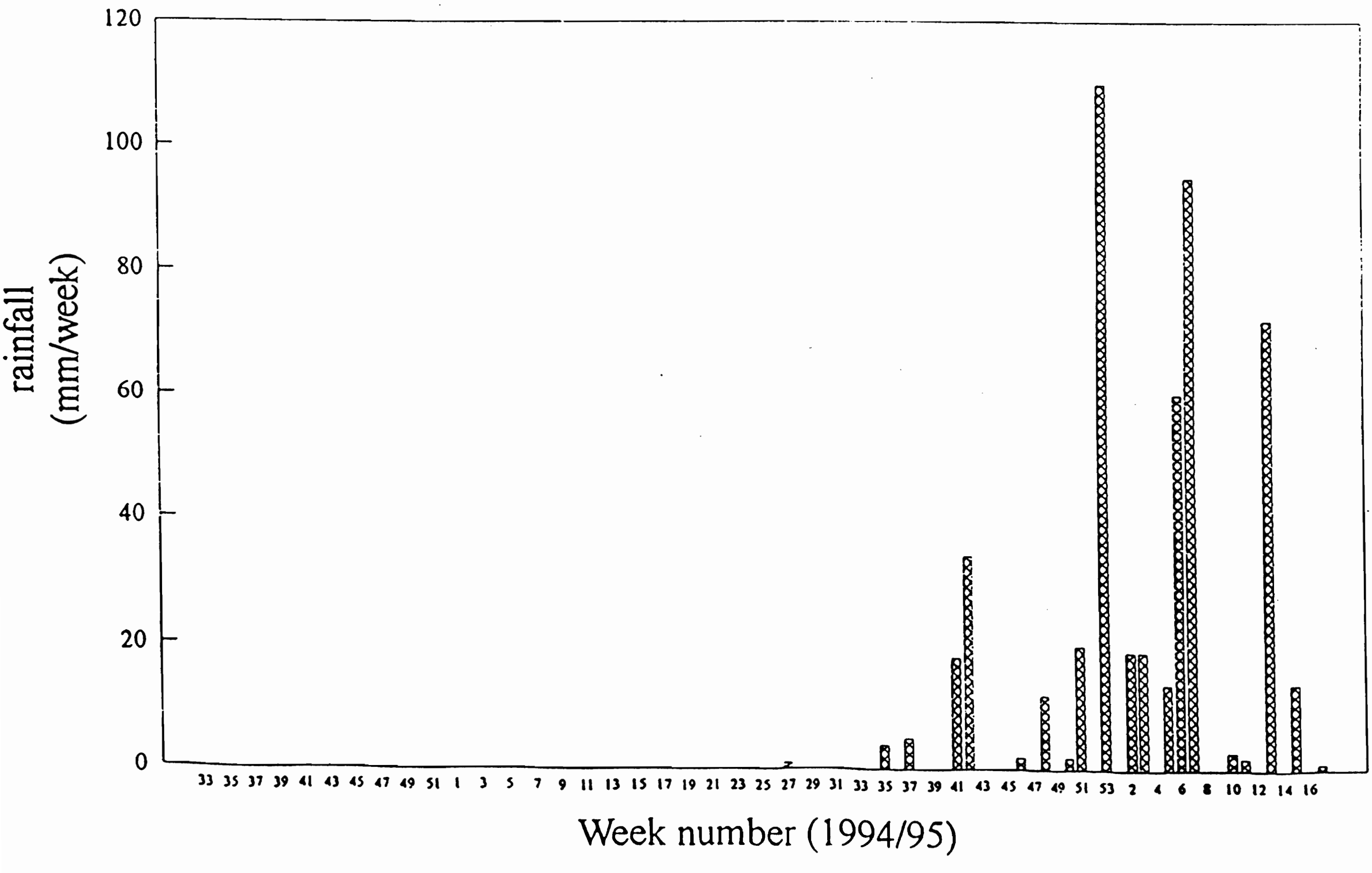


CW PILOT PROJECT SITE 5 'Mawadze'

water levels, abstraction and rainfall

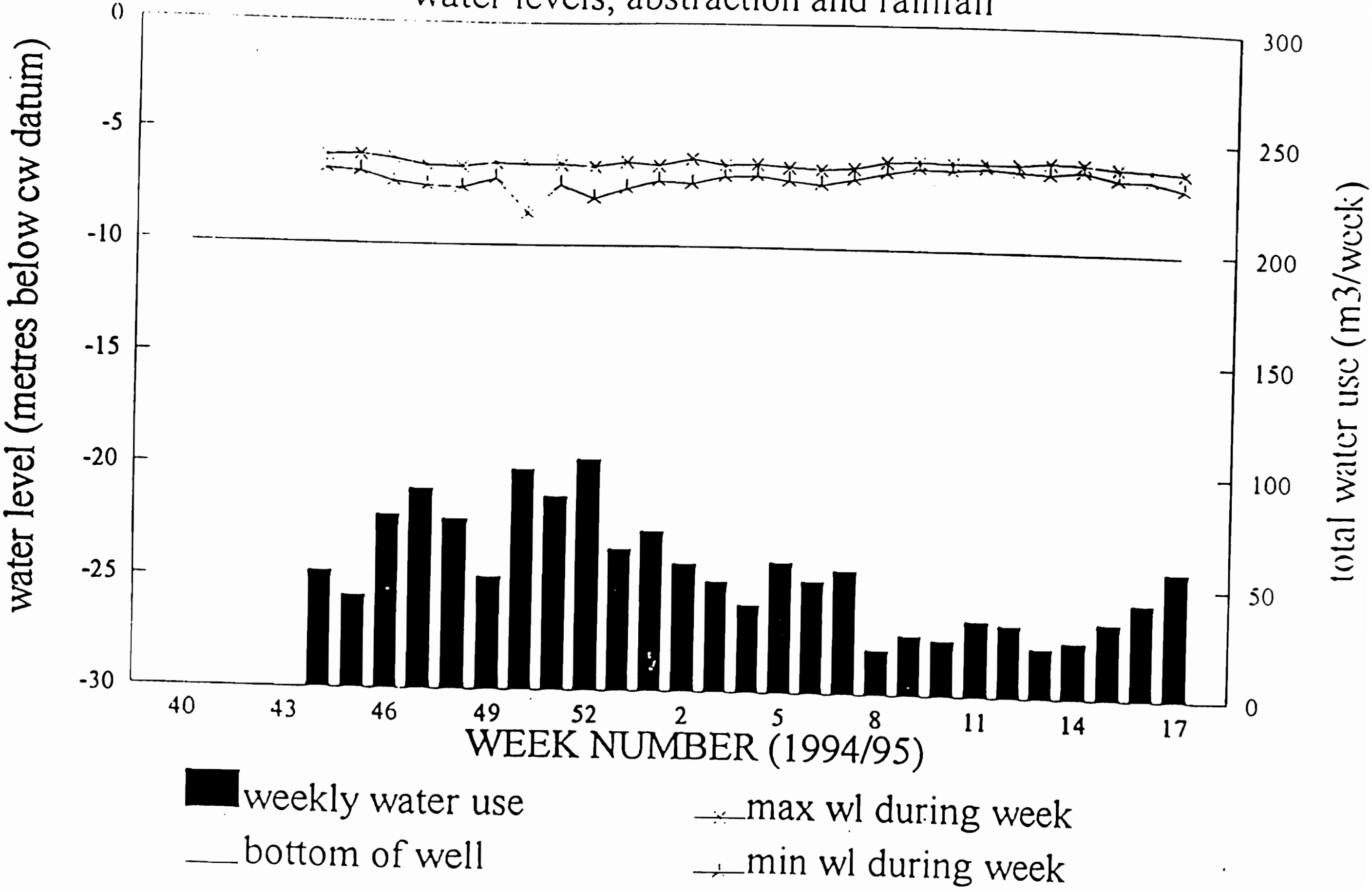


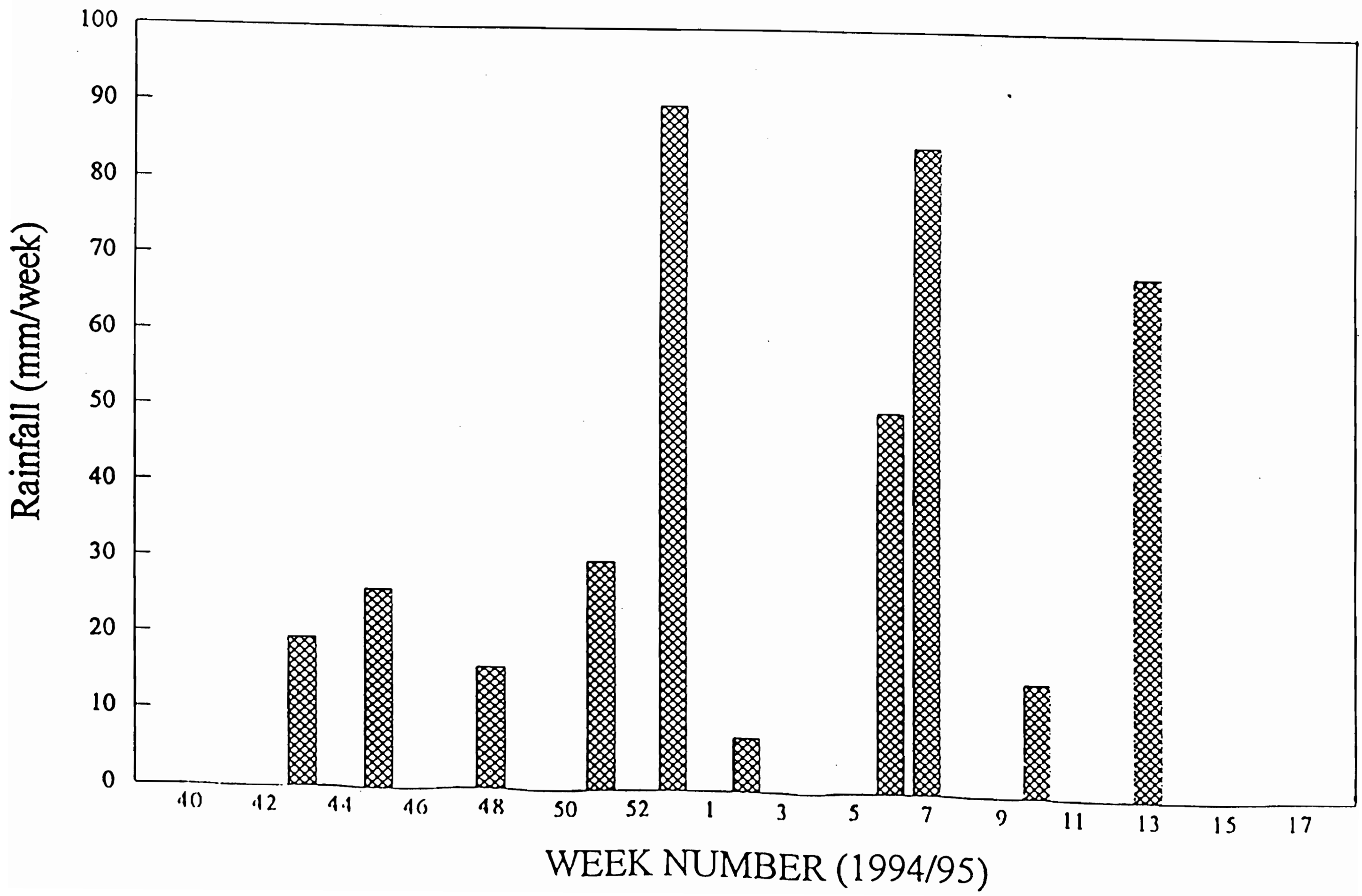
Max/min water levels indicate the daily drawdown required for illustrated abstra



CW PILOT PROJECT SITE 6 'Matedze'

water levels, abstraction and rainfall





2.4 COMPARISON OF ALTERNATIVE WELL DESIGNS BY PUMP TEST

2.4.1 Background

Appraisal of the first collector well garden completed in Chivi District in 1991 gave an indication of the economic viability of small scale vegetable production when water for irrigation could be made available to communities in this dry region (Brown,1992). Similar and even higher returns at pilot project schemes confirm viability of gardening (section 2.2). However, this appraisal does not indicate whether a collector well is the *most* viable or cost-effective means of providing water to support this activity.

The capital cost at the time of the first collector well and garden (Z$30,000) could (in theory) be repaid over ten years at the appropriate AFC lending rate by members using income from their garden. Considered as a single unit, the scheme was thus viable. However, if considered as separate units (namely garden and well) economic viability of the latter appeared less certain. Lateral drilling increased water yield by less than 10 per cent at this site. It appeared possible that the scheme could in fact be more economically viable if a large diameter well only had been constructed and the extra expense of lateral drilling avoided.

No comparative studies of alternative well designs were possible at the time of the first scheme. In order to address this issue and properly assess technical and economic viability of collector wells (see Section 1) a methodology has been developed and implemented in the present work.

2.4.2 Alternative well designs

Four alternative types of well can be compared:

Traditional dug well

In Africa, the traditional source of groundwater is a dug well. Generally, these are dug by hand using chisels and picks and a bucket and windlass to remove the spoil but without the aid of a dewatering pump. They are usually 1-1.2 metres in diameter. The level of abstraction sustained is generally low but can be sufficient to supply a family with water for domestic use and small garden. Final depth of the well is controlled primarily by degree of weathering in the upper layers of rock and by the water-table. The well cannot be dug much below this level without the aid of a dewatering pump and often will be deepened progressively during periods of low recharge as the water-table falls. With the occurrence of several dry years and increasing demands of a rising population, programmes of well deepening (often using explosives) are being undertaken in Zimbabwe by well digging teams of DDF and various NGO's. These so called 'deep wells' are included in this category of 'traditional dug well'.

Large diameter well

Large diameter wells, like traditional wells, are constructed within the weathered zone of basement rock. They are dug by hand but with the use of handtools that can include a pneumatic jackhammer and de-watering pump to allow construction below the water table. They may be lined either with steel, concrete, stones or bricks, and are usually 2-3 metres in diameter. Depth is controlled principally by weathering and required volume of water, digging usually stopping when fresh rock is encountered (at depths typically of 10-15 metres in the present work). On average, this depth is greater than that of a traditional dug well, increasing the chances of intercepting the relatively more productive zone which is often found at the base of the regolith. Abstraction sustained by a large diameter well can also be higher than a traditional dug well due to the greater wetted surface area allowing increased inflow and the greater volume of storage that is provided. Although such wells are common elsewhere (e.g. India, Sri Lanka) they are at present rarely employed for abstracting groundwater in Zimbabwe. For the purposes of comparison in the present study, the collector wells before lateral drilling served and were tested as large diameter wells.

Collector well

The upper weathered zone of basement rock generally has higher storativity compared to the unweathered bedrock below, but the overall transmissivity of the regolith aquifer is low. This lower transmissivity can cause cones of depression to develop in the saturated layer around wells. Water may be available beyond the cone of depression but the hydraulics of the system do not allow the well to tap it. The collector well was designed to overcome this problem of localised drawdown in watertable. It is a large diameter well constructed as described above but with boreholes (laterals) mechanically drilled sideways from its base. As many as six laterals may be drilled to distances of 30 metres using a specialised drilling rig. They increase the effective radius of the well and reduce the drawdown in the surrounding aquifer. Another advantage in the highly variable conditions encountered is that the laterals pass beyond localised discontinuities that exist in the weathered basement and tap again into areas of higher productivity.

Borehole

Narrow boreholes (or tubewells) of 15-20cm diameter are the most widely constructed type of groundwater abstraction points in southern Zimbabwe. Being mechanically drilled they are relatively easy to construct and can be completed in a relatively short time. In this area some are completed in the upper weathered zone but most penetrate the fractured bedrock in search of fractures which yield water. A depth of 40-50 metres is typical. Where interconnected fractures occur in the unweathered basement they allow deep boreholes to draw on the higher storativity of the regolith. If major water bearing fissures are intercepted which produce locally high transmissivity, high yields can be achieved. However, the pattern of fracturing in crystalline bedrock is highly variable and not easy to predict. Many boreholes do not intercept fracture systems that are sufficient to satisfy either volume of water or longevity of supply required, and poor drilling success rates reflect this difficulty. Generally, the weathered zone of boreholes is cased rather than screened. This reduces costs but denies access to water from the upper aquifer. The borehole is screened in the fractured bedrock but yield can in time be reduced by a build-up of material on this screen and maintenance required.

2.4.3 Factors influencing choice of well type

A number of factors influence choice of well type and should be considered during a water development programme:

Geology and climate

The principal physical factors influencing choice of well type are geology and climate. These determine the relative positions of the base of the weathered zone and the water table. Depth of weathering is a complex function of geology and rainfall; in general the former determines the degree and type of weathering and the subsequent properties of the aquifer, and the latter may have the strongest influence on the depth of weathering. Geology and climate may also influence groundwater quality. Thus, where the regolith is very thin or absent and the water tables are deep, dug well construction may be virtually impossible and boreholes may be the only option. If the regolith is thick and water table shallow, dug wells are likely to be viable.

Community preference and sense of ownership

Ensuring local involvement in designing, implementing and managing water projects brings the greatest chance of success. Sense of ownership and responsibility for upkeep of a water point is more likely if the well is dug by the community rather than drilled by an external agency.

Pump capacity and ease of repair

Rural farmers owning traditional wells generally use a bucket and windlass to abstract water. Communal wells however are often fitted with a pump. The nature of the rural environment prohibits use of high technology pumps. A source of power is rarely available or within peoples means and the necessary tools or skills are not available to repair such equipment. Simple hand-powered single action reciprocating pumps (eg.Zimbabwean Bushpump) are thus most often used. These pumps are typically able to supply 5-10 m3/day. A borehole will only allow one such pump to be fitted: the borehole may thus be under utilised if the potential yield is greater than the pump capacity. A large diameter well in contrast will allow several pumps to be fitted. This has the added advantages of less wear and tear per unit and when one pump breaks water may still be abstracted by another. Community maintenance of both well and pumps is the ultimate goal. Irrespective of well design, this requires training of local people and provision of tools, but is made easier on a dug well than on a borehole due to the shallower depth and corresponding lighter pumping unit that has to be extracted.

Well performance and cost-effectiveness

Ultimately, the type of well chosen must provide the volume of water required, be sustainable, and be cost-effective. It was with the aim of better understanding this aspect of well choice for use with small scale irrigation that the following comparison of well types was undertaken.

2.4.4 Methodology

During the present work eight schemes have been constructed, six in Zaka District in the ODA funded pilot project and two in Chiredzi District funded by Plan International. The sites have provided a range of physical settings and a variety of existing wells that could be compared with project wells as constructed.

Table 1 *Geology, annual rainfall (mm) and depth of wells (metres) constructed and existing at each site. Length of laterals (metres) are included where drilled*

Site	1	2	3	4	5	6	7	8
Geology	gneiss	gneiss	gneiss	granite	gneiss	gneiss	basalt	basalt
Rainfall	780	790	780	?	820	785	580	580
LDW	15.8	15	15	15	13	9.5	8.76	18
CW	15.8 (1x15, 4x30)	15 (4x30)	15 (8,9,25, 27,28)	15 (1x18, 3x30)	13 (14,16, 28,30)	9.5 (2,4,8,23 ,30)	8.76 (none)	18 (9,19, 27,27)
TDW	-	-	-	12.75	-	-	-	-
SEB	15	15	-	15	15	15	18	-
DEB	40	30	-	-	33	-	-	30
DCB	48	-	43	-	39	-	-	-

LDW = large diameter well
TDW = traditional dug well
DEB = deep exploratory borehole
CW = collector well
SEB = shallow exploratory borehole
DCB = deep community borehole

Pump test procedure

Pumping tests were conducted at all sites on the large diameter well prior to lateral drilling and at seven sites on the collector well after lateral drilling (site 7 was not converted to a collector well when pumping tests showed it to be productive enough as a large diameter well). Additional pump tests were also completed on the best shallow exploratory borehole drilled during each well siting; on the same exploratory hole deepened to 40 m; on the nearest existing community borehole and or traditional dug well where these existed. Table 2 shows tests conducted at each site. Results from the various tests were analysed to obtain values for aquifer parameters for both the shallow weathered aquifer and the deeper fractured bedrock aquifer at each site. Parameters for the shallow layer were used with test data for the collector well to determine the effective radius of this well. Values of available drawdown for each well type were used to model the maximum abstraction that could be sustained by each for a period of one dry season.

Table 2 *Pumping-tests performed at each site*

Well type	Pumping rate (litres/sec)	Pumping time (mins)	Site
LDW + CW low discharge	0.65	120	1 + 2
LDW + CW high discharge	4.5 2.65	120 240	1 + 2 3 + 4
LDW + CW medium discharge	1	300	5 + 6 + 8 (no CW at 7)
SEB	0.4	60	1,2,4,5,6,7
DEB	0.6	240	1,2,5,8
DCB	0.6	60	1,3,5

Complexities of the basement aquifer

A pumping-test is a method to estimate properties of the aquifer within which the well is situated. Drawdown on pumping and subsequent recovery of the water-level with time are monitored. By fitting the water-level response to a mathematical model, the aquifer properties can be estimated. The mathematical model forms a simplification of the aquifer system.

Crystalline basement rocks form complex aquifers. The weathered shallow aquifer and the deeper bedrock aquifer are different in form. The weathered aquifer or saprolite can vary greatly in thickness over short distances and in composition both vertically and laterally. Derived from insitu weathering and disaggregation of the parent rock, its permeability is related to rock types. Quartz-rich metamorphic rocks may produce more permeable weathering products, whereas rocks richer in dark minerals often produce a less permeable clayey regolith. Permeability will also tend to increase with depth in the regolith as the proportion of secondary clay minerals reduces (Chilton and Foster, 1995). In contrast, the bedrock permeability depends on the density and connectivity of the fractures. The boundaries between saprolite, saprock, and the fresh bedrock are not usually sharp. The form of the aquifers will change from site to site as they are dependent on the lithology of the parent rock and the tectonic, climatic and geomorphological history. Even at one location the lateral variation may have hydraulic significance, for example where hard bands in the rock form local flow barriers.

This complex nature means that it is difficult to describe them with a mathematical model. There may not be a single set of parameters that define the hydraulic system in the weathered zone. One method of incorporating the complexities of the system is to set-up a detailed numerical model. This type of model is very time-consuming to develop, requires detailed input data and can be site specific. It was decided that the only practical approach was to use a model that simplified the system. The limitations of this approach are considered below.

Pumping test analysis using programme BGSPT

The program used for pumping-test analysis in this study is an in-house BGS computer model, BGSPT. The package consists of two programs: PTFIT which analyses pumping-test data; and PTSIM which simulates well drawdown using a specified set of well and aquifer parameters and which is used to estimate the sustainable yield of the well. PTFIT accepts ranges of aquifer parameters as input. It then optimises the fit of the pumping-test data to the built-in conceptual model by varying the parameters within these ranges. The conceptual model is that of a fully penetrating well in a semi-confined homogeneous aquifer of infinite extent. The semi-confining aquitard is itself unconfined. Flow within the aquifer is assumed to be horizontal and within the aquitard, vertical. The water-table in the aquitard is assumed horizontal.

The well is defined by the radius of the casing Rc and the screened section of the well Rw. The program allows the radii to be varied along with other parameters. This enables the increase in effective radius of the large-diameter well due the laterals to be estimated. The variation of the radii also account for the effects of partial penetration and the possible existence of a seepage face. The model has the advantage over other computer models in that it can consider large-diameter wells. It can also consider a semi-confining layer but information required as input for this case was not available. The aquifer in all cases was assumed to be confined.

This assumption appears justified by observations at most sites that the depth of the first water strike during drilling was well below that of the rest water-level measured later. It is unlikely, however, that the weathered aquifer remained confined throughout the test. Other assumptions within the model are also not valid for the sites and tests of this study. The aquifers do not extend infinitely and drawdown in the wells is not small compared to the saturated thickness. The assumption that the well is fully penetrating, however, is reasonable as increasing difficulty of digging means the wells were completed approximately at the base of the weathered zone.

Difficulties experienced in pumping-test analysis

As might be expected from the above, a number of difficulties were experienced in the analysis of data obtained from the pumping tests. In some cases, data could not be fitted to the model without allowing the input parameter ranges to be set at unrealistic values. In particular the fitting of storativity was problematic. Values were obtained that were higher than would be expected even for an unconfined aquifer. In addition, different values resulted from tests at the same site in the same aquifer. As well as invalidation of some assumptions made in the conceptual model, a number of other causes may have contributed to these problems.

Rarely were true rest water-level conditions possible prior to tests. Both large diameter and collector wells were dewatered to allow digging and drilling. The time required for full recovery would have affected project progress overall and denied access to water by the local people. The consequence of a test being started from below rest water level is that recovery from test drawdown is combined with recovery from pumping prior to the test. This has particular relevance to tests where drawdown was not great and in these cases compensation was made during analysis. In some cases, fracturing of the aquifer in the vicinity of the well may have increased storage; the water-level did not decline as fast as expected. In others, a seepage face developed in the well producing greater drawdown than was expected.

In the light of these problems and the simplifications made in the model, results presented below should be considered as indicative rather than absolute. However, the modeller was able to develop a feeling for the level of confidence that could be placed on results determined for each site, based on the sum of the errors of the modelled fit, consistency of results at each site, and how drawdown predicted using the parameters matched recorded performance of the individual wells. This degree of confidence (shown with the results) has been assigned a level ranging from 1 to 5, most confidence being represented by the higher values. Results obtained for the first collector well completed in Romwe catchment in Chivi District in 1991 are also included for comparison.

2.4.5 Results

Aquifer Properties

Table 3 shows aquifer properties determined at each site using pumping test results for the various wells. Transmissivities in the deeper aquifers are generally greater than in the shallow aquifers and storativity smaller. However, there are exceptions and some important implications for the performance of different well types in these aquifers:

Site 1: there is a noticeable difference between values obtained for the transmissivity and the storativity of the deeper aquifer at the community borehole and at the exploratory borehole. As confidence in both results is reasonably high this suggests high spatial variability in this aquifer.

Site 2: the parameters obtained for the deep aquifer are not significantly greater than the shallow aquifer. This suggests that this deep exploratory borehole did not intercept a productive network of fractures.

Site 3: the community borehole is extremely productive due to a very high value of transmissivity in the deeper aquifer.

Site 4: the community borehole gave a value of transmissivity smaller than that in the shallow aquifer. Confidence in this result is not high but the inference is that this community borehole has not intercepted a productive network of fractures.

Site 5: both the community borehole and the deep exploratory borehole tests suggest low values of transmissivity for the deeper aquifer. The shallow aquifer here had the highest value of transmissivity of all the crystalline basement sites, favouring construction of a well or shallow borehole.

Site 6: no deep borehole was available to test. The shallow aquifer gave a high value of storativity suggesting that the assumption made that the aquifer was confined was not valid here.

Table 3 *Pumping-test results for shallow and deep aquifers at the nine collector well garden sites completed to date*

	SHALLOW AQUIFER					DEEP AQUIFER				
Site	**Depth (m)**	**T (m^2/d)**	**S**	**Conf**	**Source of data**	**Depth (m)**	**T (m^2/d)**	**S**	**Conf**	**Source of data**
1	15	0.8	0.005	4	LDW	48	32.0	2e-6	4	DCB
						40	4.48	5e-3	4	DEB
2	15	1.4	0.008	4	LDW	30	2.4	8e-3	4	DEB
3	15	2.9	0.007	1	LDW	43	118.0	7e-3	4	DCB
4	15	2.9	0.010	3	SEB	25	0.9	1e-2	2	DCB
5	14	3.1	0.007	3	LDW	33	5.6	9e-3	3	DEB
						33	0.8	7e-3	2	DCB
6	10	2.5	0.077	4	LDW	-	-	-	-	-
Romwe	12	1.1	0.520	2	LDW	-	-	-	-	-
7	9	30.2	0.565	3	LDW	18	206	2e-3	3	DEB
8	18	9.8	0.004	3	LDW	30	9.8	1e-6	2	DEB

Effective Radius of Collector Wells

The laterals of collector wells allow more productive zones of the weathered basement aquifer to be tapped. In some cases, the local variability of weathering is so great that individual laterals pass through hard, unweathered zones of rock into more weathered and productive zones, or encounter individual yielding fractures. In these circumstances local "barrier" conditions may result from the discrete productive zones at different distances from the well. However, due to the limited data available, the simplification was made for this study that parameters obtained from the large-diameter well tests and/or the shallow exploratory borehole tests could be applied to the collector well pumping-test data. The data was then fitted by allowing the effective radius of the well to vary. In this case, predictions based on modelling could be compared with measured well performance (Section 2.3.2) and the effective radius varied accordingly. Values thus determined and with confidence levels shown are given in Table 4. The actual radius of the large-diameter well in each case is 1.05m.

Table 4 *Effective radii of the nine collector wells*

Site	Effective radius (m)	Confidence level
1	9.2	4
2	1.33	4
3	19.0	3
4	10.3	2
5	8.9	2
6	4.7	4
Romwe	1.35	2
7	NA	NA
8	1.85	4

Predicted levels of sustainable abstraction

Monitoring of the nine collector wells indicates that the average daily abstraction required to satisfy both domestic and garden requirements is 15m^3 and that this abstraction occurs mainly in the early morning and in the afternoon. To compare performance of the alternative well types at each site, measured aquifer properties and well dimensions were input to the PTSIM program within the BGSPT package. The model was modified to simulate a repeated cycle of daily abstraction pumping at 1.5m^3/hour for five hours in the morning (06:00 to 11:00) and five hours in the afternoon (13:00 to 18:00). This was repeated for 240 days, the average length of a dry season. The drawdown at the end of this period due to the abstraction rate of 15m^3/day was then scaled up or down to equal the maximum available drawdown, thereby giving the maximum possible abstraction rate. Available drawdown was taken to be the inlet depth of the pump in the case of the shallow wells and two-thirds the depth of each borehole (the level of drawdown considered to give optimum abstraction for a borehole). Results are shown in Table 5.

2.4.6 Discussion

Monitoring of water use from collector wells shows an average abstraction rate of about 15m^3/day. It is very difficult to partition this to garden and domestic use, or even to quantify how many families are served by this volume. Other water points exist at each site and provide domestic water for some families. Surface water exists at some sites at some times of the year and provides additional water for the gardens. However, it is fair to say that at all sites 0.5ha gardens are being successfully irrigated from the wells when surface water is absent and that the majority of families (a conservative estimate being between 50 and 100) now draw most of their domestic water from these wells.

Table 5 *Maximum sustainable yield of wells tested at each site for a simulated dry period of 240 days*

	LDW		CW			TW		DCB cased in WZ		DEB screened in WZ		DEB cased in WZ	
Site	Q	CL	Q	CL	%imp	Q	CL	Q	CL	Q	CL	Q	CL
1	11.5	4	18.0	4	56	-	-	200	2	43	2	35	2
2	16.7	4	17.1	4	2	-	-	na		26	2	8	2
3	26.1	3	34.1	3	31	-	-	769	2	-	-	-	-
4	24.1	3	40.2	3	67	2.1	3	2	2	-	-	-	-
5	22.3	3	42.5	2	90	2.9	2	1.4	2	37	3	25	3
6	12.4	4	18.3	4	48	-	-	-	-	-	-	-	-
Romwe	10.2	3	10.8	3	6	1.6	2	-	-	-	-	-	-
7	47.0	3	NA	NA	NA	-	-	-	-	-	2	347	2
8	55.3	4	62.5	4	13	-	-	-	-	-	2	<2	2

WZ = weathered zone

Table 5 shows that at no site did a traditional dug well satisfy this requirement of $15m^3$/day. This is due in part to the smaller diameter and shallower depth typical of this type of well. It is also due in part to the method of well siting. A communal farmer is restricted to siting his own well on his own land, ideally in a position where it is convenient to his house or garden. He may employ the skills of a water diviner but they would still operate under the above restrictions. In contrast, large diameter wells and collector wells for the project were sited to serve the community, with no restrictions on area and with the benefit of exploratory drilling to locate the preferred aquifer properties prior to digging the well. It is likely that a well of traditional diameter also sited in this way would have higher potential yield.

At six of the nine sites, the large diameter well is shown to supply the required volume of water . This ratio improves to eight of the nine sites with lateral drilling. As might be expected, heterogeneity found in basement complex aquifers meant that lateral drilling success varied from site to site. At site 2 and at Romwe the improvement was minimal. At other sites on the basement complex the average improvement was 59 per cent. This improvement can be thought of in two ways. Radials can increase the maximum sustainable yield for the period of a dry season. Alternatively, radials increase the period for which a particular abstraction rate can be sustained. At site 1 for example, the large-diameter well could sustain pumping at 11.5 m^3/day for 240 days before drying. The collector well would last for 300 days pumping at this rate. Clearly, this has important implications for villagers trying to continue to water their vegetables through a period of low recharge or an extended dry season, and care must be taken when placing a value on this additional water. Any increase in yield made possible by lateral drilling cannot simply be divided by the additional cost of this operation.

Sites 7 and 8 characterise the role that geology can play in final choice of well type. Unlike weathered basement at the other sites, the shallow weathered zone of basalt at 7 and 8 is not pronounced. Instead, the groundwater flow is concentrated in zones of horizontal sheet jointing, and these zones both shallow and deep are highly transmissive (Table 3).

Consequently, both large diameter wells and exploratory boreholes gave significant amounts of water, but digging was particularly difficult and slow due to the compact layers of rock. Although either well type would provide the required water at these sites, a borehole is preferable due to relative ease of construction.

On the basement complex, transmissivity and storativity of the shallow weathered aquifer and the deeper fractured bedrock aquifer are shown to vary (Table 3). In some places, the bedrock aquifer is transmissive and provides high yields as recorded at the existing community boreholes at sites 1 and 3. In other places the bedrock aquifer is quite untransmissive; poor community boreholes at sites 4 and 5 highlight this problem. In general, yields from project deep exploratory boreholes were higher than from existing community boreholes especially where the weathered zone was screened rather than cased. This has important implications. It suggests a) that siting boreholes by exploratory drilling in the shallow regolith may be a better method, helping to overcome the variability found in productivity of the deep aquifer, and b) that boreholes in this region would be better if screened in the regolith rather than cased. Site 5 provides a case in point.

It is interesting to note also that, although less at some sites, yields predicted for all large diameter and collector wells are more consistent in value than borehole yields and are adequate for small scale vegetable production. Pumping capacity is also an important factor here. Although high yielding, the boreholes at sites 1 and 3 unfortunately hold only one handpump each and actual abstraction is thus far less than potential. The large diameter and collector wells thus have the advantage in that they can hold more than one pump. It may be a cost effective option at sites such as 1 and 3 to use a design of pump that allows two units to be mounted on the single casing (eg. Vergnet foot pump as used in West Africa) or to drill a second borehole at each site hoping to intercept the same productive aquifer. Either way would increase pumping capacity and provide additional security against pump breakdown, but neither option has been tested in this project. Likewise, the cost-effectiveness of purposely siting single high yielding boreholes to provide water for small scale vegetable production will depend very much on the method of siting employed and the corresponding success rate of drilling. Data are being collected but again this is an aspect that requires further study.

3 Replication of schemes on a wider scale

3.1 DEVELOPMENT OF GUIDELINES

3.1.1 Key steps

Valuable lessons have been learnt during the pilot phase and these have led to significant improvements in implementation of the later schemes. Key steps found to be important during site identification in order to promote successful collaboration with communities and help ensure implementation of schemes more likely to be sustainable from a social point of view were presented in the fourth progress report. Figure 3 below presents an extended version of that figure to include the steps also found helpful during scheme construction and thereafter. These steps are not intended as a prescription but rather as a guide and checklist. They will vary to some extent between different areas and different communities. Notes to accompany the extra steps are:

(6) Membership

Membership is decided by the community. It can be achieved giving recognition to those persons who work towards the project. For example, upon signing the informal contract, thirty men of one community dug their well and paid Z$10 to join the garden, non-digging persons completing the fence or preparing the land or providing building materials of sand and gravel paid Z$70, and non-working persons paid Z$90. The money raised was used to buy first inputs for gardening. A total of 50 families joined the garden in this way, and 117 use this well for domestic water.

(7) Scheme Design

It is important that affordable and reliable components and sources of inputs are used in scheme design. In Zimbabwe, a locally manufactured 'B' type bushpump has proved to be robust and can be repaired at relatively low cost. Two are fitted per collector well. Use of a motorised pump is not to be preferred. It has higher running costs and difficulties of repair that can be beyond the means of poor rural villages. A motorised pump also lacks the control against groundwater depletion inherent in the use of handpumps, an important consideration in these dry areas.

(8) Self Reliance

To promote self reliance and remove need for external inputs, communities are trained in pump repair and are donated the necessary tools and manual. Each well is completed with a steel gantry to allow the pumps to be removed easily. At pump installation, a training day is held. At least four men and four women chosen by the community assemble the pumps piece by piece, time being taken to indicate the function of each component and to allow each person to participate. The importance of routine maintenance is stressed. Results to date indicate that this approach make community maintenance possible. Initially, repair may not be achieved immediately after breakdown but this appears to be primarily a matter of confidence. The rate at which this confidence develops varies between communities and depends largely upon personalities present. It has been pleasing to note that some persons trained now help other neighbouring communities if their pump breaks.

(9) Official Ownership

It has been found helpful upon completion of each scheme to hold an official opening ceremony and handover. This event can be attended by local and foreign dignitaries as appropriate. It helps to seal the sense of ownership felt by the community, it allows the community to show with pride what they have already achieved in their garden, and it is an appropriate time for a celebration.

(10) Future Development

Community participation in development of small scale irrigation using groundwater provides an ideal springboard to other community projects, especially in agriculture, health and the environment. In Southern Zimbabwe, villagers given water in the present project are now

Figure 1. Key steps to be taken in development of community gardens using groundwater

Hypothetical Target: 250 farmer-managed community gardens in Southern Zimbabwe irrigated using groundwater. Each garden to be 0.5ha or larger and to serve upward of 50 families. Each will require a minimum of 15 cubic metres of water per day (including domestic water) abstracted using the most appropriate well design determined for the area.

Define Programme Area eg. Masvingo Province — Notes:

↓

Select one District at a time eg. Zaka

↓

Liase with District Development Committee in order to:
* Identify ongoing and proposed water development projects eg. dams boreholes, irrigation schemes, water and sanitation programmes
* Avoid duplication of effort or possible conflict of interests
* Collate hydrogeological data for existing wells and boreholes
* Identify Wards where present programme would appear appropriate based on need, hydrogeology, viability of other types of surface water development project

↓

Consider one Ward at a time eg. Bota South — 1

↓

Liase with WADCO and field staff of Agritex and DDF in order to:
* Confirm status of water supplies and gardens in the Ward
* Identify potential communities or VIDCO's based on need and anticipated community interest

↓

Visit selected communities or VIDCO's eg. Gondora

↓

First Community Meeting and Site Visit to Assess:
* Existing sources of water (visit plus hygrogeological records)
* Community need — 2
* Community interest
* Community structure

↓

Area considered to show potential

↓

Hydrogeological Evaluation (See separate reports)

↓

Area considered to show potential

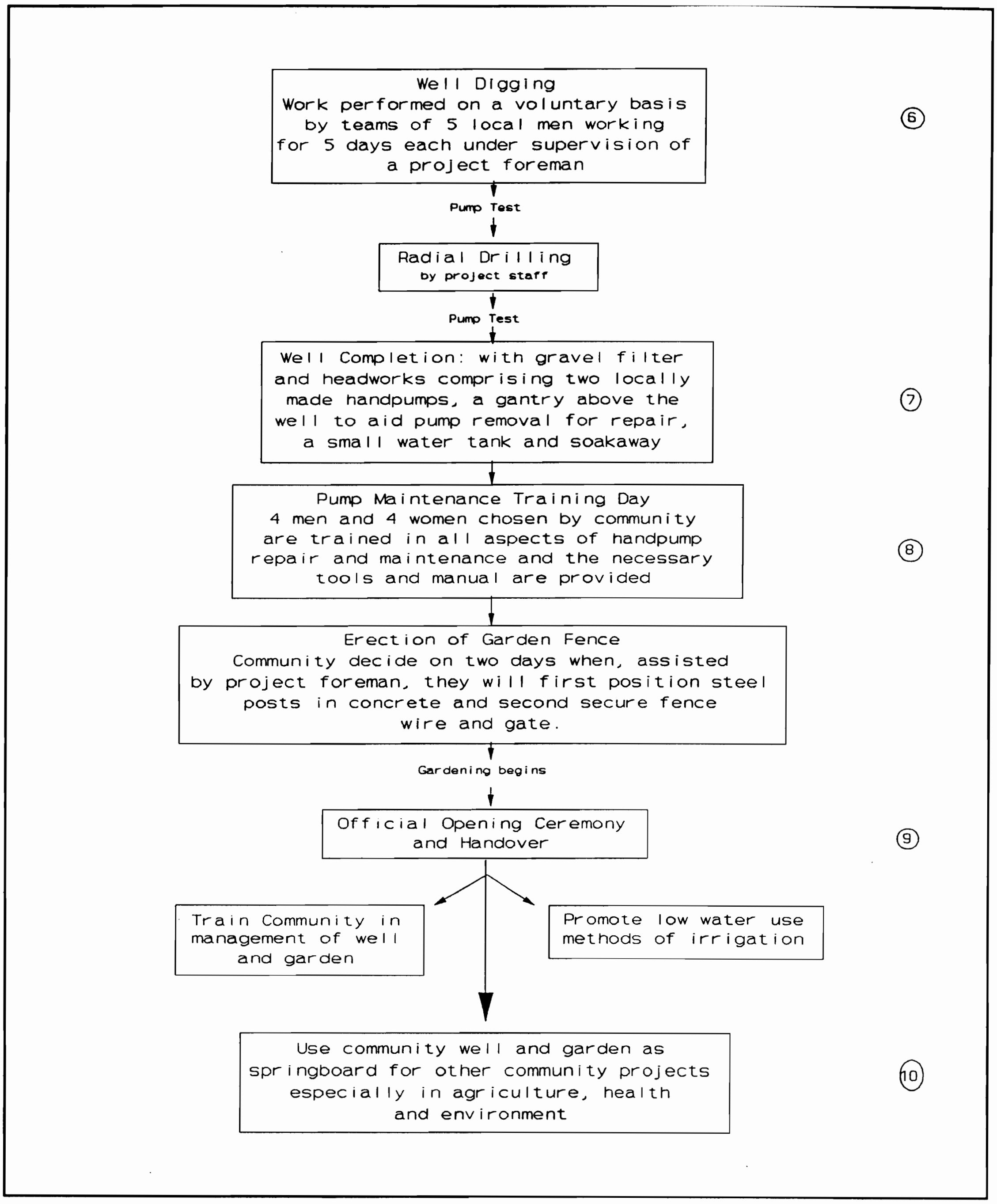
↓

Second Community Meeting to: — 3
* Describe potential project to community
* List external contributions that can be made
* List community contributions that will be required
* Answer any questions from the community
* Clarrify any misconceptions
* Confirm community committment
* Define project community and placename
* Agree community contribution to construction — 4
* Agree allocation of land for the project
* Agree programme of work
* Sign informal contract with the community — 5

↓

Begin Work

↓



beginning other projects that include keeping rabbits and growing fruit trees. Community workers in the area are now able to advise on nutrition at the new gardens. Agricultural extension staff and NGO's are providing advice on agronomy and garden management and are promoting low water use methods of irrigation. Perhaps most exciting is a proposal currently being prepared by Government to replicate community gardens using groundwater on a wider scale. This proposal recognises the opportunity to initiate concurrent community-based management of soil and water resources in each small catchment. In this way, the people themselves will become responsible for recharge to their well and the life of their scheme, and in so doing will also begin to address the problems of environmental degradation too daunting when considered on a larger scale.

3.1.2 Revised capital costs

A spreadsheet to analyse the capital costs of collector wells and boreholes was presented in the fourth progress report. Revised capital costs are presented in Appendix 1.

The main revision concerns cost of well lining material used. Enquiries show that steel well lining manufactured by Armco Superlite (Pvt) Ltd in South Africa is cheaper than similar material manufactured by Asset International Ltd in Wales and (surprisingly) cheaper than either concrete segments or concrete rings manufactured locally by Fort Concrete (Pvt) Ltd in Gweru. Bricks and cement represent a low cost alternative but, unlike steel or concrete added as sections from the top, would require the well to be dug first and lined from the bottom upward. The use of a temporary steel lining prior to a final lining of bricks and cement would seem possible.

The following provides a comparison of costs for a 15 metre deep collector well lined using the alternative materials:

Lining material	Lining cost (Z$)	Completed well (Z$)
2.0mm SA Armco steel	8226	88307
1.6mm SA Armco steel	15387	85457
1.6-2.5mm UK Asset steel	27000	97082
Concrete Segments	23274	93362
Concrete Rings	27900	97982
Bricks & Cement	9757	79847

When comparing these costs for 'completed well' with those for other well types such as boreholes, it should be noted that these costs are for a well that will successfully serve a community garden and implemented by a multidisciplinary team following the full sequence of steps shown previously in Figure 2. Costs to purely construct a collector well in the same manner as a borehole drilled by a contractor on behalf of a client would be less by approximately 15 per cent due to the reduced staff and vehicle inputs required.

Costs for each item shown in Appendix 1 (for both wells and boreholes) remain those valid in September 1994. They can be updated as necessary. In the meantime efforts are continuing to identify any further savings that might be made in future work, particularly with respect to drilling equipment used. Enquiries to date suggest that Marlow (Pvt) Ltd can manufacture a portable drilling rig capable of lateral drilling and at approximately half the cost of the present Demco (Pvt) Ltd drilling rig. It remains for this alternative to be evaluated but if found suitable this option would further reduce costs by 10 per cent.

3.2 PROPOSAL FOR TRANSITIONAL PROJECT

3.2.1 Formation of a Steering Committee

Much interest continues to be expressed by communities and organisations in the region wishing to develop community gardens using groundwater. Donor interest in supporting the costs of scheme construction has now been expressed by at least nine organisations (Red Cross, World Vision, Plan International, Christian Care, GTZ, CARD, Kellog Foundation, KFW and IFAD). Numerous written and verbal requests continue to be received by project staff from communities wishing to copy what they have seen at pilot project sites.

At the second annual project review meeting in November 1994, a steering committee was appointed by the review mission. It was charged with the task of beginning to design a next phase of work: a transitional project to develop capacity in Government, provide an interim period to monitor all aspects of scheme performance and sustainability before full-scale replication, and to implement more schemes in needy areas. The design of project will be consistent with the National Action Plan and use the Water Resources Management Strategy as a reference point. The committee will provide Agritex with a project design that can be used to seek funding.

Members of the steering committee are:

Mr Chitsiko (Chairman)	Agritex
Mr Madhiri	Agritex
Mr Mugweni	Agritex
Mr Sunguro	DWD
Mr Mharapara	DR&SS
Mr Nhunama	NCU
Dr Lovell	Project

3.2.2 Progress to date

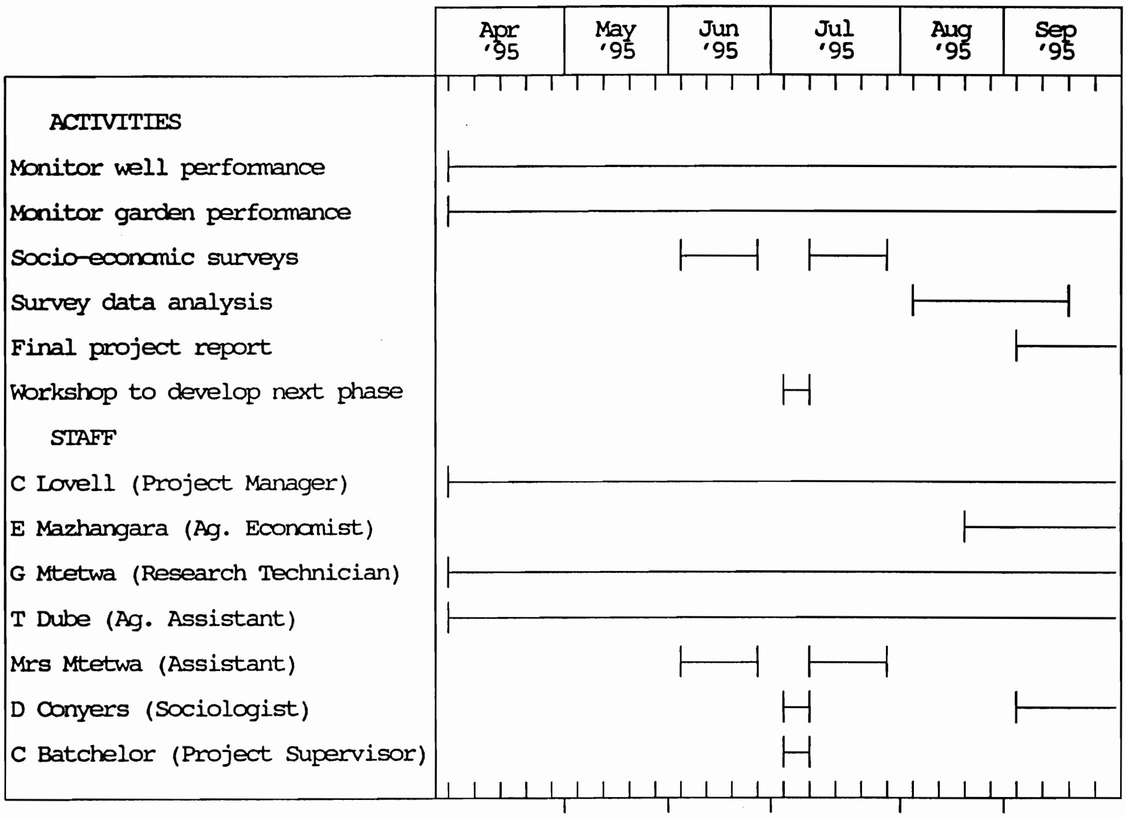
The steering committee held its first meeting immediately after the review mission proceedings were closed. Two further meetings were held in November 1994 and April 1995.

A possible framework for the project was prepared and a number of issues identified for discussion. These include: overall project goal (short-term 'drought relief' type project or long-term Government implemented programme); integration with ongoing programmes (such as Rural Water Supply and Sanitation Programmes) and existing structures (such as Rural District Councils); mechanisms to develop capacity (for example, the concept of a National Training Team or Unit to train provincial teams to undertake district programmes); input by Government and potential for co-funding of various aspects (for example, development of National Training Team, implementation of district programmes, monitoring of environmental, social, economic and institutional aspects); preferred channels of funding (for example, via Rural District Councils) and overall project management and ownership.

A workshop supported by ODA will now be held in Masvingo 3-5 July in order to properly discuss these issues and to develop a logical framework for the next phase of work. Invitations to participants from all Ministries and Departments involved are being sent at present.

4 Programme of work for the next six months

The following is the programme of work proposed for the final six months:



4.1 STAFF

Each site continues to be visited on a monthly basis by Mr Dube (DR&SS) and Mr Mtetwa (DR&SS) in order to collect data on garden performance, well performance, and scheme progress in general. Mr Mtetwa was trained in analysis of well performance data by Mr Thompson (ODA APO) prior to Mr Thompson's departure in March.

Mr Mazhangara, DR&SS Agricultural Economist, took over analysis of the economic data following Mr Brown's departure in September. Unfortunately secondment to ICRISAT now means that he has considerably less time available to spend on the project although he believes it is still sufficient to analyse forthcoming data.

Mr Rastall, BGS Driller, completed his assignment in October 1994 when drilling operations for the project ceased. The drilling equipment is presently in Botswana.

A socio-economic survey designed to follow the baseline survey and to assess scheme impact on both members and non-members of each community will be conducted during June and July. Dr Conyers (Social Development Adviser) has assisted in design of a questionnaire to be used (see Appendix 3). Mrs Mtetwa will accompany Mr Dube to conduct the survey and collect data on all aspects including gender related issues. Mr Brown (former ODA TCO Agricultural Economist) has offered to analyse the survey data from his home base in the UK.

5 Acknowledgements

Many staff of MLAWD and MLGRUD have given their advice and support to this project during the fifth six months of work. Particular thanks also go to Social Development Adviser, Dr Diana Conyers for her continued assistance, and to Mr Norbert Honigmann for advice regarding pump design.

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Appendix 1: Garden Performance at Sites 1-6 and Tamwa/Sihambe/Dhobani

A1.1 MUZONDIDYA COLLECTOR WELL GARDEN: FIRST WINTER SEASON 1994

Introduction

The start of the winter cropping season at Muzondidya was adversely affected by the lack of effective leadership. The chairman apparently advised members of the garden that he had purchased seed and sown a nursery at his homestead for close monitoring. In the event, members had to buy rape and sweet cabbage seedlings from private sources when it became clear that the chairman had in fact misappropriated their funds.

Cropping Pattern

Garden members first transplanted a bed each of rape and sweet cabbage in March, followed by a bed of tomatoes and another of sweet cabbage in May. The following Table summarises the dates of transplanting and cropping pattern for the 134 members.

Table 1 *Dates of Transplanting and cropping*

Date	Crops transplanted (beds per member)
14 March	1 Rape
15 March	1 Sweet cabbage
11 May	1 Tomato
12 May	1 Sweet cabbage

Irrigation

Irrigation varied from four to five 20l buckets from March to October although the frequency remained constant at twice per week. Until early June, all members came and irrigated on the same days: Monday, Wednesday and Friday. Some members drew water from the nearby stream whenever possible to avoid the inevitable congestion at the well. From early June, the committee organised watering such that groups A and B irrigated in the morning and groups C and D in the afternoon. Some members still continued to draw water from the stream until it dried in early July. The estimated total irrigation water applied, derived from the records kept by the secretary, is shown below:

Table 2 *Estimated total irrigation water applied*

Crop	Duration	Wetted area (ha)	Total Water: Litres	mm
Cabbage	15 Mar - 8 Aug	0.0804	644 160	801
Cabbage	12 May - 14 Sep	0.0804	493 120	613
Rape	14 Mar - 30 Aug	0.0804	707 520	880
Tomato	11 May - 14 Sep	0.0804	463 640	577
TOTAL (14 March to 7 October)			2 308 440	

Plant protection and Fertilization

Six pest control exercises were conducted. In April, Bexadust was dusted on rape and sweet cabbage to control aphids and leaf eaters. In May, a man was hired to spray the whole garden for $7. He sprayed using his knapsack and a chemical (unknown) left over from his cotton. He used three and a half knapsacks at 20 ml per knapsack. In June, six knapsacks were sprayed on all crops using Rogor at 5 ml per 18 l to control aphids. The chemical was purchased by the committee and the sprayman paid $5.00. The fourth spray was conducted on June 25 to control aphids in rape and cabbage. Six knapsacks of chemical (unknown) was applied at 10ml per 18 l of water. In August, Dimethoate 40 was applied in 6 knapsacks at 10 ml per 15 l of water. The man hired to do the spraying was paid $5.00. The same chemical was used at the end of September, the sprayman again paid $5.00.

Seventy-five percent of the garden members said that they applied manure at approximately 70 kg per bed. Members applied the manure mostly at time of initial land preparation. A few gave supplements during the cropping season. Inorganic fertilizer was not used in the garden.

Production

Estimates of total production from Muzondidya garden based on records provided by the garden secretary are shown in Table 3.

Table 3 *Estimated total production from the garden*

Crop	Production Sold	(kg) Consumed	Total (kg)	Ave Area (Ha)*	Yields (t/ha)
Rape	74	97	171	0.1206	1.42
Tomato	45	80	125	0.1206	1.04
Cabbage	151	320	471	0.2412	1.95

* Includes pathways

Financial Performance of the Garden

A gross margin analysis was to be performed for the season based on the above records of production. However, upon inspection it became clear that the records were inaccurate and that production was in fact grossly under-reported. Investigation of the cause revealed that a) the secretary at this site attended the garden primarily during mornings only and very often did not report on afternoon activities; b) she also did not report on substantial sales of vegetables made to buyers coming from as far away as Jerera; c) members were generally reluctant to reveal to her their true crop yields for fear that they might be disadvantaged in some way in the future; d) members had free access to the garden to harvest vegetables at any time of day making precise record keeping difficult.

This episode highlighted the difficulties faced by a single person asked to keep records; two secretaries are now to be appointed. It also highlighted the need for project staff to look more carefully at data as it is collected, and to re-stress to each community the importance of accurate record keeping to the future of the project.

Discussions with the Agricultural Extension Worker, Mr Makunde, revealed that production at Muzondidya was in fact on a par with that at Gokota, a site for which he also had responsibility in the absence of a colleague. It was decided therefore that a best estimate only could be made for financial performance at this site using all data collected but supplemented by crop production figures collected at Gokota.

Estimated Gross Margin Analysis

Output (based on crop production at Gokota)				**Z$**	**Z$**
Rape (fresh leaves)		4916 kg	@$1.00/kg	4916	
Cabbage "		6588 kg	@$1.00/kg	6588	
Tomato		1942 kg	@$1.00/kg	1942	
Total value of output					13446
Variable (cash) input costs					
Seed:	Rape			8	
	Cabbage			7	
	Tomato			15	
	Onion			8	
	Total seed cost			38	
Chemicals:	Dimethoate 40 (400ml)			42	
	Bexadust			12	
	Total chemical cost			54	
Hire Charges:	Knapsack & sprayer			22	
	Total hire charges			22	
Total Variable Cost					114
Gross Margin					13332
Average Gross Margin per hectare					27673
Average Gross Margin per Member for the season					100

Average estimated labour inputs/member household	**"man"-hours**
Digging,manuring,bed prep & transplanting	24
Irrigation (including pumping) and weeding	
- 2 hrs/week by 4 weeks	8
- 4 hrs/week by 4 weeks	16
- 6 hrs/week by 12 weeks	72
- 9 hrs/week by 4 weeks	36
- Watering during the week of transplanting (5 operations of 4 beds at 1hr per bed)	20
Total labour input per member household	176
Average Gross Margin return to labour ($/labour day)	**4.52**

A1.2 GOKOTA COLLECTOR WELL GARDEN: FIRST WINTER SEASON 1994

Introduction

Gokota collector well garden was completed in October 1993. No progress was recorded until February 21, 1994 when the first nursery bed of rape seedlings was planted by a volunteer chairperson. Problems until this time included a leadership crisis and an unfulfilled promise by the Assistant District Administrator to provide a free tractor to prepare the land. These problems paralysed progress for the 130 members who had paid a $2.20 joining fee until a young man called Luke took initiative as chairperson. This report covers the first cropping season from March to October 1994.

Cropping Pattern

The first nursery bed of rape was planted by the volunteer chairperson (later elected chairperson) on February 21. Other seeds included onion, sweet cabbage and tomato also planted later. With the garden experiencing the problems described above, membership that started at a high of 130 paid up members dropped to 112.

Initially members came at different times and the cropping pattern was generally uneven. In March, the garden had 63 beds of rape and 36 beds of cabbage. Each bed was 5 metres by 1 metre. By April, the number of rape and sweet cabbage beds had increased to 130 and 125 respectively plus 66 beds of tomato and 39 beds of onion. In May, five beds of rape were uprooted due to stem rot and worms, while the number of tomato and onion beds went up to 81 and 71 respectively. By June each of the 113 members had 1 bed of rape, 1 bed of sweet cabbage and 1 bed of tomatoes. This pattern was maintained in the month of July. In August, 73 members added the 4th crop of shallots from their own private sources. The garden was fully utilized by mid-August. Table 1 shows the dates of transplanting.

Table 1 *Dates of transplanting and cropping pattern*

Date	Crops transplanted (number of beds)
(per entire garden records)	
28 February &	63 Rape, 36 Sweet cabbage,
11 March	67 Rape, 89 Cabbage, 66 tomato, 39 Onion
15 April	32 Onion
4 May	15 Tomato
(per member records)	
17-18 May	1 Rape
21-22 June	1 Sweet cabbage
2-3 August	1 Shallots

Irrigation

The irrigation schedule was twice per week except for April when garden members irrigated thrice per week. The amount of water applied varied according to stage of crop and temperatures. The general pattern was that more water was applied at the early stages of transplanting to keep the seed bed moist and less after establishment. In June and July, the quantity applied also declined because of the cool weather conditions. Water applied in August increased as temperature increased. Estimated total amounts of irrigation water applied and derived from the records kept by the secretary are shown in Table 2.

Table 2 *Estimated total irrigation water applied*

Crop	Duration	Wetted* area (ha)	Total Water: Litres	mm
Rape	28 Feb - 7 Jun	0.0315 (63)	221 760	704
Rape	11 Mar - 7 Jun	0.0335 (67)	187 600	560
Rape	17 May - 30 Sep	0.0560(112)	267 680	478
Tomato	28 Feb - 24 Jun	0.0330 (66)	274 560	832
Tomato	4 May - 15 Aug	0.0075 (15)	31 560	421
Onion	11 Mar - 29 May	0.0195 (39)	104 520	536
Onion	15 Apr - 29 May	0.0160 (32)	46 720	292
Cabbage	21 Jun - 5 Nov	0.0560(112)	394 240	704
Shallots	2 Aug - 8 Oct	0.0365 (73)	125 560	344
TOTAL	(16 April to 19 November)		1 654 200	

* Excludes pathways
Figures in parenthesis shows the number of members each with a bed of the crop.

Plant protection

A total of five sprays were applied to the garden crops. The first two, 37.5 ml and 90 ml of Carbaryl, were sprayed to control leaf eaters during the first and second week of March respectively. The third spray of 45 ml of Diazon was applied to all crops during the last week of March. In April, the fourth spray of 45 ml of Diazanon was applied on all crops. For these four sprays, the chairman, Luke Chikwera, did all the spraying using a knapsack sprayer. The last spraying was conducted in July by the members on each of their own crops to control aphids and red spider mites. Problems of stem rot in leaf vegetables were encountered. Samples were sent to the Horticulture section at the Lowveld Research Station who diagnosed over-watering at this time (3 irrigations per week). When members reduced the schedule to twice per week the problem was solved.

Fertilization

Maintenance and fertility was in general ad hoc. Members applied three or four 20l buckets full of either kraal manure or chicken droppings. This was generally done at bed preparation before transplanting. A few of the members did apply manure around harvest time. No inorganic fertilizers were used.

Production

As Table 3 shows, production levels were quite satisfactory considering that this was the first cropping season. Tomato and rape yields were particularly impressive and were undoubtedly helped by the intermittent spraying done to control disease and pest infestation. There is scope for onion yields to improve.

Table 3 *Estimated total production from the garden*

Crop	Production Sold	(kg) Consumed	Total (kg)	Ave Area (Ha)*	Yields (t/ha)
Rape	2270	2646	4916	0.1815	27.09
Tomato	429	1513	1942	0.0608	31.94
Onion	21	21	42	0.0533	0.79
Cabbage	1746	4842	6588	0.0840	7.84
Shallots	5	129	134	0.0548	2.30

* Includes pathways

Financial Performance of the Garden

Results of a gross margin analysis for the season is presented below. Gross values were calculated on "garden gate" prices which are expressed in local units of measures such as bundles and heads. The gate prices were $2/kg for tomatoes and $1/kg for all the other crops. Jerera Growth Point market prices are listed in Table 4 below to enable comparisons to be made.

Table 4 *Jerera Price Data for Winter 1994 ($/kg)*

Date	Rape:	Cabbage:	Tomato:	Onion:
May 11	2.22	2.20	3.62	---
Jul 12	2.81	3.02	2.17	---
Aug 8	1.64	1.68	2.76	---
Sep 5	1.28	1.39	3.33	---
Oct 5	2.38	2.50	3.85	---
Oct 31	2.00	—	4.00	---
Dec 5	2.32	2.71	—	—

Gross Margin analysis (whole garden)

Output		**Z$**	**Z$**
Rape (fresh leaves)	4916 kg	4916	
Cabbage "	6588 kg	6588	
Tomatoes	1942 kg	3884	
Onions	42 kg	42	
Shallots	134 kg	134	
Total value of output			15564
Variable (cash) input costs			
Seed: Rape		36	
Cabbage		22	
Tomato		68	
Onion		56	
Total seed cost		182	
Chemicals: Carbaryl dust (80g)		10	
Diazanon (100ml)		17	
Total chemical cost		27	
Total Variable Cost			209
Gross Margin			15355
Average Gross Margin per hectare			35348
Average Gross Margin per Member			316

Average estimated labour inputs/member household	"man"-hours
Clearing out old crops	3
Digging;4 beds at 1 hour/bed	4
Nursery	8
Transplanting; 8 transplanting at 2 hours/bed	16
Irrigation (including pumping) and weeding	
- 8 hrs/week by 4 weeks	32
- 6 hrs/week by 12 weeks	48
- 9 hrs/week by 8 weeks	72
-12 hrs/week by 8 weeks	96
- extra watering of new transplants; 8 transplanted beds by 1 hour/bed by 5 days	40
Total labour input per member household	319
Average Gross Margin return to labour ($/labour day)	**3.42**

A very high gross margin was achieved. Part of the success of Gokota collector well garden can be explained by members maintaining good dialogue. They have been holding an impressive series of meetings in which issues ranging from the successful construction of a toilet, Rotating Savings and Credit Association (RoSCA), and the Official opening ceremony were discussed with all members present. Good leadership from Luke Chikwera is also worth acknowledging. For instance, when the revolving fund started to decline, he quickly realised that the reason was that members were now consuming more vegetables and making fewer sales. He called a meeting and the fund stopped.

The gross margin return to labour of $3.42 per labour day can improve. It was lowered partly as a result of overwatering, which was also counter productive causing stem rot. However, if one considers the near zero opportunity cost of labour during the winter when these vegetables were grown, $3.42/day is clearly an attractive and profitable use of labour.

Conclusion

Despite slow progress at the beginning caused by leadership problems and unkept promises, and some reduction in yields due to overwatering during the season, the community at Gokota have achieved very good success in their first cropping season. The gross margin recorded is the second highest estimated so far for any community garden in the project. Given that members will have learned from past experience, it is possible that gross margins and returns to labour may be even higher in subsequent seasons. Mr Luke Chikwera, Mr Vudzijena (AEW) and the 112 members are to be congratulated.

A1.3 DEKEZA COLLECTOR WELL GARDEN. FIRST WINTER SEASON 1994

Introduction

An advisory committee of six, consisting of the agricultural extension worker, the councillor and four village community workers, was self-appointed in September 1993 to advise on garden matters. By the end of September, 56 members had been randomly selected and vetted by the advisory committee. From the 56 members, an eight member garden committee was elected. This committee differs from committees elected at other sites in the sense that it has a president, Mr Dekeza Munjanja, who is the Headman of the area. Mr. Solomon Mahiya was elected chairman of the garden committee. In November 1993, fence posts were erected by garden members but not all were present. In December, the garden members came together to erect the fence. The chairman enlisted only those members who were not present for the previous task but this resulted in insufficient help. It became apparent that the community had a misconception regarding ownership of the garden as most of them thought they were assisting project staff. The chairman then suggested that a fine of $5 be charged for members who did not report for community duty. By February 1994, thirty-eight members had fully paid their $4 monthly subscriptions and an additional 18 were to pay $120 each to cover fines they had not paid and or months for which they had not paid their subscriptions.

Three sides of the garden were completely fenced by February. A team of 4 hired oxen were used to plough the garden at a cost of $160. Payment was not a problem because the garden had already raised a total of $550 in fines and monthly subscriptions. By April when the first nursery was put in, membership had risen to 43. This report covers the first cropping season, April - November 1994.

Cropping Pattern

The size of beds at Dekeza were pegged at 1 x 3.5 metres each. Members were allocated by the committee up to 15 beds each. Three beds of rape, 3 beds of sweet cabbage and 4 beds of tomatoes were transplanted during the last week of April by 43 members. Five new members who joined at the end of May got 3 beds of rape, 3 beds sweet cabbage and 4 beds of tomatoes. Seedlings for the additional five came from the already transplanted crops which where closely spaced. Between May and July, 3 additional beds of Rape, 1 of spinach and 1 of onion were transplanted. The following Table summarises the dates of transplanting and cropping pattern.

Table 1 *Dates of Transplanting and cropping*

Date	Crops transplanted (beds per member)
25 April	3 Rape
26 April	2 Sweet cabbage
29 April	4 Tomato
Additional 5 members	
28 May	3 Rape
28 May	3 Sugar loaf
28 May	4 Tomato
16 June	1 Onion
7 July	3 Rape
16 July	1 Spinach

Irrigation

Irrigation applied varied from three to six 20l buckets from April to October although the frequency remained constant at thrice per week. The committee organised the members into two groups, A and B, to avoid congestion at the well. Before July both groups were working on the same days with Group A working in the morning from 6.30 am to 12 noon and group B from 12 noon to 6.30 pm. From July onwards Group A came to work in the garden on Mondays, Wednesdays and Fridays and Group B, Tuesdays, Thursdays and Saturdays. The estimated total amount of irrigation water applied, derived from the records kept by the secretary, is shown in Table 2.

Table 2 ***Estimated total irrigation water applied***

Crop	Duration	Wetted area (ha)	Total Water: Litres	mm
Cabbage	26 Apr - 30 Aug	0.0452	534 060	1183
Cabbage	28 May - 30 Sep	0.0053	66 300	1250
Cabbage	1 Aug - 30 Oct	0.0168	200 640	1194
Rape	25 Apr - 30 Aug	0.0452	178 020	1183
Rape	28 May - 29 Sep	0.0053	66 300	1250
Rape	7 Jul - 5 Nov	0.0504	777 600	1543
Tomato	29 Apr - 30 Sep	0.0602	959 760	1594
Tomato	28 May - 29 Sep	0.0053	88 400	1263
Onion	16 Jul - 5 Oct	0.0151	208 120	1378
Spinach	16 Jul - 5 Sept	0.0151	85 140	564
TOTAL	(14 March to 7 October)		2 308 440	

The crops at Dekeza collector well garden received abundant irrigation at about 10mm/day. More buckets of water were applied at a higher frequency and on shorter beds than elsewhere.

Plant protection

A total of seven pest control exercises were conducted. In April, carbaryl was dusted on rape and sweet cabbage by the chairman Mr. Mahiya to control aphids. On 5 May, the same chemical was applied against leaf eaters and cut worms on rape, tomato and cabbage. Two weeks later, on 18 May, Fungicide Super was applied on rape and sugar loaf at the rate of 100 ml per 18 litres of water to control aphids. This fungicide was administered by a knapsack sprayer and a hired sprayman at a cost of $5.00. In the month of June, two sprays of Dimethoate 40 were applied to rape and cabbage to control aphids at a rate 20ml/15l on June 11 and June 25. On both occasions, the chemical was administered by the chairman using a knapsack sprayer free of charge. On July 7, Dimethoate 40 was again applied as per the June sprays. The seventh and last spray was done on the 5th of August again spraying Dimethoate 40 to control aphids. A sprayman was hired for $5 and worked with Mr. S. Mashaya, one of the committee member.

Fertilization

At the initial land preparation, 14 scotch carts full of manure, provided free of charge by Mr. V. Mawere, garden treasurer, were delivered to the garden. Each bed received 2 buckets of manure. The five members who joined the scheme later also applied two 20 litre buckets of manure on each of their beds. Inorganic fertilizer was not used in the garden.

Production

Estimates of the total production from Dekeza garden are shown in Table 3. Production levels of all crops were very impressive. Good management, maintenance of soil fertility, and abundant irrigation resulted in high yields that compare favourably with yields indicated in the Agritex Horticultural Handbook derived for the whole country.

Table 3 *Estimated total production from the garden*

Crop	Production Sold	(kg) Consumed	Total (kg)	Ave Area (Ha)*	Yields (t/ha)	Handbook (t/ha)
Rape	1150	2417	3567	0.1512	23.59	25-50
Tomato	4808	342	5150	0.0983	52.39	50
Onion	1714	1418	3132	0.1010	31.01	30-35
Cabbage	5	895	900	0.0227	39.65	30
Shallots	26	325	351	0.0227	15.46	12-15

* Includes pathways

Financial Performance of the Garden

Results of a gross margin analysis for the season are presented below. Gross values were calculated on "garden gate" prices.

Gross Margin analysis (whole garden including pathways)

Output			**Z$**	**Z$**
Rape (fresh leaves)	3567 kg	@$1.20/kg	4280	
Cabbage "	803 kg	@$1.20/kg	964	
Cabbage "	2329 kg	@$1.25/kg	2911	
Tomatoes	5150 kg	@$1.50/kg	7725	
Onion	900 kg	@$3.00/kg	2700	
Spinach	351 kg	@$1.25/kg	439	
Total value of output				**19019**
Variable (cash) input costs				
Seed: Rape			27	
Cabbage			45	
Tomato			71	
Spinach			10	
Onion			24	
Total seed cost			177	
Chemicals: Dimethoate 40 (400ml)			26	
Carbaryl Dust			17	
Total chemical cost			43	
Hire Charges: Knapsack & sprayer			10	
Total hire charges			10	
Total Variable Cost				**230**
Gross Margin				**18789**
Average Gross Margin per hectare				**47459**
Average Gross Margin per Member for the season				**989**

Average estimated labour inputs/member household	**"man"-hours**
Digging, manuring, bed prep & terracing	101
Nursery (guestimate)	5
Transplanting	11
Irrigation (including pumping) and weeding	
- 9 hrs/week by 4 weeks	36
-15 hrs/week by 8 weeks	120
-18 hrs/week by 12 weeks	216
- Watering during the week of transplanting	42
Total labour input per member household	531
Average Gross Margin return to labour ($/labour day)	**5.90**

The gross margin earned by members at Dekeza during their first cropping season is very attractive. Of the gross margin per family $989, approximately $554 was received directly as cash from sales. The remaining $435 was the imputed value of home consumed produce. The average gross margin return to labour of $5.90 per labour day is also excellent and higher than achieved with first crops at other schemes. This amount represents a very profitable use of labour in the winter when the opportunities to earn an income are scarce. In subsequent seasons this figure is also likely to improve because labour to prepare beds and terrace the garden will be less than during this initial season.

Social Dynamics of Dekeza Collector Well and community garden

A few teething problems have been experienced, mainly in the form of misunderstandings among key people in the area. One of these concerned access to the well via the garden gate. The headmaster had requested a spare key to let teachers and school children get water for domestic, building and garden purposes, but was told by the chairman that the garden was exclusive to garden members. The extension worker insisted that he should also keep a spare key. The headmaster brought the matter to the attention of the Headman who resolved the issue. After that, good cooperation emerged between the school and the garden leadership. Leaders in the garden have received extension advice from the AEW and from the agricultural teacher, and cooperation from school staff was also noticeable when the bush pumps required repair.

A pending problem concerns an allegation that the garden chairman used $361 out of a gift of $861 given to the garden members by the Deputy High Commissioner at the official opening ceremony for a private celebration party, attended by the headmasters of the secondary and primary school, the Chief, vice chairperson and a few committee members. When approached by the AEW, the chairman alleged that the $361 had been given to him as a gift. The agricultural extension officer has reported this matter to his superiors at district level. The situation will be monitored.

Conclusion

The garden at Dekeza has benefitted to date from the good chairmanship of Mr. Solomon Mahiya and the good agricultural extension advice from Mr Maraiva AEW and the school agricultural teacher. This is highlighted by the resounding success of the first season. The community at Dekeza has also made a hallmark in the form of a toilet. Five hundred kilograms of cement were bought from the local store for a cash sum of $394.00. Dekeza and Gokota are the only two collector well sites to have achieved this. A ready market for vegetables appears to be available in the form of both the secondary and primary schools, Dekeza Business Centre itself, and via the road traffic that goes through to another business centre. If the pending dispute between chairman and AEW can be settled quickly and smoothly, there is good reason to hope that the scheme at Dekeza should continue to attain good production levels and excellent returns.

A1.4 NEMAUKA COLLECTOR WELL GARDEN. FIRST WINTER SEASON 1994

Introduction

A garden committee of seven women was elected during construction of Nemauka community garden. The committee set the joining fee at $6 per member, drawing from the 6 adjacent kraals who wanted to participate. 74 members paid their joining fee. On December 12th 1993, pumps were installed and 19 people trained in pump maintenance. Erection of the garden fence also began then. From that time until late April no further progress occurred. The garden had grown bushy and turned into a paddock with the gate still to be fitted and the garden ploughed. In June the garden was cleared and ploughed by a District Development Fund (DDF) tractor free of charge. With slow progress, a new committee comprising of 5 women and 3 men was elected to get things moving. An additional 10 members joined the scheme. Cropping then began with establishment of a nursery in early July 1994. This report covers this first cropping season, July - October 1994.

Cropping Pattern

Members were allocated by the committee three beds each of 1 m x 12 metres. Nearly all members dug their beds 0.45 m deep and incorporated ant heap soil and grass to improve soil fertility and soil structure. Rape, sweet cabbage and tomatoes were put into the nursery and transplanted in early August. Each member transplanted one bed of each crop. The following Table summarises the dates of transplanting and cropping pattern.

Table 1 *Dates of Transplanting and cropping*

Date	Crops transplanted (beds per member)
1 August	1 Sweet cabbage
4 August	1 Rape
15 August	1 Tomato

Irrigation

The irrigation schedule was fairly constant at eight 20l buckets thrice per week. At transplanting more water was applied to keep the seed bed moist. The estimated total amount of irrigation water applied, derived from the records kept by the secretary, is shown in Table 2.

Table 2 *Estimated total irrigation water applied*

Crop	Duration	Wetted* area (ha)	Total Water: Litres	mm
Cabbage	1 Aug - 30 Oct	0.1008	473 760	470
Rape	4 Aug - 21 Oct	0.1008	433 440	430
Tomato	19 Aug - 30 Oct	0.1008	430 080	426
TOTAL	(1 August to 30 October)		1 337 280	

* Excludes pathways

Plant protection

One spray of Rogor at a rate of 2 ml per 20l water was applied to all crops to control aphids. The chemical was applied by two men using a knapsack sprayer and hired for $30. Only two full knapsacks were used.

Fertilization

Apart from the incorporation of anthill soil and grass at time of bed preparation, a few members also applied kraal or chicken manure on an adhoc basis. Inorganic fertilizer was not used in the garden. The ant heap soil which was incorporated came from an anthill on the field set aside for the garden. Members had to level the anthill to enable cropping to begin and this provided a useful source of clay rich soil for the garden.

Production

Estimates of the total production from Nemauka garden are shown in Table 3. Production levels of all crops fell well below levels achieved elsewhere with no yield at all recorded for tomatoes. Reasons for this disappointing start are discussed below.

Table 3 *Estimated total production from the garden*

Crop	Production Sold	(kg) Consumed	Total (kg)	Ave Area (Ha)*	Yields (t/ha)
Rape	188	275	463	0.1310	3.53
Tomato	0	0	0	0.1310	0.00
Cabbage	225	170	395	0.1310	3.02

* Includes pathways

Financial Performance of the Garden

Results of a gross margin analysis for the season are presented below. Gross values were calculated on "garden gate" prices.

Gross Margin analysis (whole garden including pathways)

Output			**Z$**	**Z$**
Rape (fresh leaves)	**463 kg**	**@$1.00/kg**	**463**	
Cabbage "	**395 kg**	**@$1.00/kg**	**395**	
Tomatoes	**0**			
Total value of output				**858**
Variable (cash) input costs				
Seed:	Rape		10	
	Cabbage		10	
	Tomato		10	
	Tomato Seedling		1	
	Total seed cost		31	
Chemicals:	Rogor (500ml)		22	
	Total chemical cost		22	
Hire Charges:	Knapsack & sprayer		30	
	Total hire charges		30	
Total Variable Cost				83
Gross Margin				775
Average Gross Margin per hectare				2221
Average Gross Margin per Member				9.23

Average estimated labour inputs/member household	**"man"-hours**
Digging,bed prep & watering	31
Nursery (guestimate)	8
Transplanting;	5
Irrigation (including pumping) and weeding	
- 9 hrs/week by 2 weeks	18
-12 hrs/week by 4 weeks	48
-15 hrs/week by 4 week	60
- extra watering of new transplants; 3 newly transplanted beds by 1 hour/bed by 2 days in the week of transplanting	6
Total labour input per member household	176
Average Gross Margin return to labour ($/labour day)	**0.42**

The gross margin returns achieved at Nemauka were very low. Performance indicators of average gross margin per member $9.23 and average return to labour $0.42 highlight the problems experienced at this garden and within this community.

Social Dynamics of Nemauka Collector Well and Community Garden

The poor start recorded at Nemauka collector well garden appears to be the result of a combination of factors. First and foremost is an apparent leadership crisis. Initially, a committee of seven women was elected at the time of scheme construction. With poor progress, a second committee comprising 5 women and 3 men was elected by members in an attempt to get things going. The new committee recruited 10 new members to make the total membership 84 but did this without consulting all members. It was accused of favouritism and asked to step down in favour of the original committee. A wrangle ensued. The new committee refused to hand over books and money demanding that it was proper that they do so in front of a general meeting. The old committee did not see things that way and did not call a meeting. This went on at the expense of both pump repair and garden maintenance. When the old committee finally regained control, the chairwoman had by then gone to be with her husband in Harare. She has not returned since. The original secretary did try to call a meeting but got little attendance. All these problems weighed heavily against success during the first season at this site.

The second factor to hinder progress was the inevitable pump breakdown. Despite the fact that 19 people were trained in pump maintenance, breakdowns were not attended to on time. Clearly, this may be attributed in part to the problems of leadership at this site, but also appears to have been aggravated by the fact that when the new committee was formed, one man (former employee of DDF) was made pump caretaker. Maintenance thus rested on one man and he appears to have been poorly motivated. The outcome of all these problems was that planting only began in August. This gave a very short growing season before temperatures rose and crop yields were low. It was sad to see the deterioration of the crop which did in fact look very good in the early stages.

Conclusion

The above information was obtained over numerous visits to this site. However, project staff remain unsure if other factors related to leadership and not made public yet remain the true cause of poor progress. Inputs by the agricultural extension worker at this site are also unclear. It appears from the outside that he has made little input. If this is true, the combination of poor leadership within the community and poor motivation on the part of the AEW is proving to be a heavy burden to overcome. One outside intervention that might ease maintenance problems at this site would be to change the well pumping units from the current bush pumps to simple buckets on a stout windlass. This would cause fewer breakdowns and could be easily repaired by anybody sufficiently interested to do so. The idea would be worth trying if it were felt that less worries about maintenance allowed some members at Nemauka to regroup and basically to start again. However, members who have discussed this option are not in favour. A decision will be taken following further monitoring and prior to the winter season 1995.

A1.5 MAWADZE COLLECTOR WELL GARDEN: FIRST WINTER SEASON 1994

Introduction

Mawadze collector well garden came into operation in June 1994, with a membership of 48 families: forty-three fully paid members whose joining fee was $10.00 each, and five members who had joined later paying a late joining fee of $80.00 in monthly subscriptions. Membership of the scheme rose from 48 to 50 in September when two more people joined, paying a late joining fee of $70.00 per member. This report covers the 1994 winter cropping season from May to October.

Cropping Pattern

Mawadze collector well garden contains long beds that are 8 m x 1m and short beds that are 6 m x 1 m. Thirty eight members who joined early got 5 long beds each while the remaining 10 members, who join the scheme later, got five short beds each. To utilize remaining space, the committee also made available additional short beds for those members wishing to do more. Sixteen families responded to this possibility. The resulting cropping pattern is shown in Table 1 below.

Table 1 *Cropping pattern & distribution of beds at Mawadze Collector Well Garden*

Crops	Members	No. of Beds	Description of Beds
Rape	16	2	(1 long, 1 short)
	22	1	(1 long)
	10	1	(1 short)
Onion	16	2	(1 long, 1 short)
	22	1	(1 long)
	10	1	(1 short)
S/cabbage	16	2	(1 long, 1 short)
	22	1	(1 long)
	10	1	(1 short)
Tomato	16	4	(2 long, 2 short)
	22	2	(2 long)
	10	2	(2 short)

Transplanting of seedlings occurred on the 17th, 18, and 20th June for rape sweet cabbage and tomato and onion respectively.

Irrigation

Irrigation was generally twice per week. At transplanting more water was applied to keep the seed bed moist. The first crop was planted in June, a cooler month, and water applied was lower. The estimated total amount of irrigation applied, derived from the records kept by the secretary, is shown in Table 2.

Table 2 *Estimated total irrigation water applied*

Crop	Duration	Wetted area (ha)	Total Water: Litres	mm
Rape	17 Jun - 1 Oct	0.0304 (38)	135 280	445
Rape	17 Jun - 1 Oct	0.0156 (26)	72 800	467
Cabbage	18 Jun - 6 Nov	0.0608 (38)	232 560	383
Cabbage	18 Jun - 6 Nov	0.0312 (26)	126 880	407
Onion	20 Jun - 1 Oct	0.0304 (38)	136 800	450
Onion	20 Jun - 1 Oct	0.0156 (26)	76 960	493
Tomato	21 Jun - 29 Oct	0.0304 (38)	188 480	620
Tomato	21 Jun - 29 Oct	0.0156 (26)	101 920	653
TOTAL	(17 June to 6 November)		1 071 680	

* Excludes pathways
Figures in parenthesis show the number of members with one bed each of the crop, except for cabbage where each member had 2 beds.

Plant protection

A total of two sprays were applied to the garden crops during the course of the season. The first spray of 30 ml of Rogor, was administered by a knapsack at a concentration of 7.5ml/20 litre knapsack to control aphids. During the second spray, the same chemical was used to control aphids in rape and cabbage but at a slightly higher concentration of 7.5 ml/18 litre knapsack. Both the knapsack and two men who did the spraying were hired by the committee for a sum of $20 for each spray.

Fertilization

Members applied between four and five 20 litre buckets full of either cattle or goat manure or leaf litter at time of bed preparation. A few of the members applied two to three 20 litre buckets of manure in early September.

Production

Estimates of total production from Mawadze garden are shown in Table 3. Production of cabbage, rape and onion was impressive for a first crop season. The tomato crop was badly affected by frost on June 29 and 30 and sadly no yield was recorded.

Table 3 *Estimated total production from the garden*

Crop	Production Sold	(kg) Consumed	Total (kg)	Ave Area (Ha)*	Yields (t/ha)
Rape	357	1469	1826	0.0690	26.46
Tomato	0	0	0	0.0690	0.00
Onion	851	104	955	0.0690	13.84
Cabbage	2050	324	2374	0.1380	18.26

* Includes pathways

Financial Performance of the Garden

Results of a gross margin analysis for the season are presented below. Gross values were calculated on "garden gate" prices indicated, and which are lower for all crops than those at Jerera market shown in Table 4 for comparison.

Table 4 *Jerera Price Data for Winter 1994 ($/kg)*

Date	Rape:	Cabbage:	Tomato:	Onion:
11 May	2.22	2.20	3.62	—
8 Jun				
12 Jul	2.81	3.02	2.17	—
8 Aug	1.64	1.68	2.76	—
5 Sep	1.28	1.39	3.33	—
5 Oct	2.38	2.50	3.85	—
31 Oct	2.00	—	4.00	—
5 Dec	2.32	2.71	—	—

Gross Margin analysis (whole garden including pathways)

Output			**Z$**	**Z$**
Rape (fresh leaves)	1724 kg	@$0.67/kg	1155	
Rape (fresh leaves)	102 kg	@$1.00/kg	102	
Cabbage "	1686 kg	@$0.67/kg	1130	
Cabbage "	688 kg	@$1.00/kg	688	
Tomatoes	0		0	
Onions	955 kg	@$1.00/kg	955	
Total value of output				4030

Variable (cash) input costs

Seed:	Rape	15
	Cabbage	12
	Tomato	35
	Onion	39
	Total seed cost	101

Chemicals:Rogor (700ml)	31	
Total chemical cost	31	
Hire Charges: Knapsack sprayer	20	
Spraymen	20	
Total hire charges	40	
Total Variable Cost		**172**
Gross Margin		**3858**
Average Gross Margin per hectare		**11183**
Average Gross Margin per Member		**233**

Average estimated labour inputs/member household	**"man"-hours**
Digging,bed prep & watering	8
Nursery (guestimate)	8
Transplanting;	6
Irrigation (including pumping) and weeding	
- 8 hrs/week by 8 weeks	64
- 6 hrs/week by 9 weeks	56
- 2 hrs/week by 1 week	2
- extra watering of new transplants; 5 transplanted beds by 1 hour/bed by 2 days in the week of transplanting	10
Total labour input per member household	154
Average Gross Margin return to labour ($/labour day)	**4.18**

Gross margin returns at Mawadze were lower than those recorded at Gokota, Dekeza and Tamwa/Sihambe/Dhobani because of the lower prices charged. Market competition exists in this area. Prices at Jerera are higher and one would expect customers and middlemen to flock to the scheme to buy cheaper vegetables, but garden members stated that they could not find a ready market for their vegetables because of competition from Mushungwa and Nerupiri gardens which are nearer to the tarred road. Members also felt that the scheme was new and few buyers knew about its existence. They hoped that the official opening ceremony would increase publicity of the scheme. In the event, some members resorted to moving around with their vegetables selling door-to-door in the neighbouring villages while the rest dried the vegetables for the summer period when relish becomes scarce. The gross margin return to labour based on people's account of time spent on the different tasks is $4.18 per labour day and is comparable to figures obtained from the first crop in other schemes. Clearly it still represents a profitable use of labour in the winter period when labour opportunity cost is normally low.

Social Dynamics of Mawadze collector well garden community

It should be noted that the community at Mawadze has shown cohesiveness throughout, from the time of first discussions about the project through construction of the well and on to production from the garden. This has paid off and has been highlighted by the particularly smooth running of this scheme. This scheme was the first to open a savings account with the Post Office Savings Bank, and is the only scheme to date to purchase a stock of bushpump spares in anticipation of breakdowns. Credit must go to the chairman Mr. Mawadze and to the agricultural extension worker Mr. Magonde who are clearly well motivated leaders.

Conclusion

Mawadze provides the first example of a scheme affected by market competition in the area. It provides an opportunity to study this effect more closely. The existing price gradient from Jerera to the scheme should tip business in favour of the scheme but this is not occurring. Further information about buyers and sellers would help identify what actually goes in the market. The possibility also exists at this scheme to construct a roadside stall at the nearby bus stop. This would enable garden members to gain entry into the road-user market but the question remains as to why this has not yet occurred. Perhaps it is that by-laws prevent it, or just that nobody has yet thought about it. Continued monitoring will provide further information.

A1.6 MATEDZE COLLECTOR WELL GARDEN

On completion of the scheme in October, the headmen of the five kraals plus the twenty-five men who dug the well (five from each kraal) undertook initial preparation of the garden and planted nine beds each of rainfed maize. This crop was considered to be an interim measure only until full membership of the garden was decided prior to the winter season 1995.

In March 1995, the twenty-five diggers, five kraal heads and five new members from each of the five kraals formed a membership of fifty-five and paid amounts of $1, $20 and $20 respectively to join. Beds were marked and a communal nursery sown. Thereafter, membership has increased to seventy-four, comprising of the twenty-five diggers who have now paid $5 each and the remainder who have paid $20 each. A good sense of project ownership can be observed, all committee members are active, transplanting of the first crop of rape and cabbage has taken place and prospects for a successful first season are good.

A1.7 TAMWA/SIHAMBE/DHOBANI COLLECTOR WELL GARDEN: WINTER 1994

Introduction

This report covers the winter cropping season of 1994. There is no clear ending of the cropping season as some of the early winter crops were removed and replaced with follow up crops. For this report winter includes all crops planted or transplanted between April 1 and August 31. Data was compiled from the garden secretary's monthly records on inputs and labour and production.

Cropping Pattern

Generally a slow start to the season was made as members took time to hold a meeting and decide what crops to grow. In early March, nine nursery beds were prepared and equally divided to rape,onion and tomato crops. Sugarloaf cabbage seed was bought by the committee but garden members did not plant it because they preferred sweet cabbage. With seedlings from the nursery, each member planted 1 bed of rape, another of onion and 2 of tomatoes. As the season progressed, an additional bed of rape was planted per garden member to make 2 beds of rape. The two beds of tomato were destroyed by frost on July 1 and were eventually uprooted and replaced by one bed of rape and one bed of sweet cabbage.

Table 1 *Dates of transplanting or planting of crops and the cropping pattern*

Date	Crops transplanted (beds per member)
16-21 April	1 Rape
22 April	2 Tomatoes
2-4 May	1 Onion
28-30 June	1 Rape
1-2 August	1 Rape & 1 cabbage

Irrigation

The pattern of irrigation more or less followed the usual schedule of 2 irrigations per week, except for the month of October. In October, one of the hottest months of the year, the usual number of 20-litre buckets per bed were applied to all crops but were split into three applications. The schedules for irrigation were set by the committee as previously. The estimated total amount of irrigation water applied, derived from the records kept by the secretary, is shown in Table 2.

Table 2 *Estimated total irrigation water applied*

Crop	Duration	Wetted area (ha)	Total Water: Litres	mm
Rape	16 Apr - 9 Sep	0.0384	249 600	650
Rape	28 Jun - 29 Sep	0.0384	188 160	490
Rape	1 Aug - 19 Sep	0.0400**	208 000	520
Tomato	22 Apr - 30 Jul	0.0768	322 560	420
Onion	2 May - 23 Sep	0.0768	218 880	285
Cabbage	1 Aug - 19 Nov	0.0400**	176 000	440
TOTAL	(16 April to 19 November)		1 363 200	

* Excludes pathways
** Membership increased from 48 to 50.

Plant protection

A total of six sprays were applied mainly to rape and cabbage. Carbaryl dust was the first chemical dusted onto the crops to destroy general pests at the end of May. A second spray of Carbaryl 85 WP was administered to rape using the garden knapsack and a person hired for $5.50. August had a severe infestation of aphids on rape and cabbage. Two sprays of Dimethoate 13 days apart were applied on these crops. The last two sprays were applied in September, 11 days after another build up of aphids on sweet cabbage and rape. The money to pay the sprayman who did all the spraying was collected as $0.11 contributions per member.

Fertilization

No chemical fertilizers were used. Two bags of leaf litter, adding up to a total of 30 kilograms, were applied to each bed at seed bed preparation. Other members applied three to four 20 litre buckets full of kraal or chicken waste. Although this practice may seem to be an unrefined method of soil fertility maintenance in the sense that there is no recommended quantities of application, the people believe it yields tangible results.

Production

Production figures for the season are shown in Table 3. Compared to winter 1993, the yield of rape went up by 8.9t/ha whilst that of onion rose by 5.17 t/ha. Total cabbage production fell by 1.2 tonnes. The increase in rape yield may be attributed to improved soil fertility and improved spraying. The decline in cabbage production was a result of the reduced area planted and also the fact that the cabbage was planted late. Judging by results during winter 1993, when the first cabbage crop yielded 22.31 t/ha, it seems that the mistake made by the committee purchasing the wrong seed also cost members in final yield due to subsequent late planting. Although the tomato crop grew well after transplanting and looked healthy, it was hit by frost in July and was later abandoned. Ratios of rape and onion consumed to sold are 1.3:1 and 5.4:1 respectively.

Table 3 *Estimated total production from the garden*

Crop	Production Sold	(kg) Consumed	Total (kg)	Ave Area (Ha)*	Yields (t/ha)
Rape	1994	2569	4563	0.1752	26.05
Tomato	--	--	--	0.1522	--.--
Onion	247	1325	1572	0.1152	13.65
Cabbage	0	523	523	0.0576	9.63

* Includes pathways

Financial Performance of the Garden

Gross values of produce were calculated on "garden gate" prices. By dividing the total value by total weight of this produce, the average prices of rape, leaf cabbage and onions were calculated to be $0.70, $3.62 and $2.53 per kilogram respectively. These prices can be compared to market prices at Ngundu:

Ngundu Price Data for Winter 1994 ($/kg)

Date	Rape:	Cabbage:	Tomato:	Onion:
5 Jan	---	---	3.33	5.00
2 Feb	1.61	---	3.02	7.35
2 Mar	1.12	1.54	3.08	8.07
6 Apr	2.00	---	1.82	8.00
6 May	3.85	---	2.65	---
1 Jun	2.27	---	3.04	---
6 Jul	1.59	2.14	3.20	7.22
3 Aug	1.86	1.89	2.90	3.95
31 Aug	1.04	1.34	2.99	3.64
6 Oct	no records			

Gross Margin analysis (whole garden)

Output			Z$	Z$
Rape (fresh leaves)		4563 kg	3199	
Cabbage "		523 kg	1894	
Tomatoes		0 kg	0	
Onions		1572 kg	3984	
Total value of output				9077
Variable (cash) input costs				
Seed:	Rape		45	
	Cabbage		36	
	Tomato		92	
	Onion		80	
	Total seed cost		253	

Chemicals:Carbaryl dust (80g)	10	
Agricura (800g)	10	
Total chemical cost	20	
Hiring the sprayman	33	
Food for Extension Worker	15	
Total Variable Cost		321
Gross Margin		8756
Average Gross Margin per hectare		18903
Average Gross Margin per Member		378
Average estimated labour inputs/member household		**"man"-hours**
Clearing out old crops		6
Digging;7 beds at 1 hour/bed		7
Nursery & Fence Repair		10
Transplanting; 7 beds by 2 hours/bed		14
Irrigation (including pumping) and weeding		
- 4 hrs/week by 4 weeks		16
- 6 hrs/week by 8 weeks		48
- 9 hrs/week by 13 weeks		117
- extra watering of new transplants; 7 beds by 1 hour by 5 days		35
Harvesting and marketing; (no records)		
Total labour input per member household		253
Average Gross Margin return to labour ($/labour day)		5.77

Rape and onion made large contributions to the total value of output compared to cabbages. No yield was recorded for tomatoes, the whole crop written off by frost before fruiting. The total variable cost increased by 38% percent during the year, reflecting the general increase in production costs felt throughout the Zimbabwean economy. However, the gross margin obtained this season is higher than that of last winter and gross margin returns to labour still look very attractive given that during winter the opportunity cost of labour is close to zero.

Social dynamics of the Collector Well Community Garden

Following on from a 1993 summer season crop of maize that was totally destroyed by mice, the garden community were perhaps understandably slow to clear the garden for the winter programme. However, towards the end of February a first meeting was called and a new committee chosen. A new vice chairman, vice secretary and treasurer were elected and the remainder re-elected. A date was set for clearing the seed bed and repairing the fence. A second meeting was convened in March at which the garden members decided on the crops to be planted during the season. A fine of $1/member was also set for those members who missed a meeting or who did anything wrong. In this second meeting, two new members were allowed to join to utilize space in the garden previously taken for Lowveld Research Station demonstrations. A joining fee was set at $50 each for these two places and beds allocated with a ruling that they only start cropping after full payment. They were allowed until the end of July to make full payment.

In May, transplanting was done but a few problems arose. The pipe from well to garden got blocked and people started using the domestic pump. Mr. Ncube, secretary to the garden, got a job with Triangle Company and left. Before he left, he promised to train the newly appointed vice secretary (who then became secretary) to keep records but unfortunately he never got round to doing this. This affected record keeping for a while. The domestic pump broke down on the 31 of May. Although seven people were initially trained to repair the pump, there was a general reliance on one, Chris Mhlanga, to organize the repairs. When the pump broke, he was too busy to attend to the job. The six other men had also gone to work in Triangle. Two lessons were learnt from this experience - it is better to train both men and women to repair the pump because the latter tend to be more resident, and each man or woman should take a turn to organize repair of the pump rather than relying on one person.

During the third week of June the Chairman, Mr Tamwa, called for a meeting and discussed the importance of repairing the pumps. He requested contributions of $1/family from both garden members and non-members alike. Contributions did not come as expected but rather trickled in. However, both pumps were soon repaired. In July, Mr. Tamwa called a meeting to inform the members that they would plant a nursery. The pipe that delivers water from well to garden again got blocked and was repaired in August. Around the second week of August, the domestic pump broke down again. The garden pump also developed a crack on the pipe causing leakage during pumping. It was repaired by the community within three weeks but the domestic pump lay broken until February 1995.

As the longest running collector well and community garden, this scheme provides most information on trends in performance over time. Table 4 provides performance indicators for the garden since it began in 1991 and some brief explanatory notes.

Table 4 *Past and Present Performance of the first collector well garden*

Season	Cropped Area ha	Gross Margin $/ha	Returns to labour $/day	Notes
winter 91	0.21	658	-	Poor start due to inexperience and poor social cohesion.
Drought 91/92	0.22	45870	2.85	Drought year, high sales.
Summer 92/93	0.30	7965	8.68	
Winter 93	0.46	18333	3.56	
Summer 93/94		-	-	No crops, destroyed by mice and hail.
Winter 94	0.46	18903	5.77	

Conclusions

Despite a disastrous infestation by mice during the previous summer season, and numerous day to day problems during the present season, members of the first community garden at Tamwa, Sihambe and Dhobani have, in fact, continued to achieve a very high gross margin during their fourth winter season. They continue to receive an attractive return to labour and membership of the scheme has in fact increased. The problems of bushpump breakdown and slow maintenance are worrying, but the community does eventually get around to it and are quite capable of mending the pumps once they have decided to do this.

Appendix 2: Revised Capital Costs for Programme of 250 schemes

Capital costs for establishment of a collector well and comparisons with a borehole (semi-commercial approach using South African steel well lining)

ASSUMPTIONS

A Government department or NGO contracts a commercial company to put in the collector well or borehole.

The commercial company charges the Govt/NGO the full cost to cover the commercial rate of interest (25%; which it uses to write off its equipment) and includes a profit margin (25%)

Govt/NGO writes of its investment (ie the collector well or borehole) at the economic/social rate of interest (13%). This is the yardstick set by Government through the Agricultural Finance Corporation (AFC) for appraising projects aimed at benefiting the small-holder farming sector.

The aim is to put in 25 collector wells per year for 10 years. For this, 5 sets of digging equipment will be required (see 1 below); each set will simultaneously dig 5 wells per year. One set of drilling equipment is required (see 2 below). * = imported goods (£1 = Z$13 rate assumed).

These capital costs are for establishment of collector wells using South African steel well lining material, a lorry-mounted drilling rig manufactured by Demco, UK, and pick-up trucks rather than Landrovers where possible. Personnel costs remain for a full multidisciplinary team.

Part A **Estimated costs of establishment per collector well**

	$Z inc tax	Life years	R&M %	Annual cost ACC	Avge cost R&M	Z$/well
1. Digging equipment						
Small compressor	973000	10	2.5	27247	2433	5936
De-watering equipment:						
Diaphragm*	16250	10	50	4551	8125	2535
Air line	1200	2	0	833	0	167
Hose (3" by 40 metres)	2160	2	0	1500	0	300
Jack hammer	10000	10	5	2800	500	660
Air line	1200	2	0	833	0	167
Points (3 per well)	600					300
Manual winch	1200	10	0	336	0	67
Cable	700	1	0	875	0	175
Kibble	600	10	0	168	0	34

Concrete mixer	27500	10	1	7701	275	319
Gantry	4524	10	0	1267	0	253
Oil drums (4)	200	2	0	139	0	28
Tent	3000	5	5	1116	150	253
Steel shed	3575	10	0	1001	0	200
Gum boots (6 pairs)	410	1	0	513	0	103
Goggles (2 pairs)	50	1	0	63	0	13
Hard hats (2)	50	1	0	63	0	13
Gloves (5 pairs)	95	1	0	119	0	24
Pick axes (3)	160	1	0	200	0	40
Shovels (3)	250	1	0	313	0	63
Wheelbarrow	400	2	0	278	0	56
Sub-total digging equipment						12003

2. Drilling equipment

Drilling rig & lorry*	1300000	10	5	364044	65000	17162
Landrover (2)	460000	10	5	128815	23000	6073
Pick-up truck (3)	360000	10	5	100812	18000	4752
Trailer (2)	40000	10	5	11201	20000	528
Bowser	20000	10	5	5601	1000	264
Sub-total equipment						28779

3. Staff

Agricultural Extension Officer	3000	1440
Community Development Worker	3000	1440
Drilling	4000	1920
Pump Test Engineer	3000	1440
Scientist/Monitoring	3000	1440
Mechanic	3000	1440
Assist Driller/Crane Operator	3000	1440
Foreman (5)	1200	2880
Sub-total staff		13440

4. Other costs per well

	ZS/litre	Litres	
Diesel fuel	2.02	3000	6060
	Z$		
Hand pumps (2) & headworks	7000		7000
Brickwork	1000		1000
Crushed stone	1800		1800
	Z$/metre	Metres	
Lining (SA Armco. 2.0mm)	1215	15	18225
Sub-total other costs			34085
GRAND TOTAL (non-profit making)			88307
Company profit (%)	25		22077
TOTAL COST (profit making company)			110384

Assumptions

Commercial Discount factors	(25%)	No'years:
	1	0.8
	2	1.44
	3	1.952
	4	2.362
	5	2.689
	6	2.951
	7	3.161
	8	3.329
	9	3.463
	10	3.571
Economic/social discount factors (13%)	10	5.426
No' wells dug/team/year		5
No' wells drilled/year		25

Part B Borehole costs by commercial driller (55m hole)

	Z$
1. Using handpump	
Average total cost	31000
Success rate (%)	51
Real cost per success	60784 ie Borehole giving 0.3. l/s
2. Using motorised pump	
Borehole cost less handpump	28000
Success rate (%)	35 ie Borehole giving 0.6 l/s
Real cost per success	80000
Cost of motor pump	28000
Total cost per borehole	108000

Part C Comparisons of yields and costs

Pumping rates (li/sec):		
Collector well (handpump)	0.30	
Borehole (handpump)	0.30	
Borehole (motor pump)	0.60	
Pumping hours per day	7	
Handpumps per collector well	2	
Handpumps per boreholes	1	
Maximum yields (li/day):	Li/day	Cu um per year
Collector well	15120	5518.8
Borehole (handpump)	7560	2759.4
Borehole (motor pump)	15120	5518.8

Annual Capital Charge (Z$ per year)

Collector Well	20343 10 years at 13%
Borehole (handpump)	11202 10 years at 13%
Borehole (motor pump)	19904 10 years at 13%

Average Capital cost per cu m water:

Collector Well	3.69
Borehole (handpump)	4.06
Borehole (motor pump)	3.61 Plus operating costs

Appendix 3 Questionnaire to evaluate scheme impact by comparison with baseline household surveys and allow project appraisal by the communities. Surveys to commence June 1995

NON-MEMBERS

Site:................................Kraal...............................Date...........................

Head of Household..

Respondent(s)...

Family circumstances

1. How many people are members of the household and which of them help out with the farming and garden work?:

	Total in household	Number who help with farm or garden full-time	What do the rest do ?
Men			
Women			
Children (3-14)			
Infants			

2. When is the busiest time of year and why?

3. Do you ever need to hire labour? If yes, What for?

4. What would you say are the most serious problems facing people living in this community? (rank 1,2,3,4,5)
   a) water shortage
   b) food shortage
   c) poor nutrition
   d) poor health
   e) poor sanitation
   f) poor leadership
   g) shortage of fuel
   h) shortage of money
   i) shortage of livestock
   j) other (what?)

5. What would you say are normally your three main items of expenditure?: (estimate $/year)
   1st
   2nd
   3rd

6. What would you say are normally your three main sources of income? (estimate $/year)
   1st
   2nd
   3rd

Current water sources

7. How many buckets per day does your household need for domestic use? Does this vary seasonally?

8. Do you have sufficient water for domestic use?

9. Do you obtain any domestic water from the collector well? If yes, how much per day? Is this water better, same or worse for drinking than other sources?

10. How far do you walk to get domestic water? Has this changed since the collector well was built? If yes, how?

11. Does the collector well save you time in any way? If yes,how much per day?

12. Does the collector well cause you problems in any way?

13. Does shortage of water still prevent you from doing anything? What?

Health

14. Are there any times of the year when sickness is common? If yes, when?

15. If yes, What do you think are the causes?

16. Has your health or health in this community changed in any way during the last two years? If yes, give details.

Vegetable consumption

17. How often does your family eat fresh vegetables?:
a) All or most days throughout the year
or
b) 2, 3 or 4 times per week throughout the year
or
c) Only at certain times of the year (when?)
or
d) Rarely or not at all

18. Where do you get most of your vegetables from?:
a) Own private garden
b) Buy from other private gardens
c) Buy from the collector well garden
d) In exchange for work in the collector well garden
e) Gathered from wild
f) Grown in rainfed fields
g) Other (where?)

19. Are there any times of the year when vegetables are in short supply? Why?

20. Do you eat dried vegetables? If yes, when and why? (need or preference)

Gardening activities

21. Do you have a private garden or have you stopped, if so, why?

22. If you have never had a private garden, why not?

23. Are you a member of any other community garden?

24. Do you ever work in the collector well garden?

25. If yes, how many hours per week do you spend there?

26. Does the collector well garden prevent you from doing anything that you used to do?

27. Does the collector well garden cause you any problems?

28. Do you receive any benefits from the collector well garden: (yes or no)
a) closer source of domestic water
b) more reliable source of domestic water
c) cleaner source of drinking water

d) opportunity to work for vegetables
e) opportunity to buy vegetables
f) opportunity to sell other things
g) opportunity to meet and talk with other people
h) water for livestock
i) any other benefits (what?)

29. Which of these benefits are the most important to you?

30. Does the scheme face any problems that you are aware of?: (tick)
a) Shortage of water
b) Shortage of land for beds
c) Shortage of cash to buy inputs
d) Shortage of labour
e) Breakdown of pumps
f) Pests and diseases
g) Disagreements between members
h) Disagreements between kraals or VIDCO's
i) Disagreements between garden committee and members
j) Poor management by the committee
k) Poor input by agricultural extension worker
l) Lack of market for vegetables
m) Too many members
n) Theft
o) Problems of land allocation for the project

31. Which are the most serious (1,2,3,4,5,6 above)

32. Do you have any ideas to avoid these problems or overcome them ?

33. What was your first reaction to the idea of a collector well garden? Has this changed in any way now?

34. Have you ever been a member of the collector well garden? If yes, why did you leave?

35. If no, have you ever been given the chance to become a member?

36. If no, why were you not given a chance? If yes, why did you not join?

37. Would you like to join the scheme now? If yes, what prevents you from joining? If no, why would you not like to join?

38. If you were offered the chance to join the scheme now, how much would you be prepared or be able to pay or how much work would you do?

39. Are there any people in the community who still want to become members? If yes, estimate how many and explain why they have not yet joined?

40. Are you happy with the way the project was introduced to the community? If no, how would you suggest it be done?

41. Are you happy with the way membership was decided? Was it a fair way? If no, how would you suggest it be done?

42. Are you happy about the way the garden is run and decisions made? If no, how do you think it should be run and who do you think should make decisions?
a) Each individual does what he/she wants
or
b) Members decide as a group
or
c) Committee decides for the group
or
d) Somebody else decides for the group (who? eg Agritex)

43. Who is on the garden committee? How was this decided?

44. Are you happy with the performance of the committee? If no, how would you like to see it change?

45. Are you happy with the design of the well and garden? If not, how would you like to change it?

46. Are you happy with use of the water for a community garden? If no, how would you like to see the water used?

47. Are you happy with the two bushpumps? If no, why not?

48. Would it be better to fit two buckets and windlass that never break instead of two bushpumps that sometimes break?

49. Who repairs the bushpumps when they break? Is this satisfactory? Who pays for the repair? Is this satisfactory? If no, how would you like to see it done?

50. Do you or would you be prepared to pay towards maintenance of the pumps although you are not a member of the garden? If yes, how much per month?

Experiences with other schemes (not just water or agriculture)

51. Are you involved in any other community development schemes? If yes,which?

52. Which Institutions or people are involved? (Eg Agritex, DDF, VIDCO, Community Health Worker, anyone else?)

53. What are your experiences of these schemes?

54. Why are you a member there but not in the collector well garden?

Contacts with Extension services

55. Does Agritex give you any advice or training? If yes, what advice or training is most helpful to you?

56. Is there any advice or training that you feel you still need either for yourself or for your projects?

57. Have you received any advice on?:
    a) garden irrigation methods to save water
    b) irrigation amounts and schedules for vegetables
    c) vegetable pest and disease control
    d) growing vegetables in time to sell
    e) planting arrangements in gardens
    If yes, from whom and please give details.

Local leadership

58. Do you or any member of your household hold a position of responsibility in the community?

59. Who are the most important people in the community?

60. Do you think that problems of leadership exist in this community? If yes, when did these problems start?

61. If yes, do they affect you and or community development projects? If yes, how?

Rainfed cropping

62. What are the crops that you have grown during the last two years?:

	Area (ha or acres?)	Average production Kg or bags?)	Estimate of Income ($/year)
Sorghum			
Maize			
Mhunga			
Rapoko			
Cotton			
Groundnuts			

Sunflowers

Other

Resources

63. How many of the following do you have now?

Cattle

Donkeys

Sheep/goats

Plough

Scotch cart

Observations:

1. Approximate age of Head of Household:
   a) Under 30
   b) 30-60
   c) Over 60

2. Type of housing
   a) All or mainly traditional
   b) All or mainly modern (Brick walls, zinc roof)
   c) Mixture of traditional and modern

3. Wealth ranking
   a) Very rich (many luxury items)
   b) Comparatively well off (a few luxury items)
   c) Average (no luxury items)
   d) Struggling to survive

Questionnaire to evaluate scheme impact by comparison with baseline household surveys and allow project appraisal by the communities. Surveys to commence June 1995

MEMBERS

Site:................................Kraal..................................Date.....................

Head of Household...

Respondent(s)...

Family circumstances

1. How many people are members of the household and which of them help out with the farming and garden work?:

	Total in household	Number who help with farm or garden full-time	What do the rest do ?
Men			
Women			
Children (3-14)			
Infants			

2. When is the busiest time of year and why?

3. Do you ever need to hire labour? If yes, What for?

4. What would you say are the most serious problems facing people living in this community? (rank 1,2,3,4,5)
   a) water shortage
   b) food shortage
   c) poor nutrition
   d) poor health
   e) poor sanitation
   f) poor leadership
   g) shortage of wood
   h) shortage of money
   i) shortage of livestock
   j) other (what?)

5. What would you say are normally your three main items of expenditure?:
(estimate $/year)
1st
2nd
3rd

6. Does the collector well or garden cost you money? Estimate per year ? What are the main items ?

7. What would you say are normally your three main sources of income?
(estimate $/year)
1st
2nd
3rd

Current water sources

8. How many buckets per day does your household need for domestic use?

9. Do you have sufficient water for domestic use? Does this vary seasonally?

10. Do you obtain any domestic water from the collector well? If yes, how much per day? Does the collector well provide water that is good for drinking? Is it better, same or worse than other supplies of drinking water ?

11. How far do you walk to get domestic water? Has this changed since the collector well was built? If yes, how?

12. Does the collector well save you time in any way? If yes,how much per day?

13. Does shortage of water still prevent you from doing anything? What? What are the main uses of 'domestic' water in your house?

Health

14. Are there any times of the year when sickness is common? If yes, when?

15. If yes, what do you think are the causes?

16. Has your health or health in this community changed in any way during the last two years? If yes, give details

Vegetable consumption

17. How often does your family eat fresh vegetables now?:
a) All or most days throughout the year
or
b) 2, 3 or 4 times per week throughout the year

or
c) Only at certain times of the year (when?)
or
d) Rarely or not at all

18. Has this changed because of the collector well garden? If yes, give details

19. Where do you get most of your vegetables from?:
   a) Own private garden
   b) Own beds in collector well garden
   c) Buy from other private gardens
   d) Buy from other members of collector well garden
   e) Gathered from wild
   f) Grown in rainfed fields
   g) Other (where?)

20. Are there any times of the year when vegetables are in short supply? Why?

21. Do you eat dried vegetables? If yes, when and why? (need or preference)

Gardening activities

22. Did you have a private garden before the project? If yes, do you still have it? If no, why did you stop? Have you started a private garden since the project began? If yes, why and how?

23. Are you a member of any other community garden?

24. Are you limited to gardening at a particular time of the year? If so, why?

25. Who in your family makes decisions about the collector well garden?

26. Who in your family does most of the work in the collector well garden?

27. How many hours per week do members of your family spend in the collector well garden?

28. What tasks consume most time?

29. Is this too much time to spend or would you like to spend more? If yes, what prevents you?

30. Does the project prevent you from doing anything that you used to do?

31. Has the project affected any other community project in any way?

32. Which benefits if any do you receive from the collector well garden:
   a) closer source of drinking water
   b) more reliable source of drinking water
   c) cleaner source of drinking water

d) opportunity to grow vegetables to eat
e) opportunity to grow vegetables to sell
f) opportunity to buy vegetables
g) opportunity to sell other things that you have made or bought
h) opportunity to meet and talk with other people
i) water for livestock
j) other benefits (what?)

33. Which of these benefits are the most important to you?

34. What do you do with the produce that you grow?:
a) Mostly eaten by the family
b) Mostly sold
c) Half eaten, half sold

35. If any produce is sold, who in the family decides what to do with the money? What is the money used for?

36. Overall, does the project earn you any money? If so, estimate per year?

37. Does the scheme face any problems?: (tick and rank in importance)
a) Shortage of water
b) Shortage of land for beds
c) Shortage of cash to buy inputs
d) Shortage of labour
e) Breakdown of pumps
f) Pests and diseases
g) Disagreements between members
h) Disagreements between kraals or VIDCO's
i) Disagreements between garden committee and members
j) Poor management by the committee
k) Poor input by agricultural extension worker
l) Lack of market for vegetables
m) Too many members
n) Theft
o) Problems of land allocation at beginning of the project
p) Other problems (what?)

38. Do you have any ideas to avoid these problems or overcome them ?

39. What was your first reaction to the idea of a collector well garden? Has this changed in any way now?

40. When did you become a member?

41. How did you become a member?

42. Are there any people in the community who still want to become members? If yes, estimate how many and explain why they have not yet joined?

43. Are you happy with the way the project was introduced to the community? If no, how would you suggest it be done?

44. Are you happy with the way membership was decided? Was it a fair way? If no, how would you suggest it be done?

45. Are you happy about the way the garden is run and decisions made? If no, how do you think it should be run and who do you think should make decisions?
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49. Are you happy with use of the water for a community garden? If no, how would you like to see the water used?

50. Are you happy with the two bushpumps? If no, why not?

51. Would it be better to fit two buckets and windlass that never break instead of two bushpumps that sometimes break?

52. Who repairs the bushpumps when they break? Is this satisfactory? Who pays for the repair ? Is this satisfactory? Any ideas to improve the system?

53. Would you be prepared to pay more towards maintenance and repair of the project if you had to? If yes, how much per month?

54. If you were not a member of the garden now but it was possible to join, would you join? If yes, how much would you be prepared to pay to join now?

Contacts with Extension services

55. Does Agritex give you any advice or training? If yes, what advice or training is most helpful to you?

56. Is there any advice or training that you feel you still need either for yourself or for your projects?

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c) vegetable pest and disease control

d) growing vegetables in time to sell
e) planting arrangements
If yes, from whom and please give details.

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59. Who are the most important people in the community?

60. Do you think that problems of leadership exist in this community? If yes, when did these problems start?

61. If yes, do they affect you and or the collector well garden project? If yes, how?

62. Do they affect other community development projects? If yes, how?

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Mhunga			
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Other			

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