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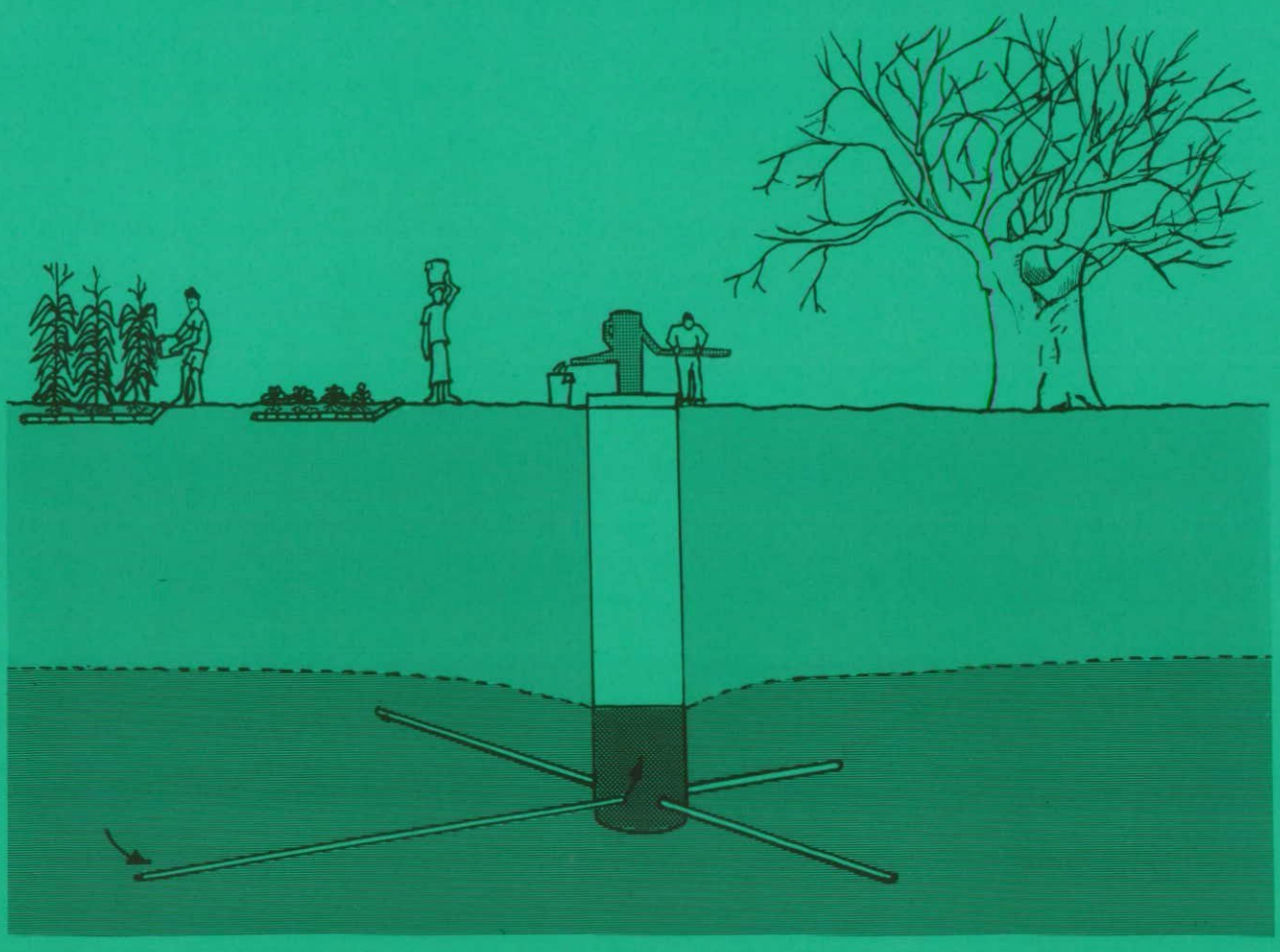

SMALL SCALE IRRIGATION USING COLLECTOR WELLS: PILOT PROJECT - ZIMBABWE

Return to Households Survey Report

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Executive Summary

As part of the GoZ/ODA pilot project entitled "Small Scale Irrigation Using Collector Wells", six collector wells each with a community garden were established at sites in the communal farming areas of Masvingo Province in south east Zimbabwe. The project ran from October 1993 to January 1996. This report describes the impact that the pilot project has had on participating communities. The information gathered from several household surveys undertaken before, during and after project implementation is used to describe the social and economic situation for each site, and overall. Comparisons are made between the situation before the collector well gardens were introduced and at the end of the pilot project. The report examines changes for both households who participated in the schemes and for those who did not.

Some of the key points that this report presents are:

- At the sites where the greatest need was for water for vegetable cultivation, communities now say the pilot project has satisfied this need. An estimated 4461 people now obtain fresh vegetables by being a member of one of the six pilot schemes, or in a members' family.

- The pilot project community gardens have *reduced* the period of fresh vegetable shortage that people in the area face by four to five months, *lowered* the number of people who feel there is a period of scarcity at all by about 25%, and *decreased* the time during scarce periods that people miss out on eating fresh vegetables by about four days in every week.

- At the sites where communities said that one of their greatest needs was for a cleaner and more reliable domestic water supply, the collector wells have helped satisfy this need despite this not being one of the pilot project's key objectives. An estimated 3882 people, both participants and non-participants in the schemes, now obtain their domestic water from the six collector wells. Furthermore, these wells experience increases in use of up to 55% during periods of water scarcity as and when other water sources fail.

- On average, at each site, a further 16 household representatives want to join the garden scheme. At all but one site, the size of the fenced plot is the major constraint. Further investigation into methods of selecting members or expanding gardens is therefore critical.

- Of those who joined each scheme, 80% were women and 49% on average were among the very poorest in the community.

- The pilot project gardens possess considerable potential for income generation and income diversification for garden members. The average value (at farm gate prices) of all vegetables grown per member in 1995 was Z$360. Average income per member obtained from selling some of this produce during 1994/5 was Z$225. (Z$13 = £1 approx). It is important to note not only the *value* of the income generated by the gardens, but also the *number of people* who are participating in this activity. On average 76% of garden members obtain an income from the pilot project, on top of their subsistence requirements.

- Women are controlling the saving and investment of cash generated from the schemes. At least 50% of all members in the schemes were found to be involved in savings clubs and revolving funds. Only one fund was said to have existed before the collector well gardens were introduced, and this has expanded. Savings from these funds are being invested in the household or in other income generating activities.

- Many of the schemes' benefits are non-market based - cleaner and more reliable water, secure tenure to grow vegetables, decreased stress on cultivating marginal lands. The quantification of some of these benefits has begun. For example, the economic value of the domestic water supplied by one collector well to an average number of users (as expressed by both participants and non participants) has an estimated net present value of £9960 per scheme. Economic valuations of this nature are important in order to compare the wide range of benefits the collector wells project supplies as compared to those of other rural water supply schemes.

- The cooperation of every type of village leader or institution has been necessary for the successful implementation of the schemes, as the benefits of the project cut across agricultural, economic, social and institutional aspects of village life.

- Further training needs are identified including flexible village level training programmes in pest and disease control, pump maintenance, book-keeping and marketing techniques. These needs must be met, but positive responses to other community initiatives and requests should also be encouraged.

To ensure the successful replication of groundwater based community garden schemes, recommendations are made for the continued monitoring and evaluation of the social, institutional and economic aspects of the six pilot schemes as they progress. Similar studies should also be undertaken on the new schemes implemented under the "NGADI" project proposal. Although much has been learned during the first two growing seasons of the pilot project, key issues requiring further study include:

1. identifying more equitable approaches for recruiting and expanding membership of the community gardens

2. the application of econometric modelling techniques to identify and predict critical variables in scheme success.

Contents

1. Introduction

1.1 PROJECT OBJECTIVES

As part of the pilot project entitled "Small Scale Irrigation Using Collector Wells", six collector wells each with a community garden were established at sites in the communal farming areas of Masvingo Province, South East Zimbabwe. A collector well is a large diameter hand dug well whose yield is enhanced by radial drilling. The project was implemented jointly by Agritex, the Lowveld Research Stations and the Department of Water Development in Zimbabwe, and the Institute of Hydrology (UK), the British Geological Survey and supported by the Overseas Development Administration of the UK. The pilot project started in October 1992 and finished in January 1996. Detailed information on the project can be found in five progress reports (Lovell, 1993, Lovell *et al.* 1993, 1994a, 1994b and 1995) and in a final report (Lovell *et al.* 1996).

The main elements of the pilot project have been:

i. the selection of suitable sites and the installation of six small irrigation schemes using water from collector wells;
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. the 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 have been:

i. to field test the validity of small scale irrigation and collector well research results obtained at the Lowveld Research Station
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.

To satisfy these main elements and objectives, extensive effort has been placed on eliciting social and economic data throughout the pilot project as to the impact of the schemes on participating communities. For example, in 1993/94, 180 households were interviewed as part of a socio-economic baseline survey undertaken before each of the schemes were implemented, and in 1995, 169 households were interviewed in a return socio-economic survey. The objective of undertaking both a baseline and a return household survey was to obtain a comparison of the social and economic situation that participating communities faced both before and after scheme implementation. Further detailed baseline case studies of four households at each of the sites were also undertaken before the schemes were implemented, and participative monitoring of each garden's agro-economic performance has taken place continuously during the pilot project.

1.2 AIMS OF THIS REPORT

This is the report of the return to household socio-economic surveys for the six collector well gardens. It is intended to describe the impact on participating communities that the pilot project has had. The information gathered from the return survey is used in this report to describe the socio-economic situation for each site, and overall, at the end of the pilot project as compared to the situation before the collector well gardens were implemented. Additional information from the return survey is also presented as data against which future social and economic developments at the sites can be compared. The key results from the return survey presented in this report can also be found in the pilot project's integrated final report as outlined in iv above. Information on parallel experimental studies into groundwater recharge, catchment management and the water use effectiveness of different small scale irrigation techniques, can be found both in the final report and in Macdonald *et al.* (1995), Butterworth *et al.* (1995) and Murata *et al.* (1995).

The return to household socio-economic survey detailed in this report builds upon the data elicited and analyses undertaken on the baseline household surveys (Brown and Dube 1994) and detailed case studies (Murata, Semple and Dube 1994). Information is also taken from an initial environmental economic survey of the schemes undertaken by Waughray and Dube (1995).

Before presenting and discussing the return survey findings, the report contains a methodology which gives an outline of the survey's design and execution, and the statistical techniques used in its analysis. After the presentation of the return survey findings there follows a conclusion which is split into two sections - a summary of the social and economic impacts of the schemes before and after implementation, and a summary of additional socio-economic information that may prove useful for future comparative analysis. Finally, Section 5 contains recommendations for further research, based on the results of the return survey and its analysis. The appendices contain information on the numbers involved in the site surveys, how the data has been organised and stored, the statistical techniques used in the report's analysis, copies of the questionnaires used in the surveys and details of specific calculations.

2. Methodology

2.1 SCOPE OF RETURN TO HOUSEHOLD SURVEY

The return to household surveys were carried out on a randomly chosen sample of households at each of the project sites between June and July 1995. Further more detailed questions were also asked in September 1995. Both the return survey and the more detailed follow up questionnaires were conducted by male and female enumerators from the Lowveld Research Stations (Terence Dube, Godwin Mtetwa and Miriam Mtetwa), with assistance from the research station's agricultural economist (Edward Mazhangara) and the Institute of Hydrology's environmental economist (Dominic Waughray). Each visit by the enumerators was pre-arranged to ensure the respondent household was at home, and the surveys were always conducted at the respondents house. Questioning took about two hours per household, and the enumerators took approximately five days to survey the total sample of households selected at each site.

The return survey obtained replies from both "members" and "non-members" of the community garden schemes. Consequently, aspects of the survey results presented in this report differentiate in places between members and non-members. A member is taken to be a representative of a household from one of the villages (kraals) in the area who has joined and remains part of one of the community garden schemes. Each scheme member is taken to represent a different household within the area, the number of households directly receiving benefits from the garden being equal to the number of members of the garden. A non-member is taken to be a representative of a household from one of the kraals in the area who has not joined one of the collector well community garden schemes. Each non-member is taken to represent a different household within the area which does not participate directly in the community garden.

The overall number of members of the pilot project's collector well gardens as of September 1995 is 514. The total number of members interviewed in the return survey was 100, and the total number of non-members interviewed in the return survey was 69. Table 2.1 below provides some background information as to the number of members in the community garden at each site and the amount as a percentage per scheme that were interviewed in the return survey. Data on the number of non-members surveyed is also presented. Appendix 1 lists all the information on the numbers involved in the site survey at each scheme.

Table 2.1 *Background Information on the Return Survey*

Site No.	Name	Members		Non-members
		No. in Scheme	No. Sampled	No. Sampled
1	Muzondidya	134	19	9
2	Gokota	109	14	12
3	Dekeza	50	13	13
4	Nemauka	84	19	11
5	Mawadze	50	18	11
6	Matedze	87	17	13
	Mean	86	17	12

When those who took part in the return survey were cross-referenced with the respondents who took part in the earlier baseline survey, it emerged that 76% of current scheme members who took part in the return survey had also taken part in the baseline survey, and 71% of current non-members who took part in the return survey were also surveyed before the schemes were implemented. Thus the social and economic information contained in the two surveys has proved to be an excellent source of comparative data as to the impact of the pilot project on participating communities. Table 2.2 shows the percentages of respondents whose socio-economic situations were "captured" by both surveys at each site.

Table 2.2 *No. of respondents at each site interviewed in both the baseline and the return surveys*

Site No.	Name	Members	Non-members
		% interviewed in both surveys	% interviewed in both surveys
1	Muzondidya	84%	78%
2	Gokota	86%	92%
3	Dekeza	85%	92%
4	Nemauka	63%	27%
5	Mawadze	72%	82%
6	Matedze	71%	54%
	Mean	76%	71%

Knowing the number of members of each garden, the number of members surveyed and the mean household sizes of those surveyed, it is possible to estimate the total number of people directly involved with the pilot project schemes. Table 2.3 presents the estimated population of members' households directly involved with the pilot project. Figure 2.1 presents this information graphically.

Table 2.3 *Estimated population of members' households directly involved with the pilot project*

Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
y = 174	y = 108	y= 97	y = 173	y = 165	y = 156
Y = 1226	Y = 840	Y = 373	Y = 765	Y = 458	Y = 799
(se 78.1)	(se 78.2)	(se 60.9)	(se 67.7)	(se 30.8)	(se 89.7)
(ci 164.01)	(ci 168.9)	(ci 132.6)	(ci 142.2)	(ci 64.9)	(ci 190.1)

y = population of sampled members households
Y = estimated population of all scheme members' households
ci = confidence interval at 95%

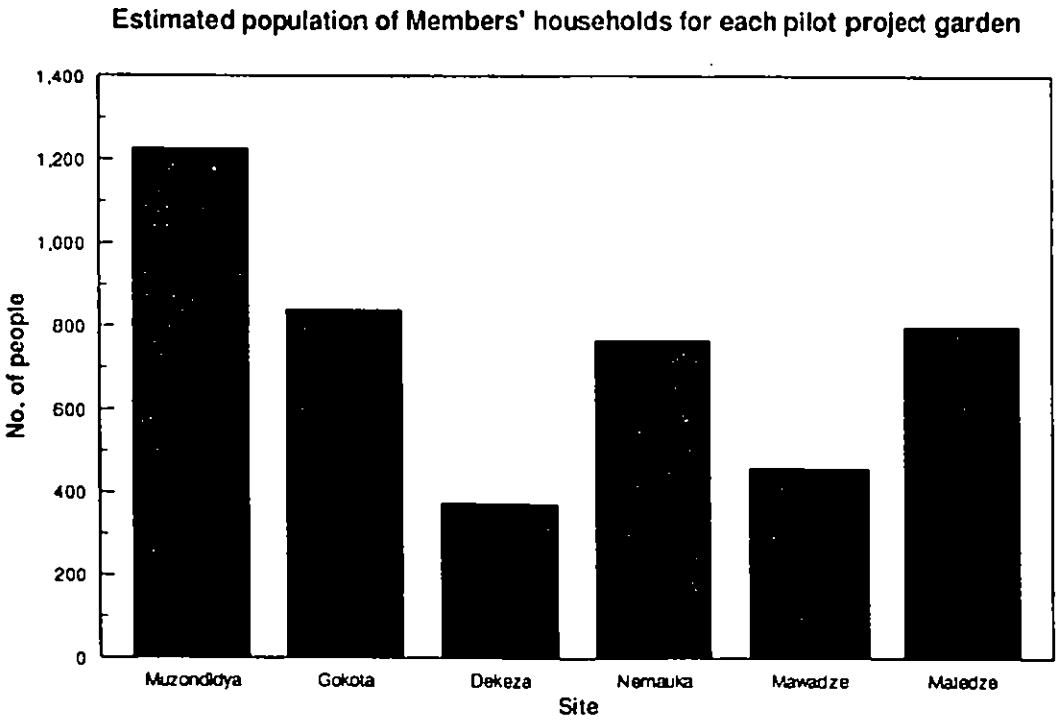


Figure 2.1

The estimated population total for the six pilot project schemes is 4 461 people *(se 206.04, ci at 99%: 409.49)*. In other words, we can be statistically 99% sure that the population of members' households served by the six schemes lies between 4 052 and 4 870 people.

2.2 STRUCTURE OF THE REPORT

The report is structured so that the presentation of findings from the return survey fall into one of four categories: social aspects, economic activity, attitudes and experiences of the collector well schemes and a final section that presents work that is aiming towards a total economic valuation of the collector wells. Apart from the last section, the categories into which the return survey information is grouped have been chosen so as to be the same as those used in the baseline survey reports. This eases the ability to compare the two sets of survey information. Information on the structure of the spreadsheets used in storing and analysing the data can be found in appendix 2.

2.3 IDENTITIES OF RESPONDENTS

The persons interviewed at each site depended on who was available from each household on the day of the interview. This resulted in a mixture of male and/or female respondents as shown in Table 2.4 below.

Table 2.4 Identities of respondents

Respondents	Per cent of sample	No. surveyed
Men only	14%	24
Women only	62%	105
Both	24%	40

It can be seen that there was a bias towards female respondents in the return survey with only 14% of interviews being with men alone. However, this bias reflected the fact that in discussing the collector well schemes most male heads of households looked to their wife or another female to answer questions about the community or private vegetable gardens.

2.4 STATISTICS USED IN DATA ANALYSIS

The first step in analysing the return survey data was to explore the information obtained for distribution of responses, central tendencies and dispersion, using frequency distributions and descriptive statistics. Population or characteristic estimates were then calculated from the sample data, and are presented in this report together with indicators of precision (standard errors and confidence intervals at 95% levels of certainty). Where appropriate aspects of the data were then used in a comparative static analysis, to examine relationships between variables, particularly income levels, to see if there is evidence of significant changes as a result of the pilot project. Details of the formulae for the calculations of the statistics outlined above are given in Appendix 3.

However, the social and economic statistics used in this report are treated as only one component of the information that can be drawn from the surveys. Any conclusions that are made or discussions that are outlined are also based upon supporting facts, trends in the range of data obtained from the project overall, and independent observations taken from experience with the different schemes from a wide range of participating communities and project personnel. It is an intention of this report, therefore, that the reader should not place too much emphasis on the individual statistics that are presented, but instead view them as indicators of the ongoing and long term changes in social and economic systems that are inherent in a community-based project of this nature.

2.5 PROBLEMS WITH THE SURVEY

When analysis began, it became clear that several questions in the return survey had captured data that seemed to be vague, unstable or in need of verification. These "grey" areas included information on fresh vegetable consumption, the use of income generated by the schemes and the best or most appropriate means of implementing new schemes. Considering that three different enumerators were used during the two month survey, two male and one female, and that it took about two hours to complete the questionnaire for each household, problems of instability or biases in the data obtained are almost inevitable. However, to tackle the problem of instability or bias in the responses, a series of ten or so further questions were subsequently asked as part of a rapid appraisal during September 1995. This rapid appraisal was conducted with a random sample of those interviewed in the return survey (5 non members, 5 members) at each site. The objectives of this exercise were to cross check, verify or strengthen the quality of the data of some of the "problem" responses. In this way it was hoped that any problems regarding unstable or biased data in the return survey could be minimised.

3. Results and Discussion

3.1 SOCIAL ASPECTS

3.1.1 Household composition, family size and labour force

Family size

The mean size of member's households from the sample interviewed in the return survey was 8.62 people *(sd 0.714)*. The mean size of non-member's households was 7.28 people (sd 0.69). Table 3.1 below shows the mean household sizes for both members and non-members who were surveyed at each scheme.

Table 3.1 Mean Household size at each scheme

Site	Members (sd)		Non-members (sd)	
1	9.15	(4.83)	6.55	(3.09)
2	7.71	(2.57)	8.16	(2.76)
3	7.46	(4.22)	7.15	(3.23)
4	9.11	(3.43)	7.00	(2.41)
5	9.16	(3.81)	8.27	(2.73)
6	9.18	(4.13)	6.54	(2.09)
Mean	8.6		7.3	

It can thus be estimated that the mean size of a member's household in the pilot project is 8.6 people *(se 3.46, ci 6.85)*, and the estimated mean size of a non-member's household is 7.3 people *(se 3.01, ci 6.00)*.

When the mean household sizes are presented as a frequency distribution, as in Figure 3.1 below, it becomes more apparent that members seem to have "marginally" bigger families than non-members of the pilot project. For example, seven members' households contain between 15 and 20 people, compared to only one non-member household.

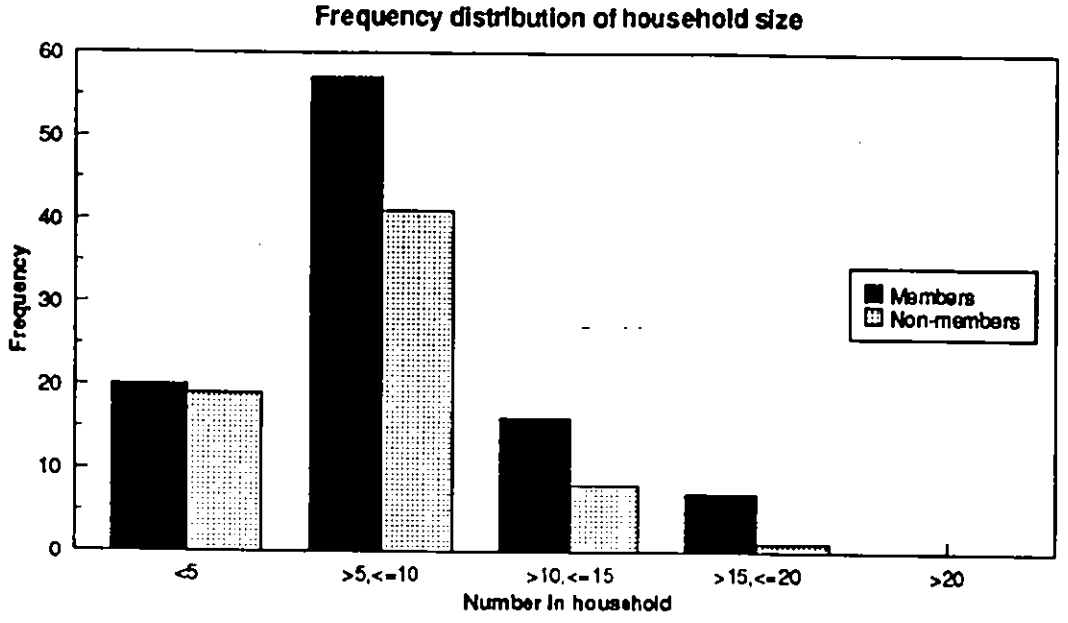


Figure 3.1 *Frequency Distribution of Household Sizes in the Pilot Project*

The difference in distribution in household sizes between members and non-members could be due to the fact that a larger sample of members were surveyed than non-members, or an indication that members' households may be marginally richer than non-member households. Alternatively it could be the case that larger families, with more mouths to feed, have a greater incentive to join the scheme.

Household Composition and Labour Force

Figure 3.2 indicates the mean household composition of the sample for members and non members. Both 39% of members and 39% of non-members are available to work full time on the farm while 33% of members and 30% of non-members are said to be attending school. The importance of off-farm incomes is indicated by the fact that 63% of members households and 62% of non-members households have at least one person earning a full-time income away from the family farm. With regards to the non-availability of farm labour this situation creates, 36% of the men in members households (79/222) and 51% (75/146) of the men in non-members households work away from the farm, whereas less than 1% of women work away. 59% of members and 45% of non-members households said they needed to hire labour to help on the family farm in summer, the busiest time of year. Enumerators in the survey also estimated that, on the basis of appearances, 78% of members' and 77% of non-members' male heads of household appear to be between 30 and 60 years old.

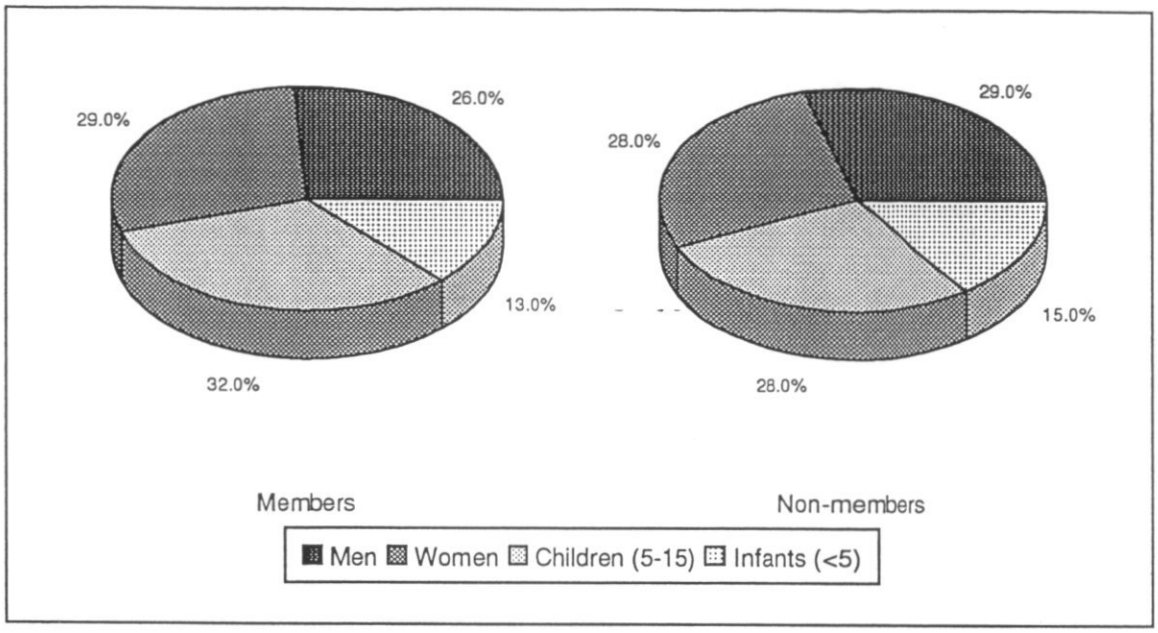


Figure 3.2 *Mean Composition of Households in the Return Survey*

There seems to be little significant difference between household composition and the labour force potential of members and non-members of the pilot project schemes, apart from the fact that slightly more non-members rely on off-farm incomes than members, although this is not statistically significant.

Comparison with baseline information

Data from the baseline survey (Brown and Dube 1994) showed that average household sizes range from seven to nine persons. This figure correlates with that obtained in the return survey. The number of male family members who were away working averaged 33% in the baseline survey. It seems therefore that the non-member households, with an average of 51% of male family members away working, do have a higher level of dependency on off-farm incomes.

In essence the baseline survey found that the prolonged absences of men together with the fact that most children attend school, meant that women made up the greater part of the farm family labour forces as Table 3.2 (Brown and Dube 1994) shows.

Table 3.2 *Availability of family members for full-time household, farm and garden work*

Site	Men	Women	Children	Total
Muzondidya	1.6	2.1	0.2	3.9
Gokota	1.0	1.9	0	2.9
Dekeza	1.3	1.9	0	3.2
Nemauka	1.2	1.9	0	3.1
Mawadze	0.9	1.5	0.1	2.5
Matedze	1.4	2.1	0.1	3.6

(Brown and Dube 1994)

At Muzondidya and Matedze households had on average the largest labour forces compared with Mawadze which had the lowest. With the exception of Mawadze the availability of female family labour was similar at all sites. The percentages of households which were headed by women ranged from 3 per cent at Gokota and Dekeza to 20 per cent at Nemauka which was the only site to choose an all-women committee to run the community garden. With the exception of Matedze, approximately one quarter of households at each site were without the full-time services of a man to assist with the farming, household and gardening tasks.

In the return survey 80% of the sample said that the main decision maker and most labour for the community garden came from women or wives of the head of household, with the help of children. At Dekeza, site 3, where there was a low percentage of households headed by women, 62% of the garden plots were said to have a female decision maker. At Mawadze, site 5, where the available labour force, and female labour in particular were lowest, 40% of the collector well garden plots had a female decision maker and the rest were managed through joint decisions.

Table 3.3 shows the availability of labour as determined in the baseline survey, and the size of the collector well garden by number of members as registered in the return survey. This table seems to indicate no strong correlation between the availability of labour and the size of community garden implemented. Indeed, a regression analysis using availability of labour as the independent X variable gave a low R squared value of 0.409. A poor correlation between the availability of labour and the eventual size of the garden scheme can be supported by the fact that there exists a range of between 10 and 22 people per scheme who still want to join the gardens. This may suggest the perceived value of the community garden. Many householders recognise that the marginal opportunity cost of labour for time spent working in the garden is actually lower than the marginal benefits to be gained from cultivating one of the garden's vegetable plots. Furthermore, the presence of existing community gardens (such as at Mawadze, site 5) does not seem to constrain the labour available for joining new community garden schemes, but in fact allows others who are not currently members of a scheme to invest their "lower opportunity cost of labour" time in the new initiative.

Table 3.3 Labour Availability and Subsequent Size of Garden Membership

Site No.	Name	Labour Availability (Baseline)	Size of Garden (Return)
1	Muzondidya	3.9	134
2	Gokota	2.9	109
3	Dekeza	3.2	50
4	Nemauka	3.1	84
5	Mawadze	2.5	50
6	Matedze	3.6	87

3.1.2 Indicators of wealth

The return survey asked the enumerator to observe the state of housing, find out the number of livestock owned and assess the comparative wealth of each household surveyed. The aim is to see if there is any difference in observable wealth status between members and non-members of the collector well scheme and also to see if the wealth of those who had joined the scheme had improved.

Housing

An immediate visual indicator of wealth is the standard of housing. Figure 3.3 below categorises the predominant housing types for both member and non-member respondents.

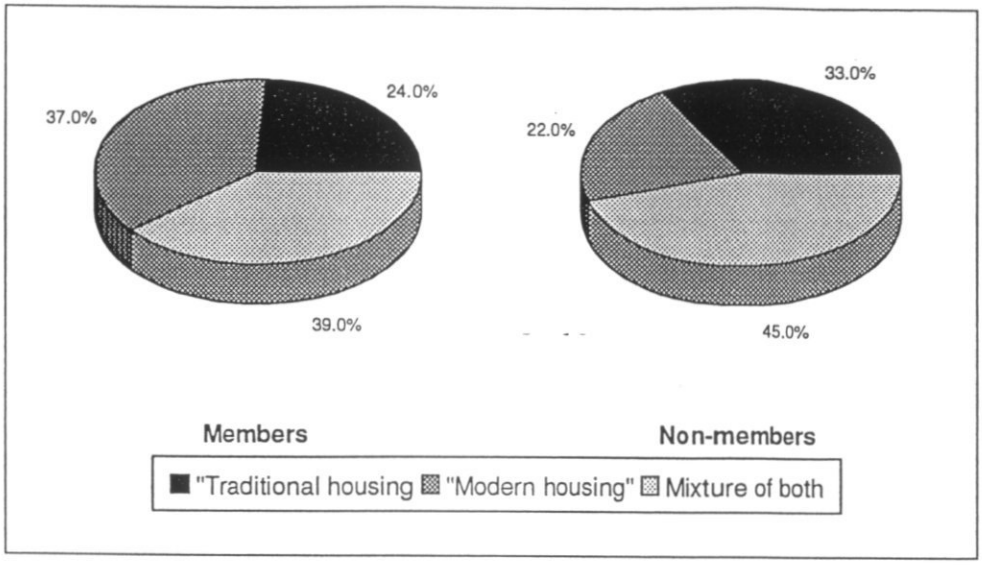


Figure 3.3 Housing Types

Traditional housing means a traditional family compound of pole and dagga thatched huts. Modern housing means a more costly style of housing constructed with bricks and mortar and asbestos roofs. The figure shows that the majority of respondents occupy a mixture of both these housing styles, although more members of the collector well garden schemes appear to live in modern housing complexes than non-members (37% and 22% respectively).

Livestock

Livestock are usually the main items of capital owned by a farmer in the survey area. Although livestock numbers are still low as a result of the 1991/2 drought, they can still provide a good indicator of comparative wealth of the respondent.

Similar to the information obtained in the baseline survey, Mawadze (site 5) was found in the return survey to have the highest rates of ownership for all livestock types, and Muzondidya the least. These trends hold true for both members and non-members at each of these sites.

Overall from the sample, 40% of members have at least one cow as compared to 22% of non members. Both 13% of members and 13% of non members have at least one donkey. 68% of members and 64% of non-members own sheep or goats. In general, the frequency of livestock ownership is heavily skewed towards a few (whether they be members or non-members of the pilot project schemes) owning a lot and many owning very little or none at all. Figure 3.4 overleaf shows the split of livestock ownership for the return survey sample between members and non-members for cattle, donkeys and sheep or goats. Differences in ownership are not significant, although the most noticeable difference lies in cattle ownership. It will be important to assess the ownership levels for cattle and donkeys over the next few

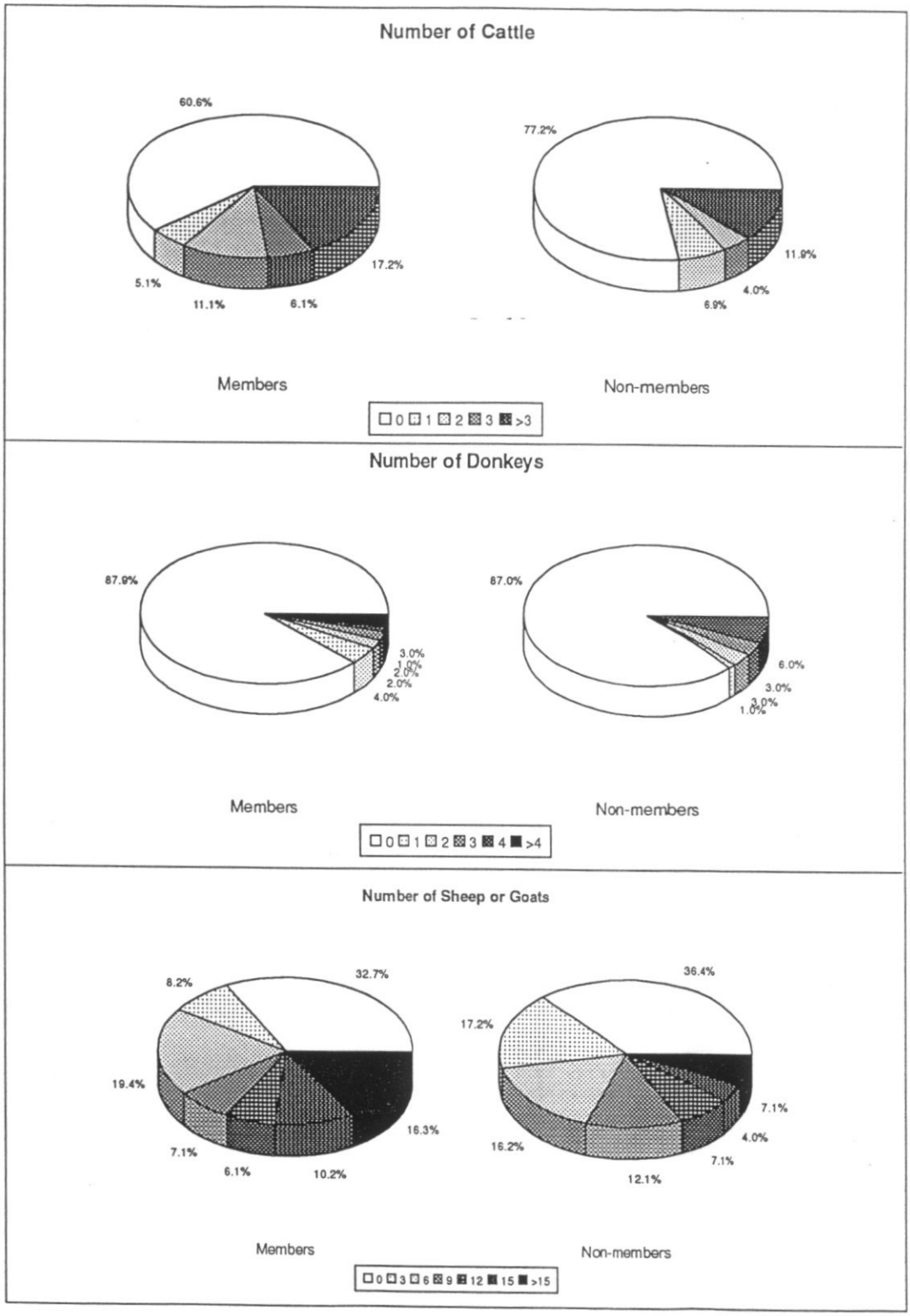


Figure 3.4 *Livestock Ownership: Members and Non-members*

years, as this may provide information about the access to water for livestock, and hence the relative wealth of member and non-member farmers.

Implements

Ownership of a plough or cart may be a better indicator of comparative wealth, for it implies the ownership of livestock irrespective of the effects of the recent drought on head numbers. From the sample surveyed 75% of members own a plough, and 9% own two. 17% of members own a animal drawn "scotch" cart. In relation to those who didn't join the pilot project scheme, 65% of non-members own a plough, 10% own two. 7% of non-members own a scotch cart. Figure 3.5 graphically represents the comparison of farming implement ownership.

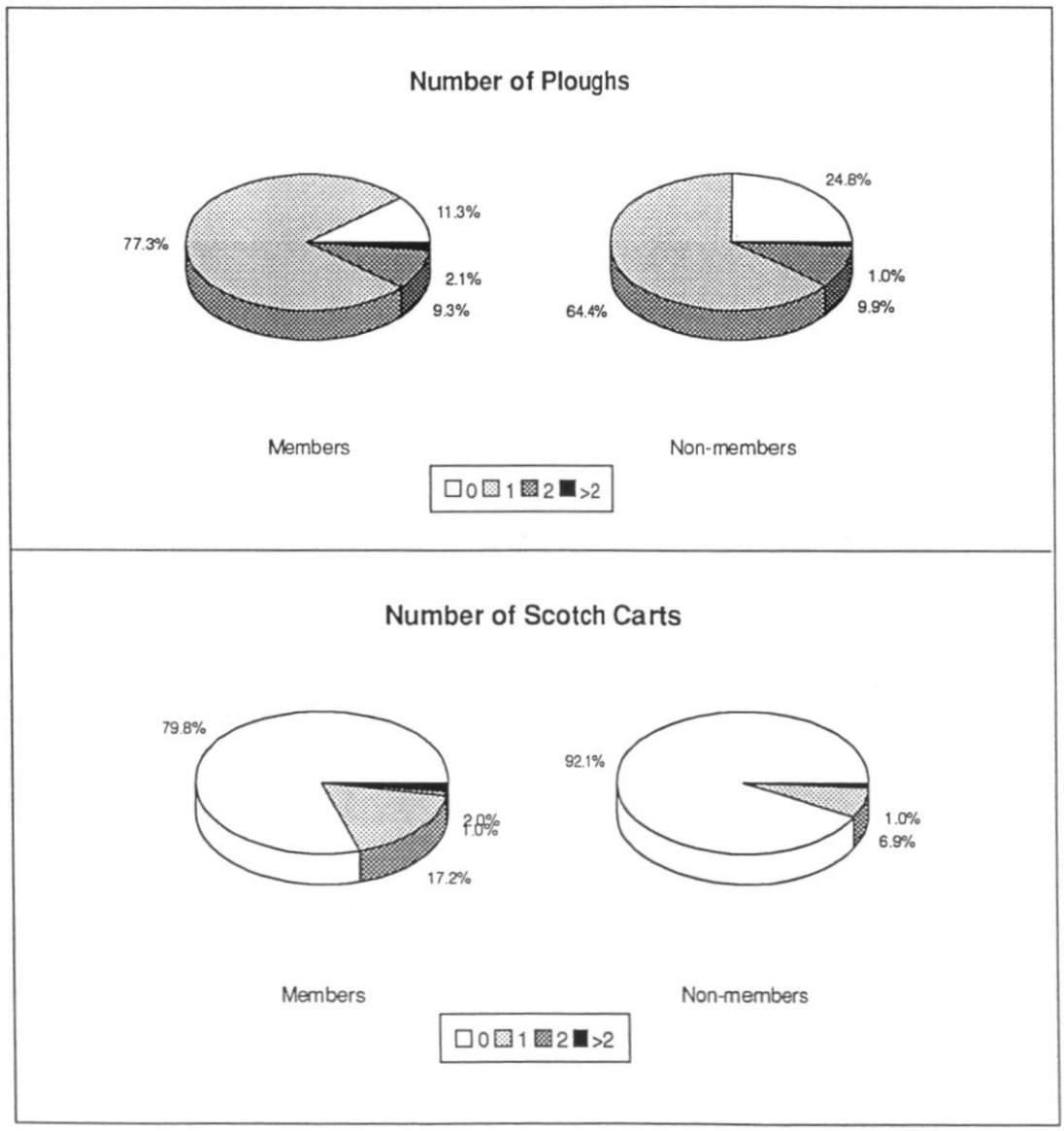


Figure 3.5 *Ownership of Ploughs and Carts: Members and Non-members*

Table 3.4 *Wealth Ranking by Site: Members*

Site	1	2	3	4	5	6
% Wealthy	11	7	15	5	11	6
% Comfortable	16	36	23	47	56	35
% Average	53	50	38	32	16	41
% Struggling to survive	21	7	23	16	16	18

Table 3.5 *Wealth Ranking by Site: Non-members*

Site	1	2	3	4	5	6
% Wealthy	0	17	0	9	27	0
% Comfortable	11	33	0	18	18	8
% Average	22	42	54	27	36	31
% Struggling to survive	66	8	46	45	18	62

It is clear overall, and in particular at sites 1, 3 and 6, that the "comfortable" are members of the pilot project scheme more than the least well off people in the community. However, is this a dynamic observation? Have members of the pilot project become more "comfortable" as a result of the community garden schemes? Or is it that wealthier people tended to become members of the community garden scheme? Given the indicators used to define relative wealth brackets, there may have been insufficient time for members to have generated sufficient income from the gardens to have purchased, for example, an asbestos roof. However, to analyse any potential dynamism in the wealth relationship between members and non-members that may already exist, a comparison to the overall wealth assessment taken in the baseline surveys is undertaken. The aim is to match the wealth assessments for specific households that were interviewed in both the baseline and return surveys and look for a significant change in observed wealth status.

Comparison to observed wealth assessments in baseline survey.

Table 3.6 shows who, in terms of observed wealth from the baseline survey, joined the pilot project scheme at each site.

Table 3.6 *Who joined the pilot project schemes?*

	No. who joined	% "wealthy"	% "average"	% "less wealthy"
Site 1	(15/30)	0	13	87
Site 2	(12/30)	8	67	25
Site 3	(11/30)	0	45	55
Site 4	(12/30)	0	42	58
Site 5	(13/30)	23	54	23
Site 6	(11/30)	27	36	37
Mean	41%	9.5	41.8	48.6
	(74/180)	*se 0.034*	se 0.057	se 0.058

All the following percentages hold as actual results from the pilot project. Estimates are made with confidence intervals on the basis of these percentages.

Overall, 41% of the population sampled before implementation joined a scheme *(se 0.037; ci 7.2%)*. Estimating from the baseline sample about who, from a surveyed community in an appropriate hydrogeological location, would join a collector well and community garden scheme in the district, 10% are likely to be wealthy *(se 0.034; ci 6.7%)*, 42 % are likely to be "averagely" well off *(se 0.057; ci 11.4%)* and 49 % are likely to be "less wealthy" *(se 0.058; ci 11.6%)*.

Improvements in observable wealth

Comparing the observed wealth status of those respondents in the baseline survey who joined a scheme to the same respondents interviewed as members in the return survey, 60% of households improved in wealth by observation. Of the "average" wealth households who joined, 71% improved in wealth by observation. Of the "less wealthy households who joined, 50% improved in wealth by observation. Overall an estimated 278 households *(se 30.1, ci 59.8)* have improved in observable wealth since joining the pilot project. Table 3.7 shows the relative change in wealth for those who joined a scheme at each site. Table 3.8 estimates, on the basis of this data, the number of member's households who improved in wealth at each site.

For a comparison of the two survey observations on wealth, anyone considered moving from a "c" in the baseline (less wealthy) to a "c" or higher (average) in the return survey, was considered to have improved. A move from a "c" in the baseline survey (less wealthy) to a "d" in the return survey (struggling to survive) was considered to have stayed the same/ got worse. A respondent who moved from an "a" (wealthy) or a "b" (average) in the baseline to a letter below was considered to have got worse. The 7 wealthy who joined were considered to not be able to get more wealthy in this scale and were discounted.

Table 3.7 *Did those who joined a pilot project scheme become more wealthy?*

	overall % improved	% "average" improved	% "less wealthy" improved
Site 1	27 *(4/15)*	100 *(2/2)*	15 *(2/13)*
Site 2	64 *(7/11)*	63 *(5/8)*	66 *(2/3)*
Site 3	73 *(8/11)*	100 *(5/5)*	50 *(3/6)*
Site 4	58 *(7/12)*	60 *(3/5)*	57 *(4/7)*
Site 5	80 *(8/10)*	71 *(5/7)*	100 *(3/3)*
Site 6	63 *(5/8)*	50 *(2/4)*	75 *(3/4)*
Mean	60 *40/74*	71 *(22/31)*	50 *(18/36)*

Table 3.8 *Estimate of the number of households at each site who improved in wealth since joining a pilot project scheme*

Site No.	Name	Estimated No. of Households	Confidence intervals
1	Muzondidya	36	*(se 15.8, ci 34.1)*
2	Gokota	69	*(se 16.7, ci 36.7)*
3	Dekeza	36	*(se 7.1, ci 15.6)*
4	Nemauka	49	*(se 12.4, ci 27.8)*
5	Mawadze	31	*(se 7.0, ci 15.3)*
6	Matedze	40	*(se 13.7, ci 30.1)*

From these sets of comparative data it can be estimated that with an average membership of 86 members per scheme *(se 19.76; ci 38.82)*, 51 households are likely to improve in wealth by observation *(se 0.060 ci 10)*; and 21 households are likely to improve in wealth by observation from being in the very poorest wealth bracket before the scheme *(se 0.08; ci 13.7)*. Figure 3.7 represents graphically the changes in observed wealth for those respondents who joined a pilot project scheme.

Overall assessment of wealth

The baseline survey had required the enumerator to tick by observation *"does the respondent appear to be a) wealthy, b) average, or c) less wealthy?"* Consequently, and to enable comparative analysis, the return survey required the enumerator to tick by observation *"does the respondent appear to be a) wealthy, b) comfortable, c) average, or d) struggling to survive?"*

By way of explanation "wealthy" was taken to mean someone owning a house with brick walls, a zinc or asbestos roof, maybe 10 or more cattle and who sells their farm produce. At best the "wealthy" member of the community would be earning no more than US$ 1000 per annum. "Average" meant a householder with a mixture of modern and traditional housing styles, who owns a few animals and who occasionally is able to sell farm produce. "Less wealthy" meant someone who does not have enough money to meet their daily needs, who lives in mainly grass thatched, pole and dagga houses, who does not have cattle and who does not sell his/ her farm produce. In the return survey, "wealthy" was taken to be the same as wealthy on the baseline, but with a well or borehole at the homestead, or maybe a car. "Comfortable" was taken to be the same as wealthy on the baseline, but without a well or car at the homestead. "Average" was the same as average above, and "struggling to survive" was taken to be the same as less wealthy on the baseline survey.

By observation the enumerators classed both 9% of members and 9% of non-members as "wealthy", 36% of members and 14% of non-members were said to be "comfortable" and 17% of members compared to 41% of non-members were said to be "struggling to survive". Figure 3.6 represents these observed wealth differences graphically. Tables 3.4 and 3.5 below detail the observed wealth status for members and non members at each site.

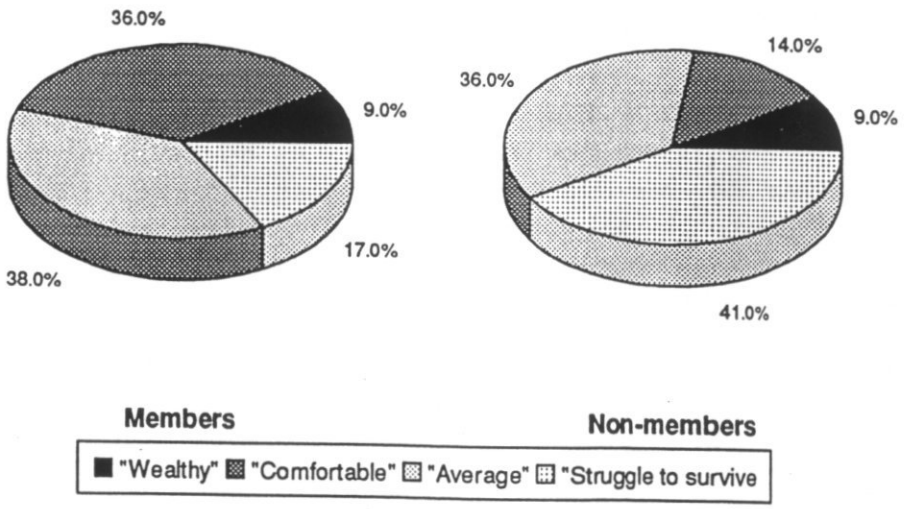


Figure 3.6 *Wealth by Observation: Members and Non-members*

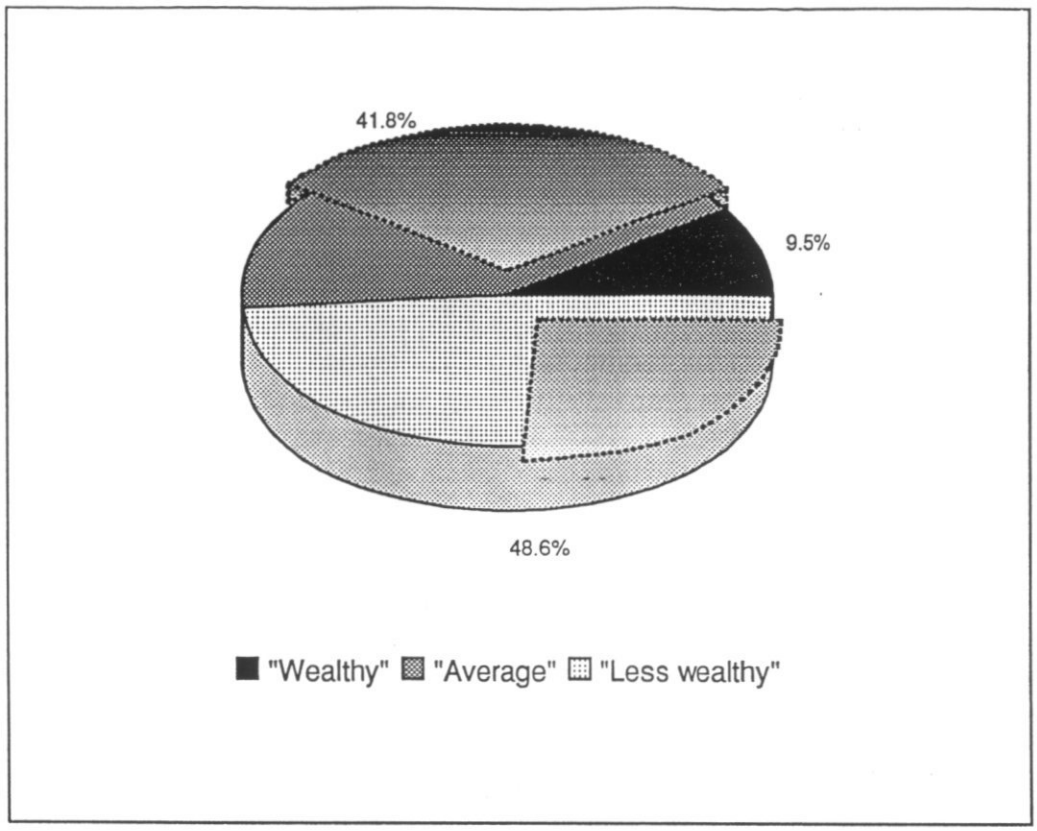


Figure 3.7 *The changes in observed wealth for those who joined a pilot project scheme.*

However, although an improvement in observable wealth is encouraging, it would be much more desirable to test for positive changes in actual income levels. Even though the gardens have been operating for only a season or two, comparative analyses on mean income levels for respondents before and after joining a scheme are undertaken (section 3.2.2 of this report; Economic Activity - household incomes). The aim is to test for a statistically significant improvement in member's actual incomes at the schemes. It should be pointed out that some of this improvement in wealth could be attributed to the good rains following the 1991/ 92 drought.

3.1.3 Health

In response to a question on health, 97% of respondents mentioned that they suffer from "colds and flu" in winter." The return survey did not elicit more detailed information on health or nutritional issues. An alternative to a direct nutritional assessment of the collector well schemes may be to examine in more depth the responses to questions regarding fresh vegetable consumption.

3.1.4 Fresh Vegetable Consumption

Frequency of consumption

The baseline survey noted that the majority of households at each site consumed fresh vegetables during the summer rainy season from October to April. Relatively few households were found to consume fresh vegetables throughout the year. There was general agreement that the main period of scarcity for fresh vegetables was the dry season, from May to October. The baseline survey predicted that:

> "It is envisaged that the collector well can help fill this gap by enabling winter production of vegetables from community gardens."
> (Brown and Dube, 1994, *p61*).

The return survey again asked respondents in detail about the periods of scarcity for fresh vegetables they faced *before* the scheme was implemented. 72% of members surveyed identified a period of scarcity for fresh vegetables lasting ten months at its widest (April - January) and four months at its peak (September - December). During this period fresh vegetable consumption was said to be, on average, 1.85 days/ week. At peak scarcity fresh vegetable consumption dropped to one or less days per week. For non-members, 91% identified a period of scarcity before the collector well scheme. The period of fresh vegetable scarcity was spread at its widest for ten months (April - January), peaking for four months (September - December). During this period fresh vegetable consumption was said to be, on average, 2.4 days/ week. At peak scarcity fresh vegetable consumption dropped to just over one day per week. These observations support the information obtained in the baseline survey, but provide more detail about the length and severity of fresh vegetable scarcity during the dry season.

The return survey then asked respondents in detail about the periods of scarcity for fresh vegetables they face *now* the collector well schemes have been implemented. When asked about periods of scarcity for fresh vegetables now, a smaller number, 47%, of members identified a period lasting five months at its widest (August- December), and three months at its peak (September - November). During this period fresh vegetable consumption is said to be, on average, 5.8 days/ week. At peak scarcity now, fresh vegetable consumption is thought to drop to about 5 days a week. For non-members, 68% still identified a period of scarcity now. At its widest the period is spread for five months (September - November), and at its peak it is said to lasts for three months (September - November). During this period fresh vegetable consumption is said to be, on average, 5 days/ week. At peak scarcity now, fresh vegetable consumption is thought to drop to about 4.5 days per week.

In essence it seems that the collector well gardens have *reduced* the period of scarcity of fresh vegetables that communities in the area face by four to five months, *lowered* the number of people who feel there is a period of scarcity at all by about 25%, and *decreased* the time during scarce periods that people miss out on eating fresh vegetables by about four days in every week. Figure 3.8 represents these results graphically .

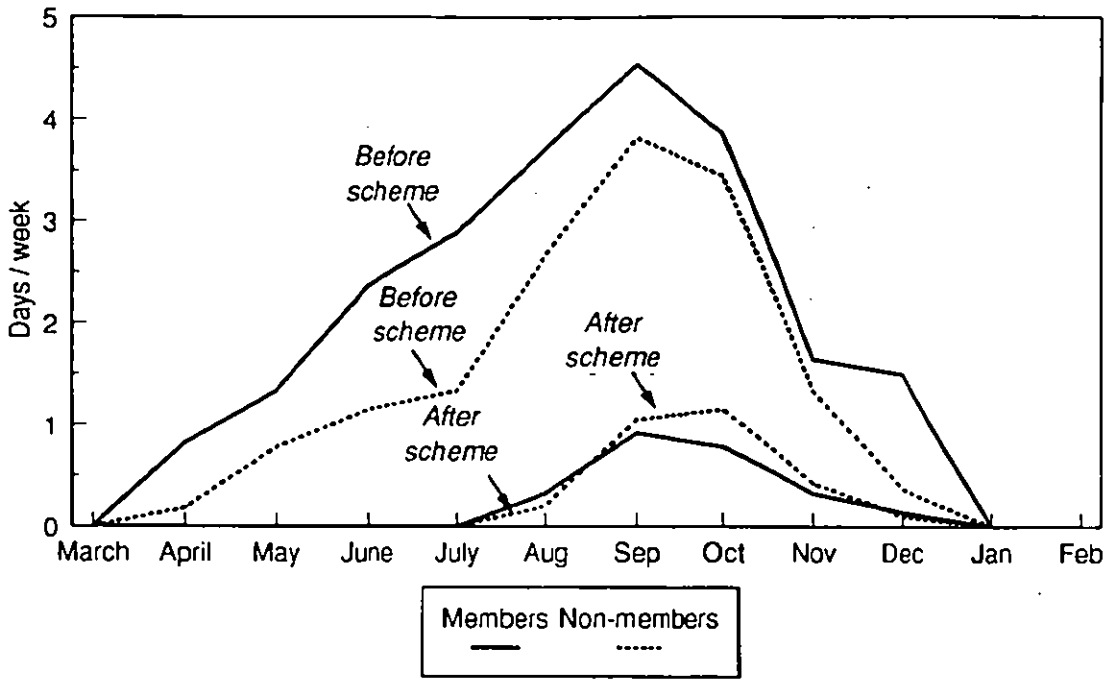


Figure 3.8 *Fresh Vegetable "non-consumption" before and after scheme implementation.*

The difference between the members and non-members "non consumption of fresh vegetables" curves is not significant. It may be attributable to respondent bias, insofar as members of the scheme may reply to the enumerators questions that "before" was slightly worse and now is slightly better than the situation actually was or is, in order to show how pleased they are with the scheme.

Sources of fresh vegetables

Figure 3.9 presents the range and relative importance of sources of fresh vegetables to communities in the pilot project region. This data was obtained in the baseline survey for the whole sample (top diagram) and the return survey for samples of both members of the pilot scheme gardens (middle diagram) and non-members (bottom diagram).

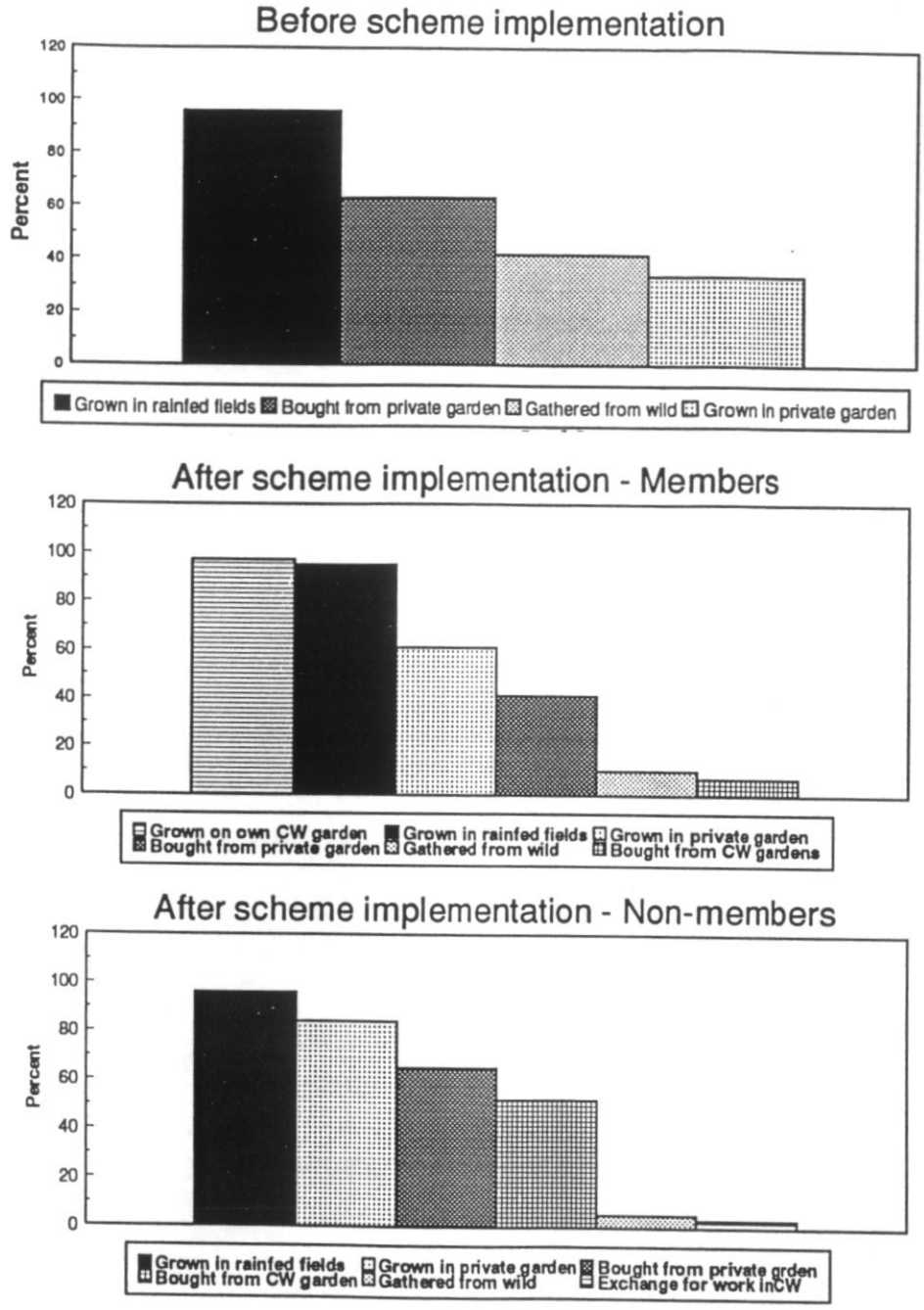


Figure 3.9 *Sources of fresh vegetables*

Clearly the introduction of the collector well garden has increased the number of sources of fresh vegetables for participating communities. An improved diversity of sources can be seen as a lowering of the risk facing households of not being able to obtain fresh vegetables should a particular source fail (for example due to drought or pests). The importance of vegetables grown in the rainfed fields during summer rains remains largely unaffected, although for scheme members the community garden has become an alternative main source to compliment the vegetables obtained from their farmland. However, the collector well garden has greatly decreased the reliance on gathering from the wild as a source of fresh vegetables. A further

result of owning a plot in the community garden for members is that the amount of fresh vegetables bought from other private gardens has also decreased, by about 20%. This is a phenomenon that the baseline survey predicted. For non-members, instead of gathering from the wild, they now buy vegetables from the community garden as a third source of fresh vegetables, but importantly buying from other gardens apart from the collector well seems unaffected.

In summary, the collector well gardens can be seen to be successfully supplying fresh vegetables to communities during the annual periods of scarcity in the dry season. They are not in competition with private gardens or rainfed crops during the wet season, but greatly ease periods of stress when people would otherwise resort to either foraging for wild vegetables, trying to buy from other (scarce) sources, or maybe just go without.

One interesting result in the data presented here is that the number of households growing vegetables in private gardens seems to have increased from 38% in the baseline survey, to 60% for members and 80% for non-members in the return survey. However, it is certain that people are not using water from the collector well to irrigate private vegetable gardens. Why then has this result appeared? There could be several possible reasons. Firstly the baseline survey asked respondents to name their *main* source of fresh vegetables, whereas the return surveys obtained information on all sources of fresh vegetables, without ranking them. If many people get a few (38%) of their fresh vegetables from their own private gardens, then this source could have been overreported in the return survey. Secondly, it could be due to the fact that when the baseline survey was undertaken it was a dry period. If streams or other seasonal water sources were dry, then far fewer respondents than average would be growing produce in a private garden. However, when the return survey was undertaken it was relatively a much wetter period. With more water available, more private gardens would be in use. Thirdly it could be that with the introduction of the collector wells and gardens the benefits of small scale vegetable production are becoming clearer and more families are venturing into this option. Unfortunately, this kind of anomalous result merely serves to highlight the difficulties of trying to undertake a quantitative comparative analysis of dynamic socio-economic trends and relationships on data that has been elicited in two different "one-shot" surveys in different seasons and through a range of different enumerators / translators.

3.1.5 Main Community problems

The main community problems which were perceived by respondents at each site as noted in the baseline survey, before the pilot project schemes were implemented, are shown in Table 3.9 below (Brown and Dube 1994).

Table 3.9 *Main community problems noted in the baseline survey*

Problem	% of respondents in:					
(shortages of:)	Muz'	Gok'	Dek'	Nem'	Maw'	Mat'
Water	100	100	100	90	100	93
Vegetables/gardens	-	33	3	3	33	77
Draught animal power	-	3	47	93	37	73
Transport	-	-	63	43	3	-
Health care	-	-	10	-	23	-
Land	-	-	13	-	-	10

(Brown and Dube 1994)

The table indicates that water both for domestic purposes and irrigation of vegetables was the principal need for people. However the baseline analysis did recognise that answers to this question may have been influenced by the fact that the surveys were related to a water and garden oriented project. The shortage of draught animal power was said to stem from the severe drought of 1991-92 which caused high mortality and forced farmers to sell livestock in order to raise money. The shortages of transport at Dekeza and Nemauka referred to the lack of bus services in those areas to connect them with the tar road and main service centres. Dekeza and Mawadze both suffered from a lack of health care facilities.

In the return survey, respondents were asked again to indicate the four most serious problems they faced on a daily basis. The main problems which were perceived by both member and non-member respondents to afflict their communities in the return survey, are shown in Tables 3.10 and 3.11.

Table 3.10 *Main community problems in the return survey for members of a collector well scheme*

Problem	% of respondents in:					
(shortages of:)	Muz'	Gok'	Dek'	Nem'	Maw'	Mat'
Water	21	29	-	-	-	12
Livestock	74	86	92	63	94	100
Transport	-	-	63	-	-	-
Health care	-	-	-	-	44	-
Land	-	-	-	-	-	-
Money	63	71	54	58	44	83
Food (cereals)	53	57	38	53	39	12

Table 3.11 *Main community problems in the return survey for non-members of a collector well scheme*

Problem	% of respondents in:					
(shortages of:)	Muz'	Gok'	Dek'	Nem'	Maw'	Mat'
Water	11	-	-	-	36	15
Livestock	73	92	69	55	63	85
Transport	-	-	54	-	-	-
Health care	-	-	-	-	-	-
Land	-	-	-	-	-	-
Money	67	33	46	45	36	46
Food (cereals)	67	50	23	27	-	54

On further questioning the problem of "food shortages" was said to mean a shortage of cereals for members, and a shortage of both cereals and, to a lesser extent, vegetables for non members.

It is clear that water shortages as a perceived problem have decreased in importance. From being cited as the main problem at 5 out of the 6 sites in the baseline survey, water shortages have dropped to being the fourth most pressing problem, and only for 4 out of the 12 sample populations in the return survey (6 members samples, 6 non-members samples). A shortage of livestock is now consistently the most important problem as expressed by the community samples at each site. This is still due to the effects of the drought of 1991/92 on livestock numbers. A shortage of food has also appeared as a problem - for members interviewed in the return survey this was said to mean a shortage of cereal crops. Consistently poor rains over the past few seasons were said to have lowered yields of staple crops such as maize from rainfed farming systems. It is interesting to note that for non-members of the collector well gardens, a shortage of food still includes vegetables. Even though they are experiencing less shortage than before (see Figure 3.8) this may be a reflection of a lack of *direct* access to fresh vegetables during the dry season, in contrast to the situation now experienced by those who were able to join the community gardens.

The final, and perhaps most intriguing, observation from the return survey on perceived community problems, is the appearance of "a shortage of money" as an issue. This ranks consistently as the second or third most pressing problem for the sample surveyed, with only two sites having a difference in ranking of the problem between members and non-members. A "shortage of money" as a problem for respondents in the return survey could be due to a number of factors. It may be a reflection of an enhanced cash-based economy operating at the sites as a result of the increased trading in fresh vegetables from the garden. It may be linked to the fact that with basic needs such as water being met, other problems, previously of lesser importance, have come to the fore in respondents' minds. Or it may even be due to the impact of wider liberalisation processes at work within the Zimbabwean economy. The cessation of subsidies and subsequent increase in the prices of staple foodstuffs such as bread and maize meal has had a significant impact on the average Zimbabwean, and focused everyday attention onto cash shortages within the household. However, with only two

growing seasons undergone at the gardens, it is too early to make definite conclusions as to this result. Continued observation and surveying over the next few years will help to clarify whether this perceived community problem is positively correlated to the financial and economic impact of the gardens as a source of income, or not.

3.1.6 Current Use and Sources of Water

Shortage of water as a problem

Compared to the major problem of water shortages that were expressed in the baseline survey (see Table 3.9), in the return survey sample a shortage of domestic water did not appear at all as a serious problem amongst respondents (Tables 3.10 and 3.11). Table 3.12 below shows the percentage of respondents at each site (both members and non-members) who considered a shortage of water to be a problem. For comparison the equivalent results from the baseline survey are also shown. However, despite the seemingly dramatic improvements in water supply at each site, it must be stressed that the baseline analysis recognised that answers to the question of water shortages may have been influenced by the fact that respondents were aware that the surveys were related to a water and garden oriented project.

Table 3.12 *Percentage of return survey respondents who felt water shortages were a problem*

		% who felt water shortages were a problem	
Site No.	Name	Return Survey	Baseline Survey
1	Muzondidya	4	100
2	Gokota	0	100
3	Dekeza	0	100
4	Nemauka	20	90
5	Mawadze	10	100
6	Matedze	10	93

Domestic water consumption rates

From the baseline survey, the mean amount of water utilised per day for the sample was 122 l/day (sd 12.07). With an average family size of 8 this worked out at approximately 15 litres per person per day.

The mean amount of domestic water utilised per day for the sample of members households is 109.5 litres/day *(range 50-300, sd 17.4)*. With an average size of 8.62 people per household (sd 0.71), this works out at approximately 13 litres per person per day.

The mean amount of domestic water utilised per day for the sample of non-members households is 97.3 litres/ day *(range 40-300, sd 16.8)*. With an average size of 7.28 people per household (sd 0.69), this also works out at approximately 13 litres per person per day.

A graphical representation of mean daily domestic water consumption rates per person at each sites as obtained from the return survey, is given in Figure 3.10.

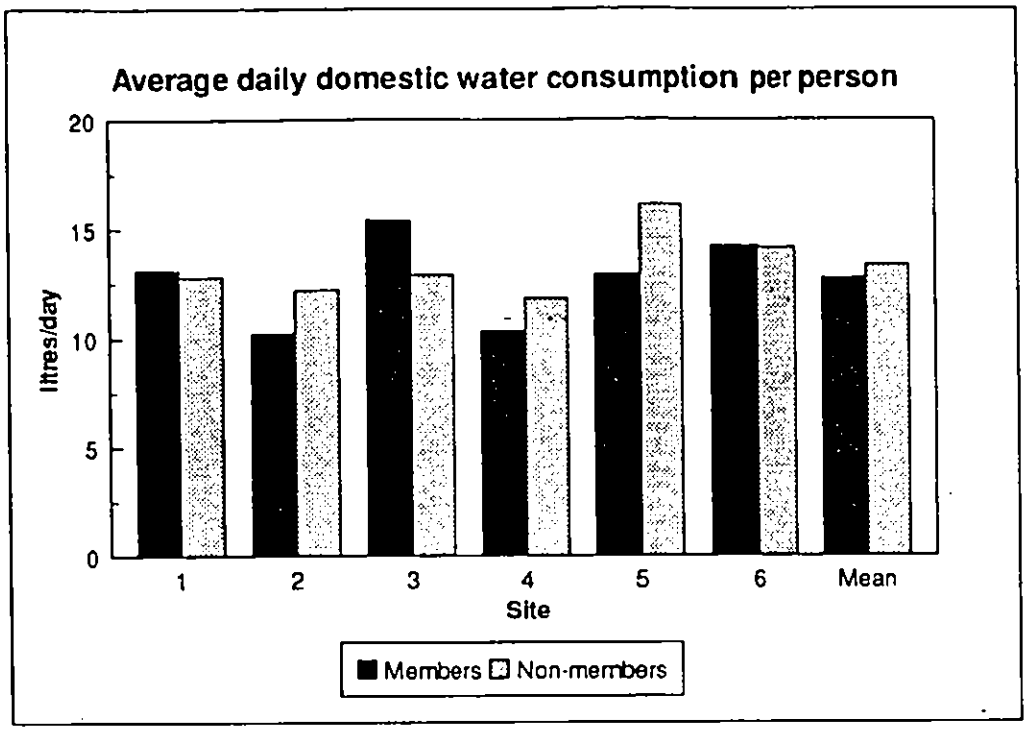


Figure 3.10 *Average daily domestic water consumption per person per site (return survey)*

Table 3.13 below shows the comparison in domestic water consumption per person per day for each site before and after the collector wells were implemented.

Table 3.13 *The comparison in domestic water consumption per person for each site before and after the collector wells were implemented*

Mean Amount of domestic water consumed per person (litres / day)				
Site No.	Name	Baseline Survey	Return Survey: Members	Return Survey: Non-members
1	Muzondidya	16	13	13
2	Gokota	15	10	12
3	Dekeza	15	15	13
4	Nemauka	17	10	12
5	Mawadze	16	13	16
6	Matedze	12	14	14
Mean		15	13	13
Standard deviation		1.6	1.9	1.4
Range		12-17	10-15	12-16

Given the degree of statistical error involved in obtaining this kind of information the difference between these figures is not significant. However, what is important to note is that there has not been a significant *increase* in domestic water utilisation per household as a result of the collector wells. Further analysis in this section on the number of people using the collector well for domestic water requirements suggests that instead of giving the same amount of people more water, the schemes are:

(i) supplying cleaner and more reliable water and;

(ii) serving more people than anticipated, particularly during periods of water scarcity.

Water Sources - choices and distances.

Members

From the return survey sample 50% of members said they obtained their domestic water from the collector well. 49% of members said they obtained their domestic water from a borehole, hand dug well, river or another water source. Of the 50% who use the collector well, 22% said it saved them on average 56 mins/day. The average distance travelled to the collector well by members to collect domestic water was said to be 1055m *(min 100 max 3000, sd 293.2)*. The average distance travelled by members to a borehole, hand dug well, river or other water source to collect domestic water was said to be 463m *(min 0 max 1500, sd 151.4)*.

Non-members

From the return survey sample 39% of non-members said they obtained their domestic water from the collector well, and 61% said they obtained their domestic water from a borehole, hand-dug well, river or another source. Of the 39%, who use the collector well, 12% said it saved them on average 42 mins/ day. The average distance travelled to the collector well by non-members to collect domestic water was said to be 1515m (min 100 max 3500, sd 862.2). The average distance travelled to a borehole hand-dug well, river or another water source by non-members was said to be 603m *(min 0 max 3500, sd 298.9)*

Figure 3.11 shows the differences in distances at each site for people who choose to walk to the collector wells as opposed to other water sources to obtain their domestic water. Figure 3.12 presents the percentages of respondents at each site who use the collector wells compared to other water sources for getting their domestic water requirements.

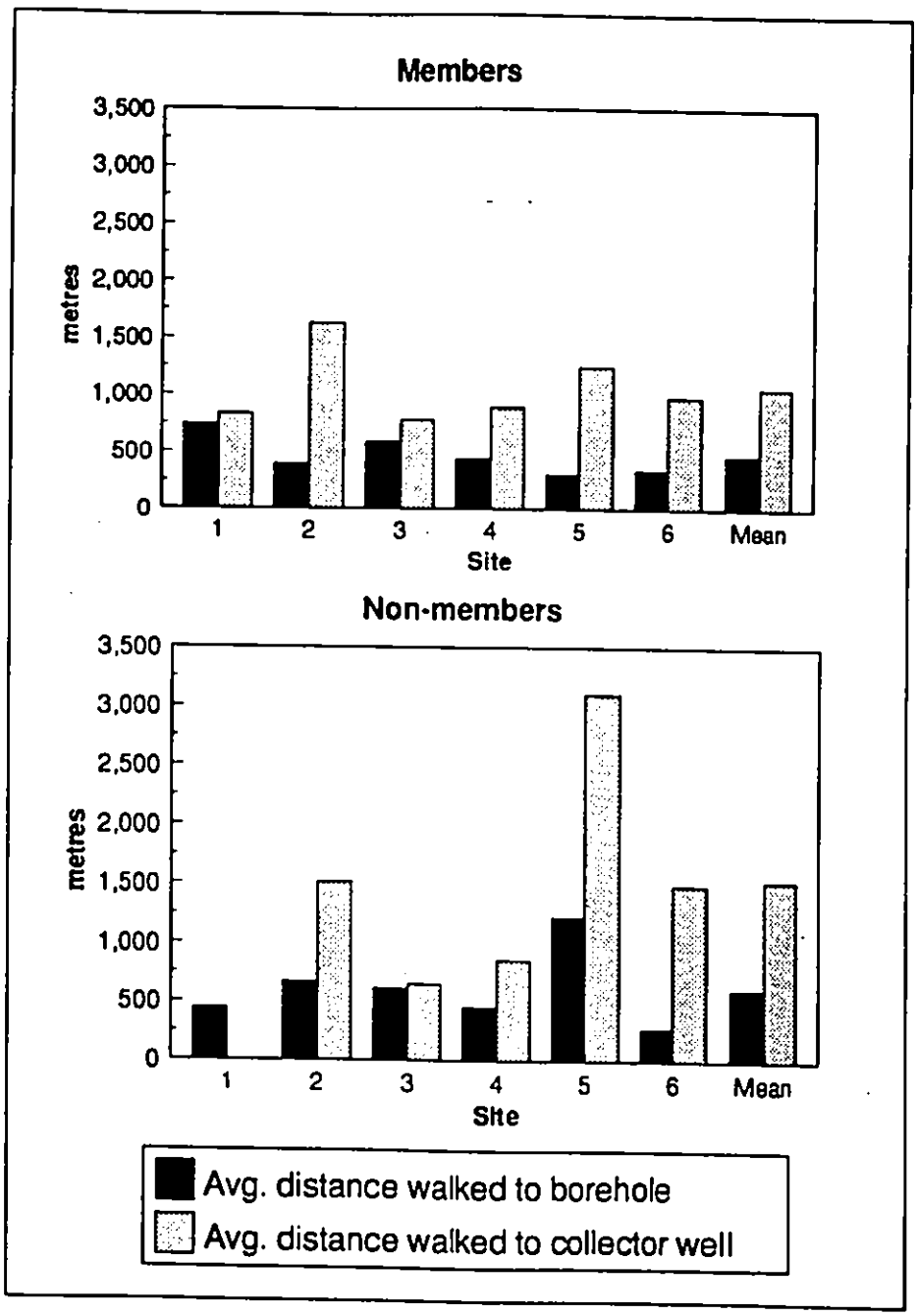


Figure 3.11 *Average distances walked to collector wells and other water sources for domestic water*

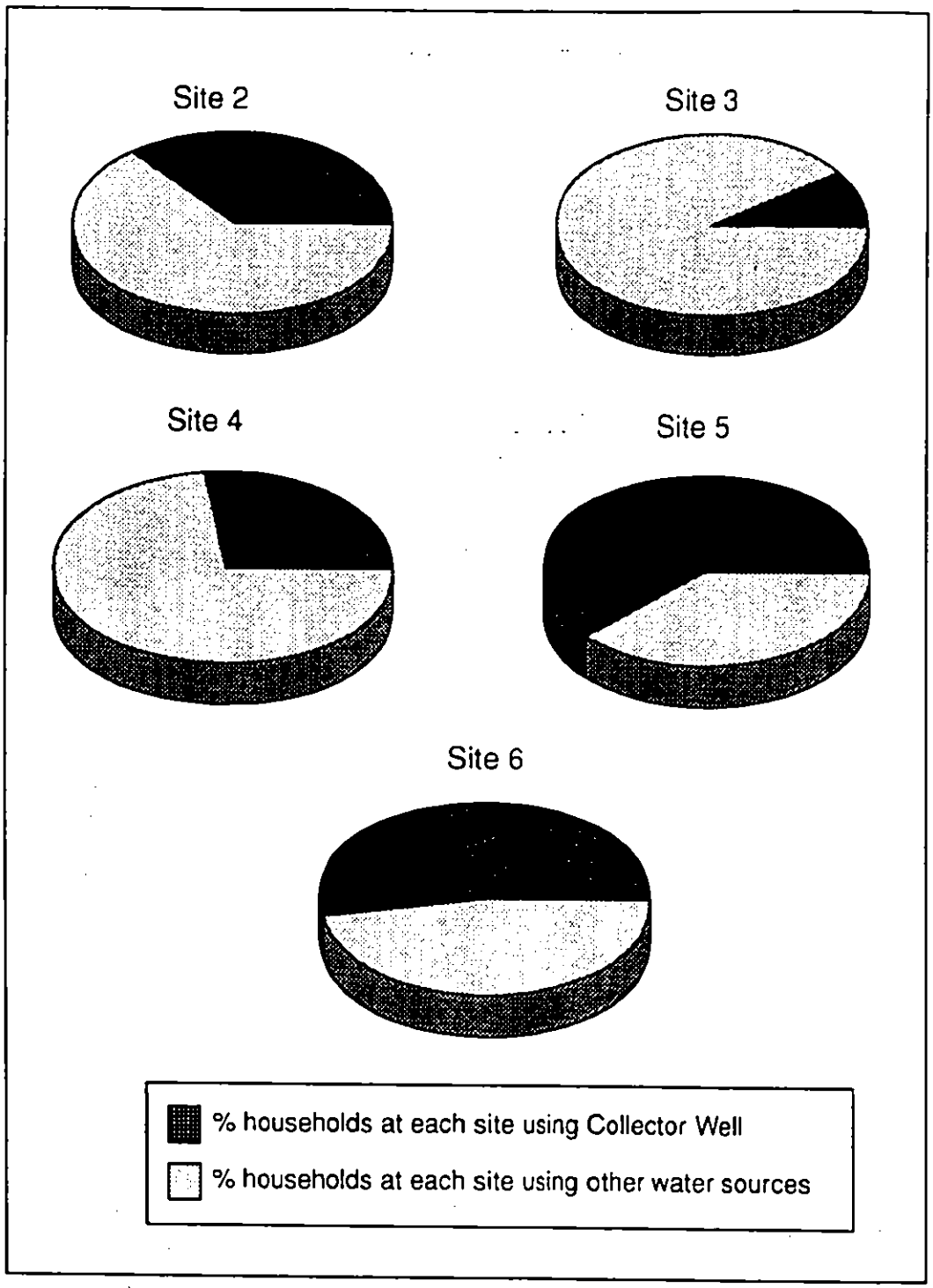


Figure 3.12 *Percentage of respondents using the collector wells for domestic water*

The Reliability of the Collector Wells

A further 22% of respondents, on average, said they also use the collector well for domestic water when their nearest other water source is "broken". 0% said the reverse (7% explicitly used the term "unreliable" when talking about their borehole). This figure varies significantly between sites, as Table 3.14 indicates.

Table 3.14 *Respondents who use the collector well when their water source is broken (members and non-members)*

Site No.	Name	% of respondents
1	Muzondidya	54%
2	Gokota	31%
3	Dekeza	38%
4	Nemauka	3%
5	Mawadze	7%
6	Matedze	3%

It is not clear whether "broken" in this context means a mechanical failure in a pump, or a seasonally dry period for the water point. Either way, the value of the reliability of the collector wells is clearly apparent. This could be due to more effective exploitation of the groundwater resources by the laterals, the fact that there are two pumps, that the pumps are relatively new, that through an increased sense of ownership and training communities have a stronger motive and ability to repair and maintain project wells themselves, or a combination of these factors.

Importantly, these figures are highest for sites 1, 2 and 3, where fewer respondents said they *always* use the collector well for domestic water requirements (see Figure 3.12). It can be surmised that the percentage of households who use the collector well for domestic water requirements experiences "surges" over time. The *peak* number of households in each area using the collector well for domestic water is thus calculated below in Table 3.15. The "surges" in collector well use when other water sources fail are presented graphically in Figure 3.13. It is not clear from the survey, however, as to how long or how frequent these periods of stress are on the collector wells.

Table 3.15 *Number of households in each area using the collector well for domestic water at peak times:*

Site No.		Peak no. using the collector well (households)	% of households in community using the collector well at peak times
1	Muzondidya	29	-
2	Gokota	146	55%
3	Dekeza	108	44%
4	Nemauka	45	30%
5	Mawadze	75	64%
6	Matedze	113	54%

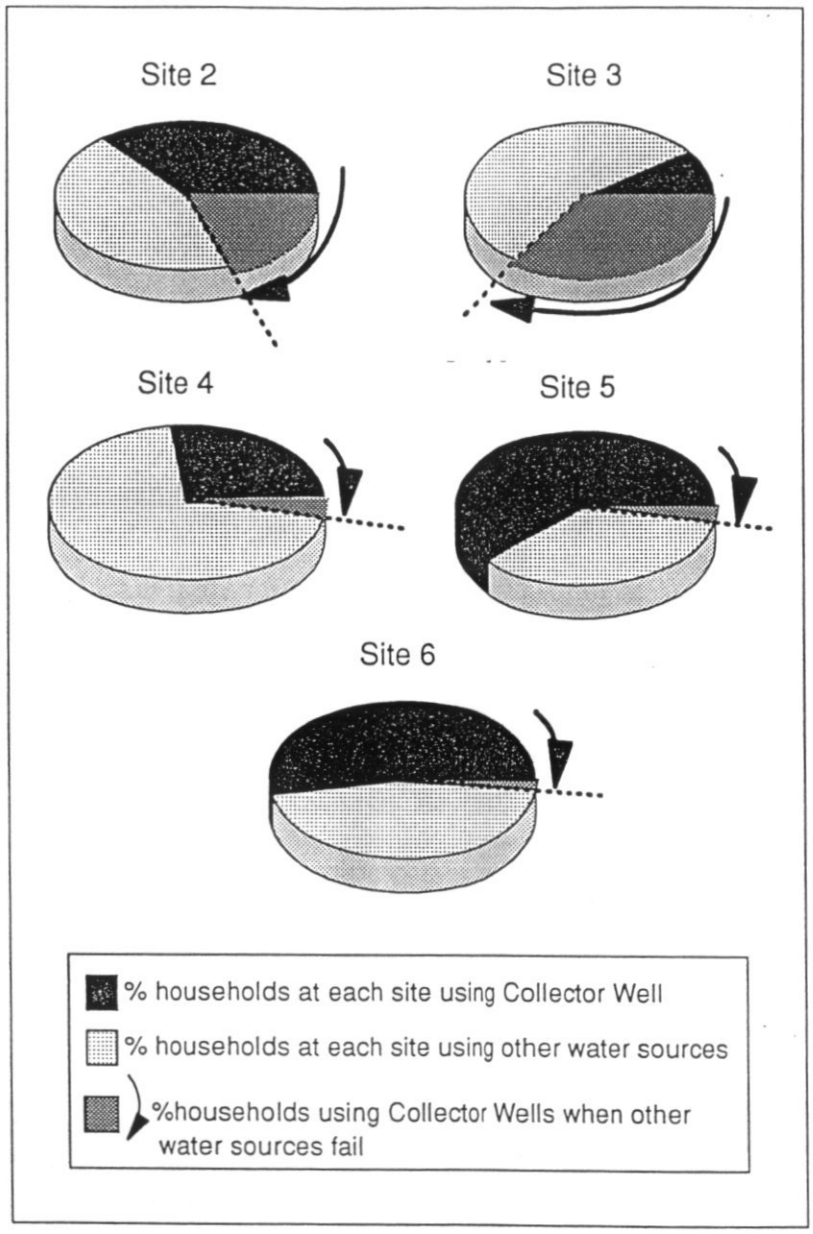


Figure 3.13 *"Surges" in collector well use as other water sources fail.*

The number of people using the collector wells for their domestic water requirements.

From the sample data in the return survey it can be estimated that a total of 489 households, or 3 882 people, are obtaining their domestic water requirements from the six collector wells, abstracting approximately 51 686 litres of water per day. The number of households is an estimate based on the sample at each site that use the collector wells. The number of people is based on mean family sizes (members = 8.6 *(sd 0.71)*, non-members = 7.3 *(sd 0.69)* x

no. of households. Litres/ day is based on the mean water consumption/ household/ day (members = 109.5 *(sd 17.49)*, non-members = 97.3 *(sd 16.83)*) x no. of households. Table 3.16 breaks down the estimated population using the collector wells for domestic water on a site by site basis. Figure 3.14 presents this information graphically. Appendix 5 contains details as to how these figures were calculated.

Table 3.16 *Population Estimates of Domestic Water Usage from the Collector Wells*

Site		No. of Households	No. of people	Litres/ day	
1	M	13	119	1424	
	NM	8	52	860	
2	M	78	601	8541	+ 1134 l/day overwatering*
	NM	15	110	1460	
3	M	19	142	2081	
	NM	41	294	3954	
4	M	27	246	2957	
	NM	89	628	8686	
5	M	39	357	4271	
	NM	50	414	4859	
6	M	62	569	6789	
	NM	48	350	4670	
TOTALS		489	3882	51686	
Members		*238*	*2034*	*27197*	
Non-members		*251*	*1848*	*24489*	

* see Appendix 5 for an explanation as to the inclusion of this extra amount for site 2.

Based on calculations of the water budget for each scheme over a particular period during the growing season of 1994, the split between water used for irrigating the community garden and water used for domestic purposes is presented for sites 1 to 5 in Table 3.17 (site 6 has not been calculated as it had not experienced a full growing season by the time the data used for calculating irrigation requirements (5th Progress Report; Lovell *et al.* 1995) was undertaken). The mean percentage of water from the collector well that was used for irrigating the garden across the 5 schemes is 68% (sd12.8). The mean percentage used for domestic purposes was 28% (sd 6.5).

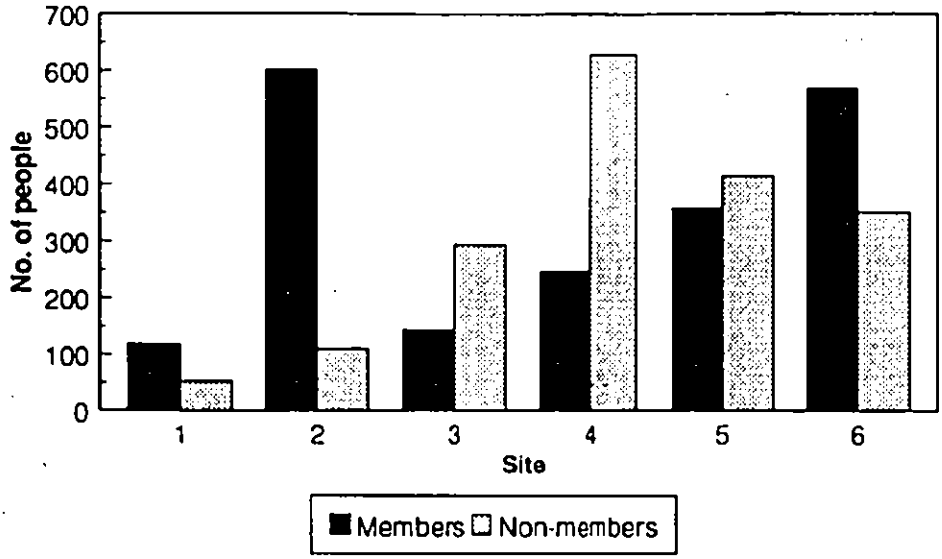


Figure 3.14 *Estimated number of people obtaining domestic water requirements from the collector wells*

Table 3.17 *The split between water used for irrigating the community garden and water used for domestic purposes*

Site No.	Name	% water used for irrigating garden	% used for domestic purposes
1	Muzondidya	80%	20%
2	Gokota	45%	55%
3	Dekeza	73%	27%
4	Nemauka	78%	22%
5	Mawadze	64%	36%
Mean		68%	28%

Interestingly, the extra value that the water abstracted from the wells for domestic consumption could bring to the gardens if it was used for irrigation, has not been calculated. This mean figure of an extra 28% could substantially improve the potential internal rates of return for the gardens.

The data presented in the tables and figures surrounding the use of collector well water, support the fact that members of the schemes may be deriving marginally greater benefits from the wells than non-members, both for domestic water and for irrigation or gardening purposes. This could be interpreted in two ways. Firstly, that the primary focus of water

abstracted from the collector wells is clearly seen to be for the garden, even though they are also important sources of domestic water (except for site 3 where the well is locked inside the fence, and there is a reliable borehole close by). Or, secondly, it could be construed that members are keen not to let non-members use the collector wells too much for their own domestic water requirements, and are acting to retain the bulk of the benefits the improved water supply brings, ultimately capturing higher incomes through the sale of vegetables. Although this is rational behaviour for members, it does not result in an equitable distribution of the welfare that the water is supplying.

The second issue leads into the debate over the need to introduce a system of water rights, permits, or pricing for the collector well water in order to make sure that a more efficient and equitable system of capturing the benefits of the water is established The potential problem of a failure to allocate water rights that could result in rent seeking by members was identified in the environmental economic reconnaissance (Waughray and Dube 1995). More research needs to be undertaken to examine the extent of this problem and how it might develop over time, and to look at potential systems of introducing property rights regarding the water or land in the garden. These kinds of initiatives can be justified on equity, efficiency and sustainability grounds, all of which could act as constraints to the long term viability of the schemes.

The fact that in times of water scarcity the collector wells experience "surges" of use by non-members who would otherwise not use them, is testament to the reliability of the wells as a source of water. The value people attach to the wells for their reliability can be seen in the greater distances women choose to walk to the source in the knowledge that it will be working. Respondents in the return survey stated that one of the key benefits of the collector wells is their reliability (see section 3.4.1). Furthermore, a high economic value for the wells, including their reliability, was elicited using direct valuation techniques (see section 3.5). However, it is also apparent that during periods of water scarcity, garden committees are becoming increasingly concerned about the open access nature of the well as a source of water for all. It has been known for disincentive flat rate charges to be set to deter people from using the well for domestic water, or for people who come from over a certain distance to be turned away. As livestock numbers increase, the pressure on the collector wells as reliable sources of water, and on the definition of property rights to use their water resources will grow. Careful research will have to be undertaken to see how, if at all, to define rights to the well water if these problems are not to escalate over the next few years, particularly during water scarce periods.

3.2 ECONOMIC ACTIVITY

This section aims to present data obtained from the return survey on both the income and expenditure patterns of members and non-members of the pilot project schemes at each site, in general, and as compared to the income and expenditure patterns of respondents in the baseline survey. It concentrates solely on labour time and costs spent in the garden, gross margins and income derived from the collector well gardens, and expenditure on fresh vegetables as part of the monthly household grocery bill. Analysis on the rainfed farming budgets at each site, based on data obtained in the return survey, is currently being undertaken by the LVRS as a separate but complementary component to this section.

3.2.1 Labour time and costs spent in the garden

According to the sample in the return survey, the peak season of activity for all collector well members in the gardens is winter; in summer the opportunity cost of labour rises as fields need to be prepared for the start of the rainfed crop growing season. During the winter period the average amount of time spent working in the scheme gardens was 10.9 hours per week *(sd 2.25)*. 79.5 % of respondents said that the main decision maker and most labour for the garden came from women or wives of the head of household, with the help of children. 86% of respondents said that the produce from the garden is both eaten and sold; 11% grow vegetables in the collector well garden only for subsistence. The task that takes longest in the garden was said to be the watering - both pumping and carrying the buckets and also queuing. This may imply that if *time efficiency* can be improved in irrigating the garden, summer vegetable crops may be promoted as well, as the main constraint to gardening, especially during the summer months, was said to be a shortage of labour. This reflects the peak demand during this period for labour preparing the rainfed fields. Table 3.18 presents these data for each site.

Table 3.18 Analysis of Gardening Patterns by Site

Site	1	2	3	4	5	6
Peak Season	winter	winter	winter	winter	winter	winter
Average hrs worked in garden/week	11.1	12.6	11.1	7.2	14.2	9.2
% with female decision maker	74%	86%	62%	89%	88%	40% (60% joint)
What happens to produce*	74% eaten and sold	76% eaten and sold	84% eaten and sold	89% eaten and sold	88% eaten and sold	50% eaten and sold
Main constraint	labour	labour	labour	labour	labour	labour
Longest Tasks	watering	watering	watering digging	watering digging	watering	watering

* the categories for the respondent to select as an answer to this question were: "eaten only", "sold only" or "both eaten and sold".

It will be interesting to see at what point the marginal cost of rainfed farm or field labour in summer is thought to equal or be greater than the marginal benefit of working in the collector well garden during the same summer months. At some sites this trade off may already be emerging as a few members prepare to invest labour time in the collector well garden instead of in the fields at traditionally the busiest time of year for rainfed farming. Indeed, ongoing monitoring of the financial performances of the gardens indicate that the gross margin returns to labour in the garden are increasing after only two seasons (see Table 3.19 below) Similar research to find an equivalent figure for labour time in the rainfed fields would provide the data needed for a comparison, and would allow predictions to be made as to when and for how long people may start to extend their work in the gardens during the summer months.

Table 3.19 Gross Margin Returns to the Collector Well Gardens

Gross margin returns to labour (Z$ / labour day)			
Site No.	Name	1994	1995
1	Muzondidya	4.52	5.3
2	Gokota	3.42	5.76
3	Dekeza	5.9	9.39
4	Nemauka	0.42	11.8
5	Mawadze	4.18	16.92
6	Matedze	-	24.78

(Lovell *et al.* 1994 and Mazanghara *et al.* 1995)

3.2.2 Household income from the collector well garden

Net returns to the garden plots, elicited from respondents in the return survey, seemed to vary significantly between sites, and were initially quite optimistic. However, the experience of quantifying and cross checking the data indicated that without careful survey design beforehand and investigative questioning during the interviews, both respondent and enumerator tend to overestimate the net income gained per month from selling the scheme's produce. It may be much more reliable to calculate financial indicators purely on recorded yields and actual farm gate prices, as has been the case in the project progress reports. Nevertheless, detailed further interviews with a small sample of members (n = 30) revealed many interesting aspects as to the income generating potential of the vegetable crops, that a standard financial analysis would not capture.

Mean income levels generated by the collector well gardens.

The data on incomes generated from the collector well gardens that the return survey revealed for the 1994/95 season are presented in Table 3.20. Figure 3.15 presents these data graphically, showing the mean amount earned per month, and the maximum selling period for each site. There also follows a short discussion on the details of the income patterns from the collector well garden at each site.

Table 3.20 *Mean income per member from the collector well gardens (1994 growing season)*

	Muzondidya	Gokota	Dekeza	Nemauka	Mawadze	Matedze
Amount earned (Z$)	67	96	664	68	430	206
Period of selling (months)	2.8	3.7	7.5	2.4	5.2	6

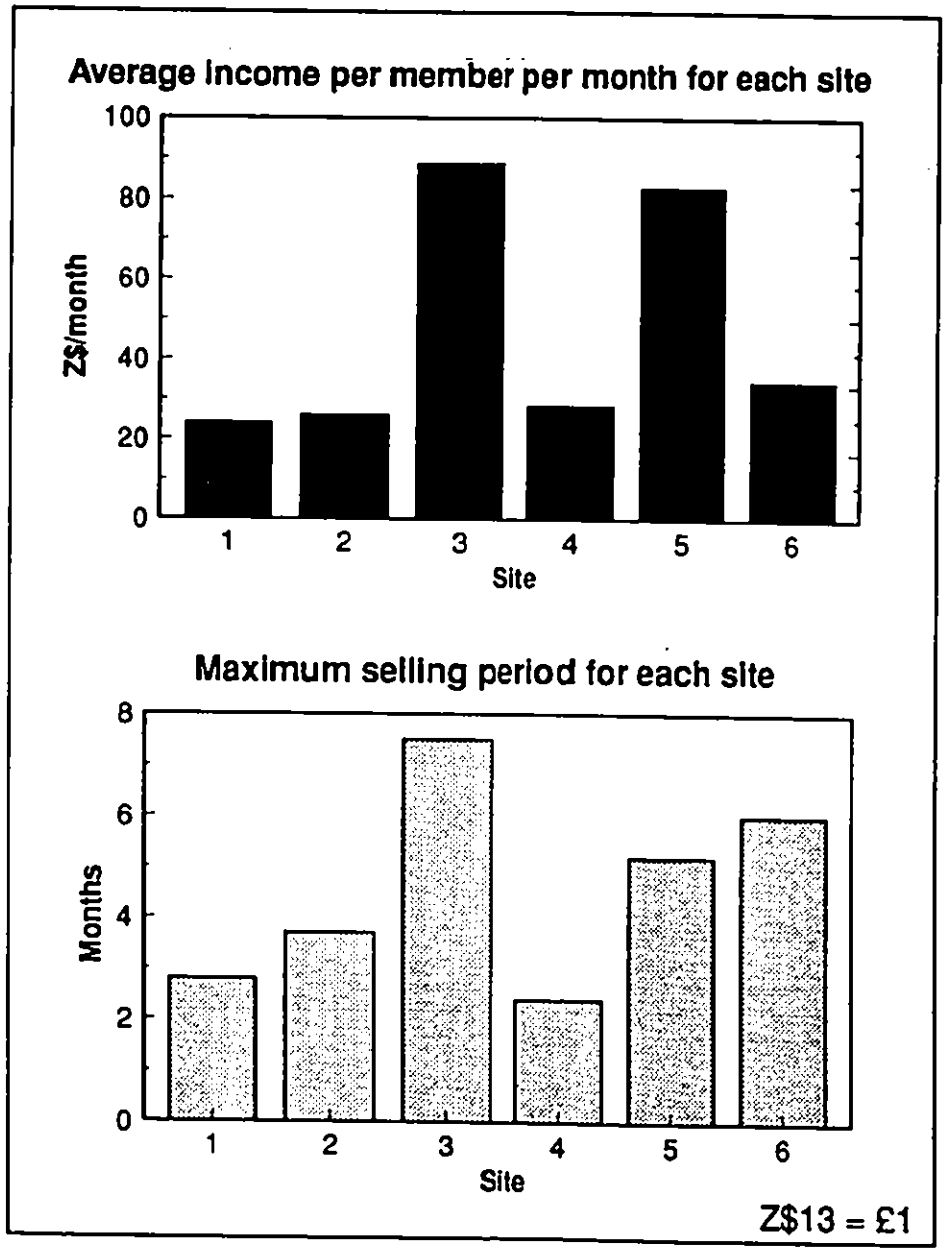


Figure 3.15 *Income per member per month and maximum selling periods for the collector well gardens (1994)*

From this information, the mean income generated from the collector well gardens per member in 1994 can be estimated as Z$ 255.20 pa *(se99.3; ci 248)*.

Estimated Income details at each site

At site 1, members earned on average (ie a net cash surplus on top of vegetables consumed and inputs purchased) Z$ 67.20 *(se7.7; ci20.79)* over a maximum period of 2.8 months selling. Customers mostly came to the garden on an informal basis. For site 2, members earned on average Z$ 96.00 *(se32; ci86.4)* over a maximum period of 3.7 months selling. Customers mostly came to the garden on an informal basis. For site 3, members earned on average Z$ 664.00 *(se242; ci653)* over a maximum period of 7.5 months selling. At this site members were active in finding markets for their produce, walking with dishes of vegetables for sale up to a 8km radius. "Block" purchases of vegetables (securing an assured Z$30 /day) also occurred with agents coming from Chiredzi and Jerera. A nearby school and small township also supply a ready market for the site's vegetables. A second crop (tomatoes) was grown in this season. It can be assumed that the members of site 3 have both sought and responded to the market potential for vegetables in the location. With effective marketing strategies and exploitation of location, site 3 may offer an example of the financial potential of the collector well gardens. For site 4, members earned on average Z$68.00 *(se 14.9; ci 40.4)*, over a maximum period of 2.4 months of selling. Customers mostly came to the garden on an informal basis. For site 5, members earned on average Z$430.00 *(se 97; ci 261)* over a maximum period of 5.2 months selling. Again, all members sampled were supplying agents with block purchases and were harvesting two crops / season. For site 6, members earned on average Z$ 206.60 (se59; ci 159) over a maximum 6 months. 60% of members sampled were supplying agents with block purchases and were harvesting two crops / season.

From both the data and the site specific discussion on income generated by the schemes, it seems that the size of garden membership (the smaller the better) and the length of time attached to both working in the garden and actively marketing its produce (the longer the better) can significantly improve net returns to effort. These observations could be important as they can help answer questions as to the relationship between the number of members, other variables and the income generating capabilities of different schemes.

For example, Table 3.21 below charts the size of the gardens by number of members, the mean amount they earned per member for the 1994/5 season, and the length of time over which members were producing and selling produce.

Table 3.21 Comparison of garden membership size and performance

Site No.	Name	Mean income per member (Z$)	No. of members	Length of selling period (months)
1	Muzondidya	67	134	2.8
2	Gokota	98	109	3.7
3	Dekeza	664	50	7.5
4	Nemauka	68	84	2.5
5	Mawadze	430	50	5.2
6	Matedze	206	87	6

A multiple regression analysis using the size of garden membership and the length of the selling period as independent X variables, and the mean income per member as the dependent Y variable, gave a high R squared value of 0.86. The value of the coefficient for the intercept was 199.6; for members it was -3.16, and for the length of growing and selling period it was 71.1. Hence the model suggests that with an average income of Z$200 per member across the schemes, every additional member (average membership being 86) lowers each members' income by Z$3.16 (se 2.17) and every extra month of growing or selling raises each members income by Z$71.07 (se 36.14).

These preliminary findings using limited datasets from only 6 schemes over just two years suggest that a smaller number of members per scheme and a longer growing season and selling period contribute to higher income generating capacity. However, the schemes are relatively new and there may be many other important variables which may emerge that can be shown to significantly influence income levels generated by the garden. For example, leadership, marketing strategies, pest control, other extension advice, effectiveness of collective action, and locational aspects, may all be critical factors. As a better record is built up over several seasons about good and bad years in the gardens, more sophisticated analyses can be carried out to ascertain the most significant variables that influence high income levels from the garden per member. Disseminating this kind of information would substantially improve the performance of ongoing and future schemes, as and when they are implemented.

Sources of household income for members and non-members

With regards to the most important sources of household income by value for both members and non-members at each site, remittances appear at the top of each ranking, although figures as to the size of remittances sent home were obtained for only two sites (approx Z$3 000 pa). The collector well income appears on 5 of the 6 lists but in last place or thereabouts, by value.

However, it is important to note not only the *value* of the income generating activity in each list, but also the *number of people* who participate in each income generating activity. This is critical if we are to examine the impact of the collector well garden on economic welfare at each site in terms of equity as well as overall financial improvement. In short, the spread as well as the total size of income gains is of importance.

Table 3.22 below ranks the most frequent income sources, as stated by the survey sample, at each site (for members) by the % of people in the sample relying on them. Figure 3.16 presents this information graphically.

Table 3.22 *The most frequent income sources for members at each site.*

Site 1	Source	No. of People	%	Site 2	Source	No. of people	%
	Remittances	10	53		Remittances	12	86
	Beer brewing	8	42		Beer brewing	3	22
	Rainfed crops	9	47		Rainfed crops	3	22
	CW vegetables	14	74		CW vegetables	12	86

Site 3	Source	No. of People	%	Site 4	Source	No. of people	%
	Remittances	8	62		Remittances	13	68
	Beer brewing	5	38		Beer brewing	9	47
	Rainfed crops	3	23		Rainfed crops	4	21
	CW vegetables	11	84		CW vegetables	17	89

Site 5	Source	No. of People	%	Site 6	Source	No. of people	%
	Remittances	6	33		Remittances	10	59
	Beer brewing	5	28		Beer brewing	6	35
	Rainfed crops	13	72		Rainfed crops	9	53
	CW vegetables	11	61		CW vegetables	12	59

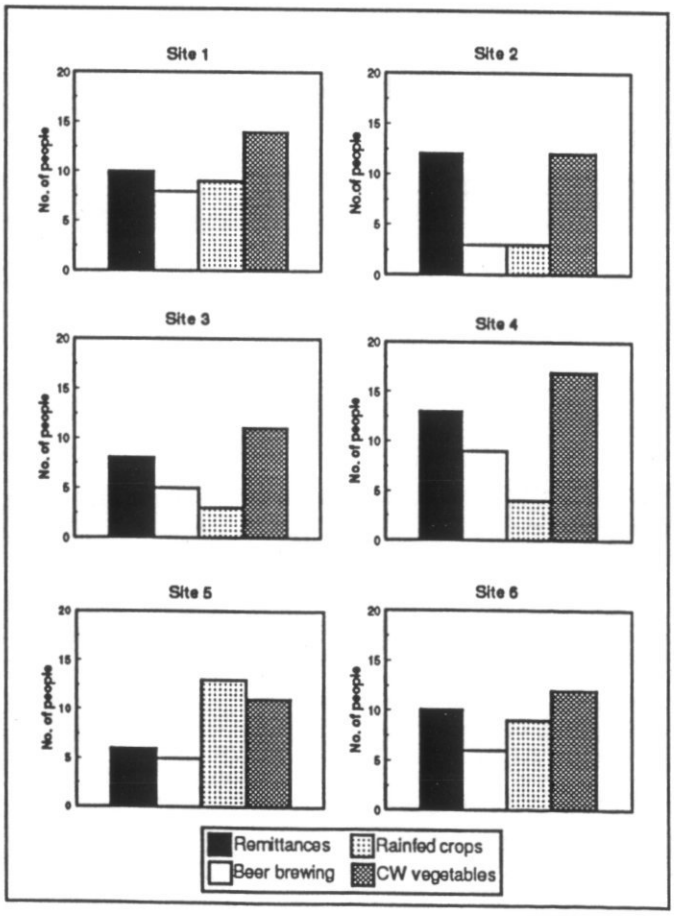


Figure 3.16 *The most frequent income sources at each site by the number of people relying on them*

Although the mean estimated income from the collector well garden's vegetables does not by any means represent a huge increase in annual income (mean = Z$ 255.20 pa *(se99.3; ci 248))*, it is certainly not insubstantial. More importantly it accrues to a wide spread of members. On average 76% of members in the sample obtained an income from the collector well garden. For those with maybe no other access to cash or materials for income generating activities, obtaining a steady seasonal income from the scheme can greatly lower elements of risk and insecurity in the household budget and decision making process.

Revolving Funds

An important aspect of the income generating capabilities of the collector well gardens is the extent they can generate enough capital to give women access to a range of other activities which can further diversify rural incomes and spread household economic risks. A good measure of this aspect is the blossoming of "revolving funds" among scheme members. One part of the return survey had aimed to gather information as to the amount of savings from the scheme that women were able to muster. 33% of respondents said they saved money from the scheme; 10% said they would if they had access to a savings facility. The most popular place to save was the post office. However, it emerged that half of this number seemed to save more than they earned per year from the garden. Through further questioning it transpired that these members were actually banking their share of a "revolving fund" that they were involved with. The survey was then widened to gain more information on revolving funds within the collector well garden communities

A revolving fund is a traditional savings club operated and managed by a group of friends or colleagues. Each member of the fund puts an equivalent amount into a fund "kitty" each week or month. The total amount in the kitty each week or month is then given to one of the members to spend on items the others in the group feel are justified. Each member has a subsequent turn of spending the kitty - hence the term "revolving" fund. Thus, if there are 5 friends who set up a revolving fund and each member subscribes Z$5 a week, then once every 5 weeks one of the members gets to spend or invest Z$25, provided he or she can justify the purchase to the others in the group. Where investment facilities are limited, or chances to invest a lump sum are erratic, and where ready cash is a scarce commodity (where there is a high marginal utility attached to money), the membership of a revolving fund is a rational, risk-lowering investment exercise, provided the member feels she has a high probability of securing a steady income from an income generating activity with which she can participate in the fund. Thus, revolving funds can spring up on the back of community focused small scale income generating activities, such as dressmaking or mat weaving, particularly among groups of women in rural areas who otherwise rarely get to manage and control any meaningful levels of capital in the household.

From a relatively small sample of collector well scheme members (n=30) it is clear from the return survey that there are at least 15 revolving funds operating within the 6 schemes. Membership of these funds ranges from 3 to 40; amounts invested per month from Z$5 to Z$120. In general lots of groups have many people putting a little aside each month for the funds, and a few groups have less people putting in more. Figure 3.17 shows the 15 revolving funds identified as operating in the 6 schemes, the number of members they involve and the total amount save each month as a result.

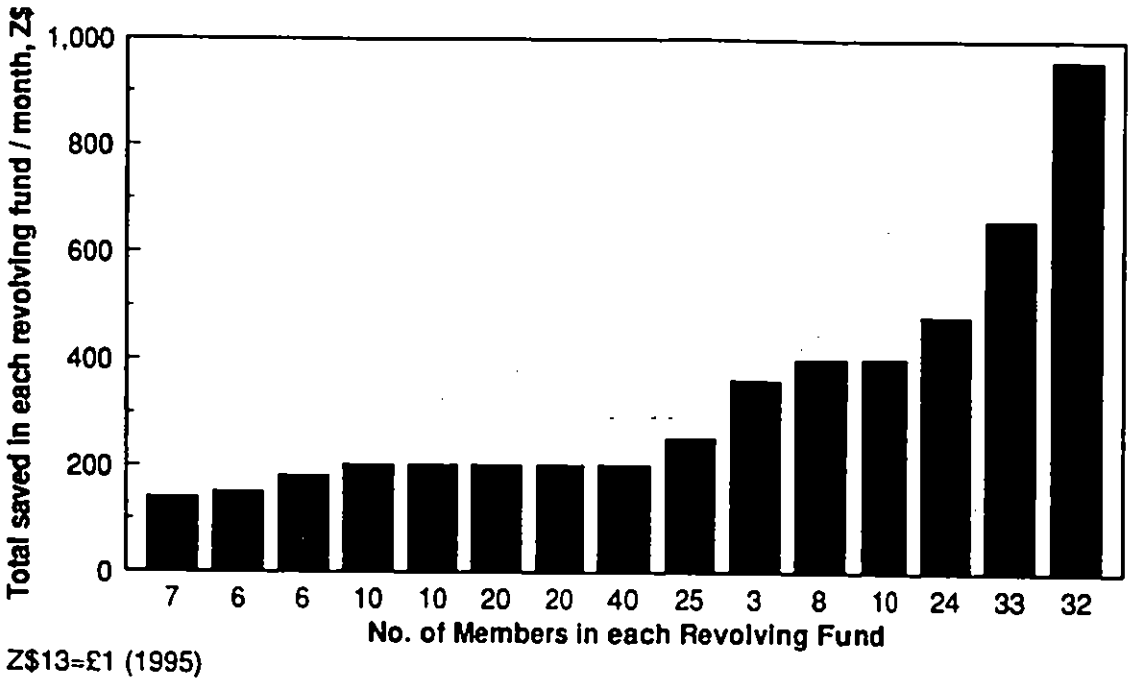


Figure 3.17 *The 15 revolving funds as identified in the return survey.*

At least 49% of all members in the schemes were found to be involved in these funds, with the total amount saved each month being at least Z$4 980. From the sample surveyed, only one fund was said to have existed before the collector well garden schemes, and that has now expanded from 10 to 33 members. The main areas of expenditure of members' "turns" of the funds are said to be school fees, kitchen utensils / pots/ pans, savings for emergencies and safe keeping and the purchase of materials for other income generating activities such as knitting and mat making. As the community garden schemes progress it will be interesting to note both the development of the revolving funds themselves and the subsequent increase or otherwise in the range of income generating activities for women, based on the capital purchases derived from these funds. Furthermore, the increase in community-based and women-focused savings groups that has resulted from the collector well gardens adds more weight to the suggestion from communities that the experience of successful collective action and involvement in the collector well scheme aids the implementation of further community-focused projects and sustainable income generating initiatives.

Income as a dynamic

It is important to find out whether the incomes between members and non-members of the scheme, or between respondents surveyed before the scheme who are members now, are statistically significantly different. An F-test was used to check if the variances of the two sets of data were from the same population (homoscedastic). Once it was established that the standard errors were not significantly different, a one tailed t-test was used to compare the two mean income levels - members and non-members now, and members before and after joining a scheme. Remittances was not included in the analysis. Appendix 3 contains details as to the formulae for the statistical tests used.

The first t-test aimed to see whether household income data obtained by the return survey were significantly different between members and non-members. Site 1 was analysed. The mean annual income for members sampled at site 1 was Z$ 438.4, and for non-members Z$ 403. The calculated t - statistic was 0.244, the table t was 2.05. Thus, even under 90% confidence limits it cannot be accepted that household incomes are significantly different between the two groups. The other mean income figures for members and non-members are of a similar overlap in distribution. It is thought that there is probably no significant statistical difference that is readily obtainable between members' and non-members' incomes, within such a comparative static analysis. This may be due to the fact that the schemes have only been running for two seasons, and a similar test should therefore be conducted later on in time. It will be important to keep track of differences that may or may not develop, between member and non-member incomes at the pilot project sites.

The second t-test aimed to see whether household income data obtained in the baseline and the return surveys were significantly different for those who became members of the collector well schemes. All 6 sites were analysed. Unfortunately, the data from the original baseline survey failed to elicit more than sporadic numerical estimates for respondents' incomes. It was decided, however, that an estimate between the two periods could be made by subtracting from the incomes of those who became members either the exact amount they said they made from the scheme (carefully elicited in a follow up return survey) or the mean amount made per member from the scheme at the relevant site. Comparison could then be made between two different means of income (before and after) to test for a significant difference. Any difference could then be attributed to the presence of a collector well scheme. The t-test was one tailed and was conducted at a 90% confidence level.

The results were initially rather disappointing. Only site 3 registered a significant positive change at a 90% confidence level. Although the income from the collector well is small, it is also constant and accrues equally to the most and least wealthy. Perhaps the relatively small changes in income patterns generated by the collector well schemes are statistically hidden by the "noise" of the larger sources of income that some richer members obtain. The difficulty was how to better represent the *greater spread* of poorer members who are receiving money from the collector well.

As mentioned earlier, many scheme members' incomes are boosted by their turn of a revolving fund (if they are a member of a fund). This boost happens on average once every 18 months, to the mean amount of Z$340, or an average of Z$226 per year. This improvement in income was not taken into account in calculating the mean income levels. In effect the revolving fund "bunches" a small but frequent income into a larger less frequent one. This may have more statistical significance in the t-test. Furthermore, many members of revolving funds actually failed to include their revolving fund savings anyhow, as part of their annual income when responding to the enumerators questions. It was only by accident through another questioning strategy that the widespread existence of the funds became apparent.

Thus the test was re-run for the sample, this time with n x random members' incomes boosted by Z$ 226. n is equivalent to the % of members at each site involved in a revolving fund as represented by the sample. Therefore, for:

Site 1	n = 3 members
Site 2	n = 10 members
Site 3	n = 9 members
Site 4	n = 4 members

Site 5 n = 13 members
Site 6 n = 7 members

Table 3.23 shows the original t-test results in normal type, and the results of the re-run in italics for each site. The results are an improvement. Site 3 showed a significant change at the 95% level, site 5 at a 90% level, site 1 at 88% level, site 2 at 88% level. Site 6 still showed no significant change.

Table 3.23 *T Test details comparing income changes for each site*

For site 1:
Mean income pa for sample with the scheme = 733.4
(with revolving fund = 775.8)
Mean income pa for sample before = 636.2
Result 1: No significant change (calculated t statistic = 0.53, table t = 0.86)
Result 2: Significant at 88% level (calc t = 0.78; table t = 0.86)

For Site 2:
Mean income pa for sample with the scheme = 526
(with revolving fund = 722.5)
Mean income pa for sample before = 455
Result 1: No significant change (calculated t statistic = 0.19, table t = 0.86)
Result 2: Significant at 88% level (calc t = 0.71; table t = 0.85)

For Site 3:
Mean income pa for sample with the scheme = 570
(with revolving fund = 754.9)
Mean income pa for sample before = 318
Result 1: A significant change (calculated t statistic = 1.2, table t = 0.86)
Result 2: Significant at 95% level (calc t = 2.25 table t=1.3)

For Site 4:
Mean income pa for sample with the scheme = 2 901
(with revolving fund = 2977)
Mean income pa for sample before = 2 004
Result 1: No significant change (calculated t statistic = 0.7, table t = 0.86)
Result 2: Significant at 88% level (calc t = 0.72; table t = 0.86)

For Site 5:
Mean income pa for sample with the scheme = 1 458
(with revolving fund = 1682)
Mean income pa for sample before = 1 196
Result 1: No significant change (calculated t statistic = 0.43, table t = 0.85)
Result 2:Significant at 90% level (calc t = 0.87; table t = 0.85)

For Site 6:
Mean income pa for sample with the scheme = 1 303
(with revolving fund = 1 434)
Mean income pa for sample before = 1212
Result 1: No significant change (calculated t statistic = 0.17, table t = 0.85)
Result 2: No significant change (calc t = 0.43)

These results, although useful, are not conclusive. It may take more time for changes in income levels as a result of the community garden schemes to become statistically significant. It *is* interesting to note that the most recent garden, site 6, records no significant change as yet for both tests. Again, it will be important to re-run these kinds of tests after a few more seasons, to see to what degree being a member of a collector well community garden can significantly improve household income levels.

As a concluding remark to this section, it should be stated that the analysis of household income from the return survey has concentrated mostly on the income *members* of a pilot project scheme are deriving from fresh vegetable sales. Less information has been obtained or analysed as to the effect on incomes of the schemes on those who did not, or who were unable to join a pilot project scheme. From information obtained as to the sources of fresh vegetables for communities, private vegetable gardens still rank as a major source. It does not appear that the pilot project garden schemes have had a seriously detrimental effect on non-member vegetable production or sales. However, continued monitoring of the schemes is again important, in order to detect the development of any possible "negative externalities" on non-member income sources in the environs of each site.

3.2.3 Household Expenditure

The analysis of household expenditure patterns in this report aims to examine the impact of the collector wells and community garden schemes on spending patterns and concentrates mostly on the expenditure relating to groceries. It is presumed that other expenses (for example, school fees, clothes etc) would remain relatively unchanged by the scheme, but that spending on groceries, such as fresh vegetables, may prove to be a dynamic variable, and may have changed as a result of the scheme depending on whether the respondent is a member or non-member of a community vegetable garden. Table 3.24 presents the data on household expenditure on groceries and fresh vegetable before and after scheme implementation. Figure 3.18 represents the information on fresh vegetable expenditure graphically.

Table 3.24 *Expenditure on Groceries and Vegetables.*

Site		Average Grocery Bill/ month (Z$)	Amount spent on buying fresh veg/ month (Z$)
1	M	74.20	before: 17.00 (sd 4) now: 0
1	NM	65.20	before: 11.00 now: 15.30 (sd 8.9)
2	M	774.2	before: 45.00 (sd14.5) now: 0
2	NM	128.3	before: 10.00 now: 22.67 (sd 1.8)
3	M	104.7	before: 23.40 (sd 5.04) now: 16.40 (sd 8)
3	NM	73.85	before: 22.00 (sd 21.9) now: 30.00 (sd 12.2)

Site	Average Grocery Bill/ month (Z$)		Amount spent on buying fresh veg/ month (Z$)	
4	M	108.33	before: now:	14.50 (sd 6.5) 0
4	NM	85.45	before: now:	8.50 (sd 3.57) 29.50 (sd 17.8)
5	M	137.64	before: now:	10.72 (sd 6.4) 0
5	NM	133.63	before: now:	5.00 2.00 (nearby dam)
6	M	138.82	before: now:	8.80 (sd 4.1) 0
6	NM	66.92	before: now:	6.00 (sd 2) 18.00 (sd 4.89)

M = member of a scheme; NM = non-member

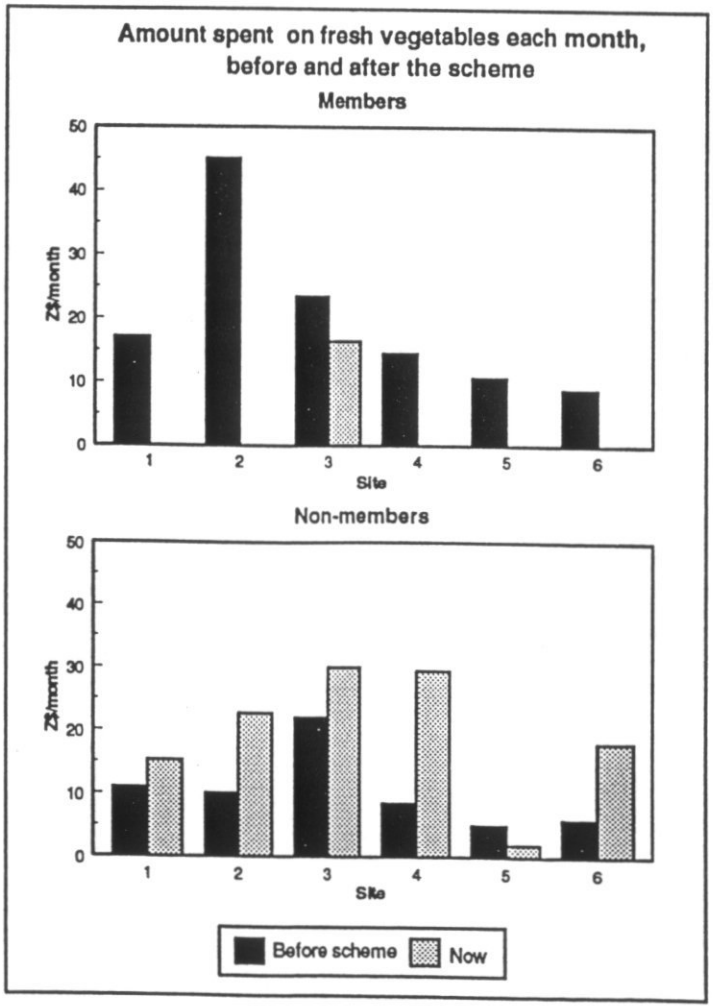


Figure 3.18 Amount spent on fresh vegetables each month before and after the scheme

The table shows that average grocery bills per month are generally higher for members than for non members, reflecting perhaps the improved levels of disposable income the scheme has generated for members. Figure 3.18 showing changes within the grocery bill for the amount spent on fresh vegetables each month is of particular interest. In general spending in this area has declined for members, but has risen substantially for non-members. This may be a reflection of there being more fresh vegetables in the region that non-members choose to purchase, or that non-members are choosing to divert disposable income away from other items of expenditure in order to buy more vegetables. Alternatively it could again be the influence of the ESAP on consumer purchasing strategies. For example, as the price of staples such as bread has risen, non-members may have decided to switch to buying vegetables to accompany their home produced sadza. Without further work on the impact of ESAP's on communities, these spending patterns can be taken to be a good indication of the collector well schemes boosting the market for vegetable trading within the region, and meeting the demand of non-member communities for fresh vegetables during the dry months.

3.3 INSTITUTIONAL CONSIDERATIONS

3.3.1 Critical People in the Community

The baseline survey found that in general traditional leaders (kraalheads and headmen) seemed to be regarded as less important in the community than the more modern institutions, such as the councillor or the agricultural extension worker. The return survey found a similar pattern, with 60% of respondents saying that the most important person in the community was the agricultural extension worker (29% said the kraalhead and 11% said both). However, 77% of respondents suggested that in order to notify project staff about a community's desire for a *future* collector well and garden scheme, a list of names should be passed to the local councillor via the traditional kraalhead or headman. Only 23% suggested that the agricultural extension worker should be the middleman (the reasons given for this apparent contradiction were that the agricultural extension worker may take too long, or that he might end up implementing the wrong sort of scheme).

This kind of feedback should not be seen entirely as a criticism of the agricultural extension worker. Instead, it may suggest that the collector well and garden schemes are perceived by the community to be not just about irrigation and gardening, but also to do with the provision of a wider range of social benefits, such as a reliable water supply and a focal point for meeting and chatting. Alternatively, this anomaly may simply be due to respondent bias. The relative importance of community leaders may have been chosen on the basis of the question being perceived to relate to agricultural or institutional issues. Thus, leadership issues at every site will be different and cannot be generalised. All leaders at any site must therefore be identified and worked with.

3.3.2 Exposure to agricultural extension advice

The baseline survey noted that the three most frequently recalled extension messages all related to rainfed cropping. Very little advice seemed to have been absorbed by communities on the subject of vegetable cultivation and no mention was made of irrigation.

However, in the return survey, respondents said that they *had* now received advice from the agricultural extension worker to help with the community garden, mostly on irrigation

amounts and schedules for vegetables, growing vegetables in time to sell and on planting arrangements in the garden. Non-members also said they had received more advice on vegetable growing, with less emphasis however on growing vegetables in time to sell. But, similar to the baseline survey, the most frequently cited pieces of extension advice both sets of respondents recalled were still to do with rainfed farming - contour ridges, winter ploughing and drainage ditches. In general, non-members of the garden schemes suggested that they got more advice from their family than from the agricultural extension worker, as compared to members.

Priorities for extension advice and assistance

By far and away the main priority for future extension advice and support that garden member's wanted in the return survey was for improved methods of pest control in the gardens. This was the case for all of the schemes. Other issues some respondents raised were for more labour and time-saving irrigation methods, as well as improved opportunities to save and join savings funds and clubs, secure methods of bookkeeping and treasury for schemes, and ideas and opportunities to market vegetables. Money for scheme inputs, such as spare parts for the pumps or pesticides, was generally said to be generated from the sale of vegetables. Thus, the worries of the baseline survey as to the ability of communities to raise funds to maintain the schemes have not really materialised.

3.4 ATTITUDES TOWARDS AND EXPERIENCES OF THE PILOT PROJECT SCHEMES

3.4.1 Benefits of the schemes

The opportunity to grow vegetables, both for home consumption and for sale was the most important expected benefit from the schemes for respondents at five out of the six sites when the baseline survey was conducted. The exception was Mawadze (site 5) where a small dam and associated gardens meant that vegetables were a lesser priority. The community at Mawadze said their greatest need was for clean and reliable water. At Gokota and Muzondidya, a reliable domestic water supply was an important consideration whereas cleaner water was in demand at Dekeza and Nemauka to replace that drawn from shallow wells in riverbeds. Closeness of supply for domestic purposes was of relatively little importance at all sites. Water for livestock also had a low priority. The baseline survey analysis suggested that this was because increased ownership is more constrained by a lack of money than by availability of water (Lovell *et al.* 1994). It is clear from the information gathered in the baseline survey, that the different circumstances at each site placed a range of competing expectations on the benefits it was anticipated that the schemes could supply. Thus, the return survey was interested in seeing whether the collector well and gardens had been able to meet the range of different needs of each of the communities.

At Mawadze (site 5), where the greatest need was for clean and reliable water sources, members said that the second-best benefit of the scheme was the provision of a more reliable water supply (the first being the opportunity to grow fresh vegetables to eat). Non-members said that the first best benefit of the scheme was a reliable water supply, and the second best benefit a clean water supply for the area. However, 36% of non-members at Mawadze still identified water shortages as a problem in the area.

At Matedze (site 6), where the greatest need was for water to grow vegetables, members said that the first best benefit of the scheme was the opportunity to grow fresh vegetables to eat, the second-best being the opportunity to grow fresh vegetables to sell. Non-members said the first and second best benefits of the scheme were a more reliable and cleaner source of domestic water respectively with the third best being the opportunity to buy fresh vegetables.

At Muzondidya (site 1) and Gokota (site 2), where secondary needs were for more reliable sources of domestic water, members at Muzondidya said that the second-best benefit of the scheme, after growing vegetables, was the provision of reliable domestic water. Non-members said the second and third best benefits (after the opportunity to buy fresh vegetables) was the provision of cleaner and more reliable water respectively. At Gokota members said that the second best benefit of the scheme, after growing vegetables, was the provision of clean domestic water. Non-members said the second and third best benefits (after the opportunity to buy fresh vegetables) was the provision of more reliable and cleaner water supplies respectively.

At Dekeza (site 3) and Nemauka (site 4), where secondary needs were for cleaner water, members at Dekeza said that the third best benefit of the scheme, after growing vegetables to eat and sell, was the provision of reliable domestic water. Non-members said second, third and fourth-best benefits (after the opportunity to buy fresh veg) were the provision of more reliable, nearer and cleaner water respectively. At Nemauka, members said that the second best benefit of the scheme, after growing vegetables, was the provision of closer domestic water. Non-members said the third best benefit (after the opportunity to buy fresh vegetables and to meet and talk) was the provision of cleaner water.

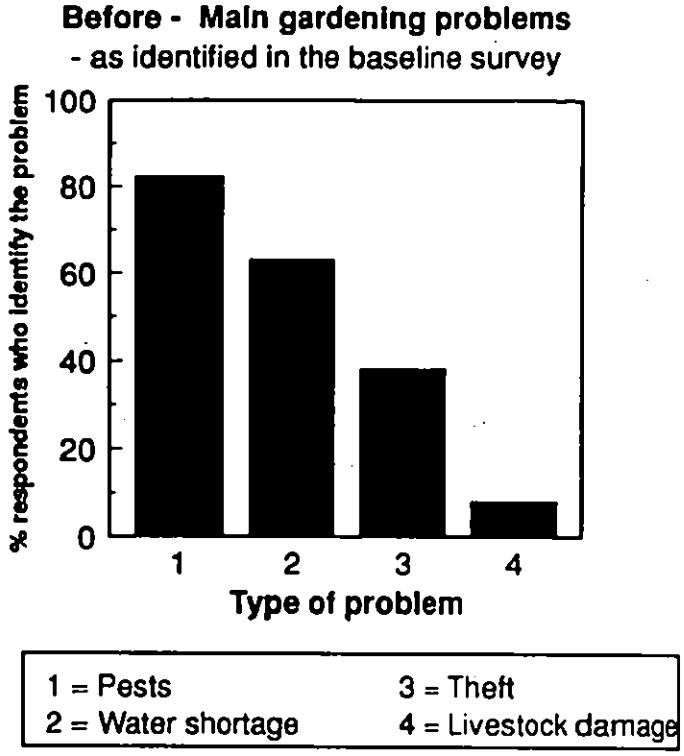
Overall it seems that the range of benefits the schemes have supplied, as identified by the respondents in the return survey, have adequately met the competing demands for a wide range of community water and gardening needs at each pilot project site.

General observations on the benefits of the pilot project schemes

Time saving does not seem to be a factor in the decision to use the collector wells. It seems that the reliability or quality of a water source is more important in a well user's calculation of her time budget. These observations were born out by the return survey which revealed that the benefits of reliability and cleanliness of water supply were consistently ranked in importance by the communities (including both members and non-members) above closeness. Another interesting aspect to note was the importance attached to the benefit of meeting and talking with others. The degree of social interaction the schemes promote within and between different kraals is clearly seen as an important secondary benefit of the project by the community.

3.4.2 Problems with the schemes

The main gardening problems that the baseline and return survey identified are shown in Figure 3.19



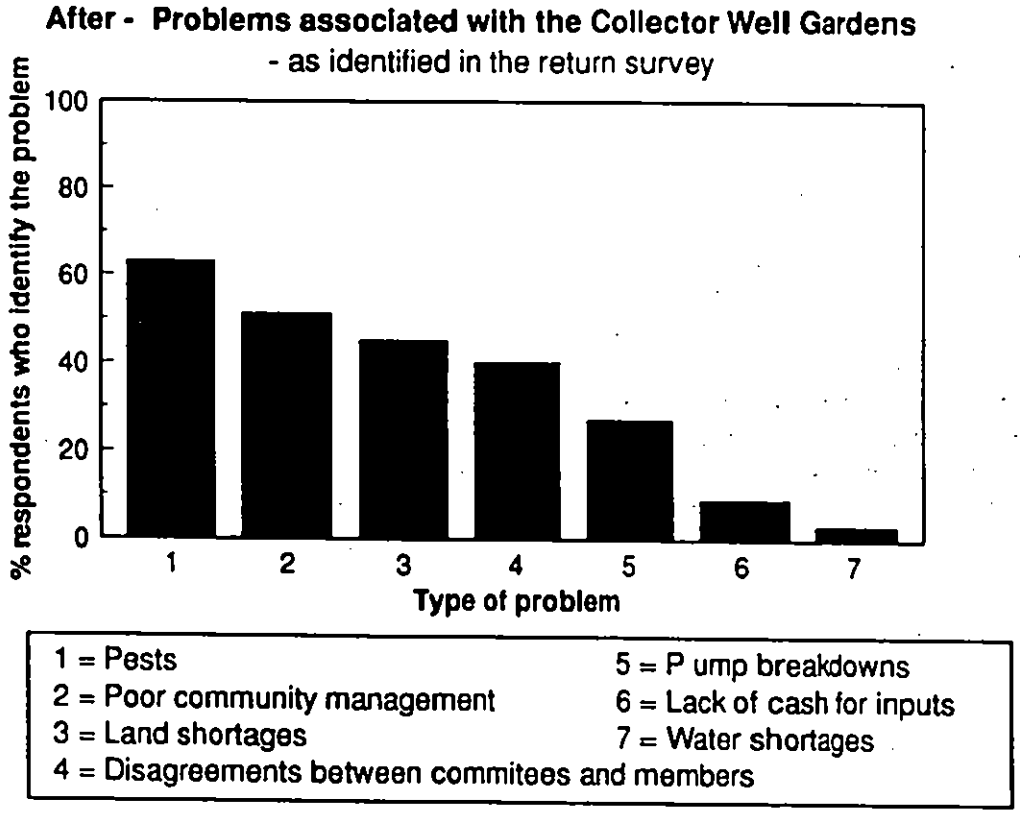


Figure 3.19 *Problems identified with the collector well gardens in the baseline and return surveys*

Before the schemes, pests and diseases were regarded as major problems at all sites except Matedze where they ranked second behind water shortages. Shortage of water was also significant at the other sites, in particular Gokota. Theft was prevalent at all sites, particularly at Mawadze, where the existing garden was a long way away. Damage by livestock was a problem where existing gardens were not adequately fenced. Minor problems mentioned by respondents at some sites comprised shortages of seed, fertilizers and implements and marketing.

Clearly, through installing the collector well and surrounding fence for the gardens, the schemes have alleviated the problems of water availability, theft and livestock damage that usually face people who make the decision to cultivate vegetables. Pests, however, continue to be perceived as a major problem. The four key problems associated with the collector well vegetable gardens are thus not to do with resource constraints, but are more concerned with social and institutional problems - the absence of village level training in pest and disease control; poor community management and disagreements between committees and members, and the desire for the community garden to be bigger.

3.4.3 Determination of scheme membership

The baseline survey identified marked differences between the sites on this issue. Respondents at Muzondidya, Gokota, Dekeza and Nemauka preferred that village leaders should decide who should join, and the kraalheads were the most commonly cited people for this task, particularly at Gokota. At Nemauka and Dekeza, however, it was advocated that agricultural extension workers should have the greatest prominence. The garden committees were deemed to be relatively unimportant in taking these decisions. A minority of respondents at each site (with most at Muzondidya) advocated a more consensus based approach whereby "the community" was to decide who the most suitable members were. At Mawadze and Matedze, payment of a joining fee was emphasised as the main criterion. 13 per cent of respondents at Mawadze favoured admitting those families who contribute labour during the construction phase. A further 10 per cent at Mawadze felt that "the needy" (defined as widows and those families without a regular wage earner) should be given priority.

The return survey aimed to find out what actually did happen regarding membership. In the end, 67% of all members across the six sites joined the schemes through a mixture of contributing labour for the well and garden's construction and paying a reduced joining fee. 32% paid a joining fee alone. The mean payment to join a scheme was Z$22, and the number of potential members still wanting to join a scheme ranges from 10-22 per site, the mean number being 16 per scheme.

The method of supplying labour to join seemed to work well, but does relate to the *availability* of labour. This is a dynamic variable. Hence, the drilling team should ask the community *when* would it be best to try and construct a well and garden (this may usually be in the winter when less labour is needed in the rainfed fields, the opportunity cost of labour to each household is thus lower, it is cooler and the water table is lower). But, many households may also rely on remittances - in other words many men may be away working. These households then lose out. Thus, *how* would it be best to construct a garden becomes the key question at each site. During the site selection process it would therefore be important to ask the community about male labour patterns in order to find out when it is best to demand male labour for scheme construction, *and* whether the community thinks it is fair to demand male labour. The need is to establish how those households who do not have spare

male labour will not lose out. The ultimate constraint is, of course, the total number of members the garden can contain, which will depend on other physical factors such as the groundwater resources available to satisfy the target well yield.

It is clear that the issue of joining and expanding membership of the schemes to ensure a fair chance for all households in the community is a complex one. Perhaps there is potential in investigating the possibility of allocating spaces in the garden within an auction system, with some kind of equity constraint. Or, of the construction of a mortgage system for the poorest or those with no male labour available that allows the member to pay back a joining fee over time with the aim of eventually buying the plot from the committee. However, this issue will need considerable research and input from participants and project staff as the schemes develop and expand before it can be resolved.

To further understand this issue, the return survey asked non-member respondents why they had not joined a pilot project garden scheme. Table 3.25 presents the reasons given, and equivalent percentages, for each site.

Table 3.25 Reasons for not joining a collector well garden scheme at each site

Constraints to joining %:

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Mean
No room	22	47	77	82	73	92	66
too expensive	22	36	23	9	27	8	21
too old/ ill health	33						7
other garden	11	8					3
too busy	11						2
left scheme		8		9			3

In identifying the constraints to joining a collector well pilot project community garden now, 65% of respondents said the main problem was a lack of room in the garden, 20% said that the joining fees were too expensive, 7% cited ill health or age as a constraint to them getting involved, 5% said they already were members of another community garden or were too busy and 3% had left the scheme. Although some respondents said that the garden plots were too expensive to buy into, the majority of respondents, particularly at sites 3, 4, 5 and 6, cited only the lack of room in the gardens as the reason for not being a member. At Mawadze (site 5) and Muzondidya (site 1) it is interesting to note that most people who originally joined the scheme did not have another garden and most who declined to join did (the dam garden at Mawadze, or existing community garden near to the river at Muzondidya). This may be due, again, to constraints on a household's labour availability.

3.5 TOWARDS A TOTAL ECONOMIC VALUATION OF A COLLECTOR WELL SCHEME

From what the respondents have said in the return survey, the two key benefits the pilot project schemes have provided are a defined, secure and well supplied plot of land in which to grow vegetables to eat and sell and a reliable and clean supply of domestic water.

These benefits may sound fairly obvious, but how much do people in the communities actually value these welfare improvements? They have said from the survey that they are the aspects of the project they like the best - it is important to quantify and present this as data. This is because attempts to show the economic value of the garden usually do so in terms of financial indicators of productivity - gross margins, returns to labour etc. But, due to the non market-based nature of some of the key welfare improvements this project supplies (reliable and clean water, secure vegetable plots to cultivate), it is critical to also try and show the economic value people attach to these benefits. These values can then be added to the financial indicators of the scheme. This would then be getting some way to establishing the *total economic value* of the pilot project schemes, properly representing the economic context of peoples' choices and decisions about using the project - walking further to get collector well water; spending time and effort in building and working in the garden and on the committee. Many of these decisions are taken by women who are very busy anyway - what is the economic value of her decision to walk further to get water from the collector well, or to invest time and effort in cultivating her new plot? For members, this value is more than purely the amount of money she gets from selling and eating the vegetables she grows. If someone is asked if she is willing to give up her plot for a year's income from it (approximately Z$200), a typical reaction would be for her to laugh and say "no way", or "maybe for Z$40 000", or some other very high figure.

Why is this? How can a monetary value to quantify what this women is saying be derived?. From the responses given in the return survey, she is indicating that now she has the community garden plot she is very loathe to give it up - it will supply her with benefits for a long time. It has a reliable water supply, a strong fence, a secure tenure and sense of ownership attached to it, and there are others in the garden like her with whom she can share ideas, plan savings funds and just chat while she works.

The endowment effect (an individual is more loathe to give a welfare improvement up for a given price once they have it, than to pay that price to get it) means that if we ask her how much she'd accept instead of the plot the figure would be very high. There would be no rational constraint to her decision. If, however, we ask her how much she'd be willing to pay to join the scheme, she has to think about all the other items of expenditure she has to secure as well. She is constrained by her budget. If within that budgetary constraint she decides that she can give up Z$x in order to join the scheme, she is effectively placing an economic value on the welfare she wishes or hopes to obtain from the project. This, in effect, is illustrating the value of the welfare improvements of the garden through the economic decisions the people who use them, or who would wish to use them, are prepared to make.

To quantify the value of the welfare improvements of the garden, the stated preferences of scheme users were elicited through a contingent valuation survey (eliciting willingness to pay responses (WTP) from respondents). In order to eliminate biases, an iterative bidding game was used. Where disposable income was limited (marginal utility of money is high) or respondents were not experienced in market based decisions, bags of maize were used as a proxy for cash. The enumerator asked both members and non-members:

i. *How much would you be willing to pay per month towards upkeep of the wells to ensure they supply water?* This is seeking to elicit an economic value as to the benefits of the establishment, the reliability and cleanliness of the collector well water. Respondents have told us they are willing to walk further to get collector well water - what is the economic expression of this decision?

The mean WTP for maintenance was Z$6.25 per month. 75% of respondents would pay Z$5 or less per month. Cross tabulations of bids by wealth and distance confirmed the stability of the figure elicited. Richer people were WTP more (although the very poorest attached a slightly higher value to the collector well water than those of average wealth), and respondents 500m or further away from the collector well were WTP more than those living nearby to ensure the functioning of the water source. Aggregated over a mean population of a collector well catchment, and assuming a 20 year project life with a 13% discount rate, the aggregate net present value of the welfare benefit the collector well water source brings the community is Z$129 501 = **£9 960** per scheme (Z$13 = £1).

Cross tabulation of the WTP maintenance bids:

By wealth

wealth rank:	1 (n = 5) mean WTPm	= 6.2 (sd 1.9)	= Z$ 74.4 pa
wealth rank:	2/3 (n= 34) mean WTPm	= 2.6 (sd 0.49)	= Z$ 30.90 pa
wealth rank:	4 (n=13) mean WTPm	= 4.38 (sd 3.07)	= Z$ 52. 5 pa

richest = highest WTPm

poor = relatively more keen on CW scheme for water than average wealth

By distance

0 to < or = 500m from water source n=32

WTPm = 4.8pm (sd 3.8) = Z$ 57.60 pa

> 500m from water source n=20

WTPm = 8.65pm (sd 9.8) = Z$ 103.80 pa

ii. *How much would you be willing to pay to join the scheme?* This is seeking to elicit a value for the benefits the garden supplies in terms of secure tenure, water for irrigation, meeting and talking, fence etc. It is *not* a value of the crop grown, but more a value of the welfare (decreased risk, increased security in the household budget) that the benefit of growing and selling vegetables over time gives to the household.

The mean WTP to join a scheme was Z$168.70 (sd93.9) as a one off payment. 60% of the sample were WTP between Z$150 and Z$300. Cross tabulations of bids by wealth and distance confirmed the stability of the figure elicited. Richer people were WTP more, and the distance that respondents live away from the collector well garden did not affect the perceived welfare benefits a garden supplies. Aggregated over a mean population of a collector well catchment, and assuming a 20 year project life with a 13% discount rate, the aggregate net present value of the welfare benefit a community garden provides is Z$114 738 = **£8 826** per scheme (Z$13 = £1).

Cross Tabulation of the WTP to join bids.

By wealth:

wealth rank 1 (n=5) mean WTPj	=	Z$ 231.25	sd 126.7

wealth rank 2/3 (n=34) mean WTPj = Z$ 173.14 sd 91.01
wealth rank 4 (n=13) mean WTPj = Z$ 135.41 sd 73.9
Richest = highest wtp

By distance:
0 to < or = 500m from garden (n=32)
WTPj = Z$169.28 (SD 98.59)
> 500m from garden (n=20)
WTPj = Z$ 167.77 (sd 84.9)
Distance doesn't affect the welfare benefits a garden supplies

Membership:
members (n=29) WTPj = Z$ 179.88 (sd 92.5)
non-members (n=23) WTPj = Z$ 155.65 (sd 93.8)

Figure 3.20 presents these results graphically.

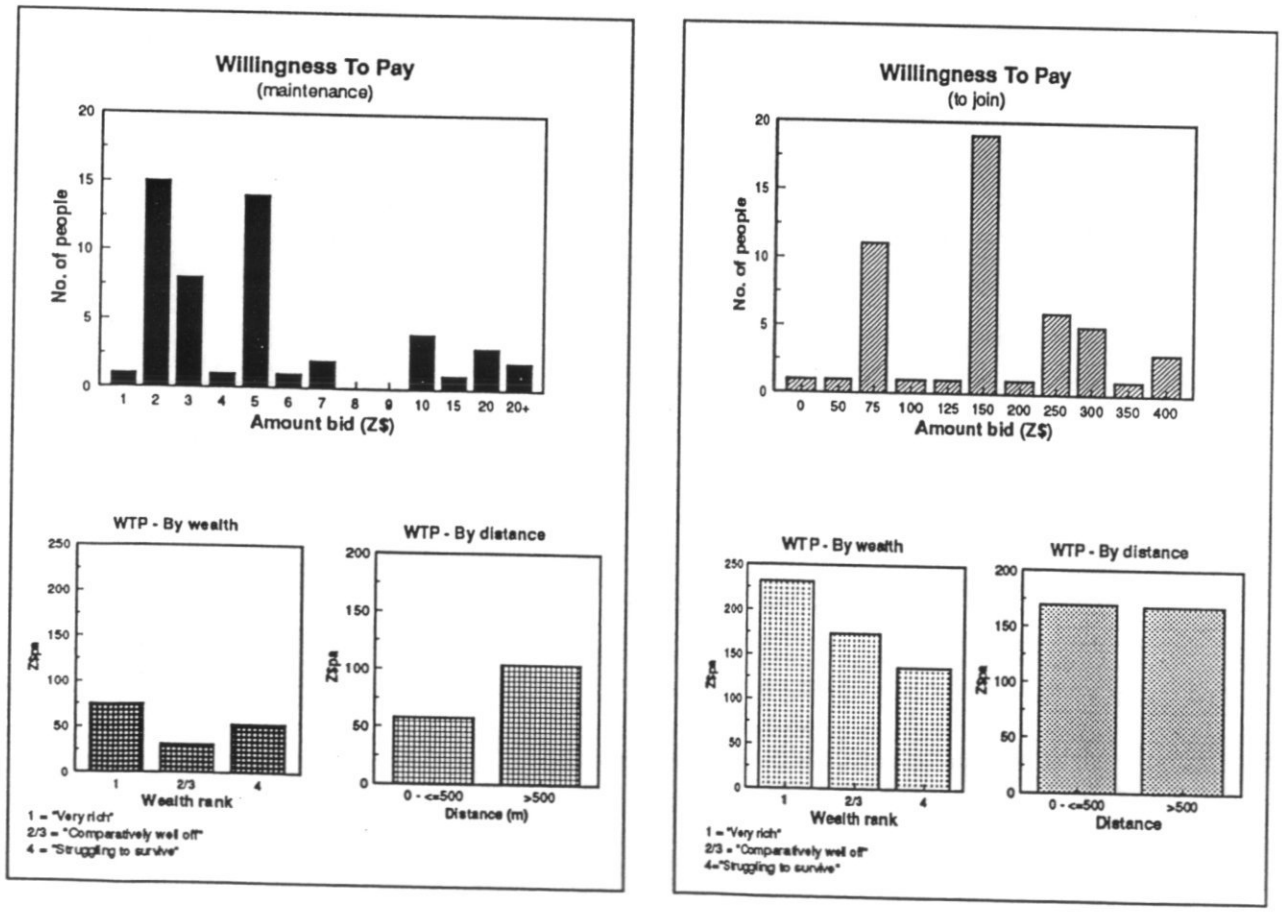


Figure 3.20 Willingness to pay to maintain the collector well and join a scheme

Further analysis using multivariate models to analyse the relationships that describe the determinants of the willingness-to-pay bids is currently being conducted. Nevertheless the values already obtained can be added to the financial value of a collector well scheme, in an attempt to calculate a total economic value for a scheme. A total economic value of a collector well scheme would include use values (both direct and indirect), and non-use values. A direct use value of the scheme could be taken to be the gross margins of vegetables grown over the time horizon of the project (Z$ 217481); indirect use values could be taken as the economic values of the clean and reliable water supplied (Z$ 129501), improved health and labour productivity, and the environmental benefits of the scheme such as reduced pressure on marginal lands (both as yet unquantified). Non-use values could be taken as the option or existence values people place on the garden's presence (Z$ 114738). However, in order to undertake this exercise in a comprehensive manner, and to properly compare the total economic value of a scheme to its anticipated cost, a full calculation of its range of benefits and costs should be undertaken using shadow prices for labour costs and gross margins.

It should also be noted that due to the variability of the physical environment on which individual schemes could be placed, and the resource-poor nature of communities in more arid locations, the marginal costs of implementing individual schemes could fluctuate by as much as three times the average. Furthermore, the erratic nature of the locational factors that affect individual scheme costs can be exacerbated by the range of social and environmental factors that may influence the level of benefits that accrue from the scheme. Disorganised communities, random feuds, unforseen environmental stresses such as pests or drought can all easily affect scheme performance and hence lower the level of quantifiable benefits. However, that should not mean that no schemes will be implemented in "difficult" areas. The resulting trade-off for both the implementing and donor agencies is whether the net benefits of the project are calculated on a scheme by scheme basis (whereby difficult sites calculated with a net economic cost for implementation would not get a scheme), or on a project wide basis (whereby across one hundred schemes net benefits are calculated to outweigh net costs, even though some schemes do not initially indicate a individual net benefit to investment). This is a critical problem to overcome, as the very poorest communities which the project would be keenest to target, are likely to be situated at sites where the cost-benefit margins for implementation are closest, and would thus be extremely sensitive to unforseen problems. The Institute of Hydrology is currently working on a decision support system for siting schemes that is able to take account of these difficulties.

4. Conclusions

The aim of this report has been to help evaluate the impact of the collector wells pilot project on both members and non-members of the schemes through an analysis of the social and economic information obtained from the return to households survey. In section 4.1 the conclusions from a comparative analysis with the social and economic information obtained from the baseline survey are presented. In section 4.2 a summary of the unforseen social and economic aspects of the scheme that have occurred are presented. As well as being of immediate interest, it is hoped that this information can itself be used in future analyses as the schemes continue to develop.

4.1 A SUMMARY OF SOCIAL AND ECONOMIC CONDITIONS BEFORE AND AFTER THE PILOT PROJECT

The baseline surveys supplied data on social and economic aspects of the six communities before they received a collector well and community garden. This information has been compared to that which was gathered in the return to household survey conducted, in most cases, two seasons after the schemes were implemented. In comparing "before implementation" to "after implementation", particular emphasis has been placed on investigating issues of equity (who are and who are not members of the schemes, especially in terms of wealth), the change in the supply of water, and the differences that the gardens have made to fresh vegetable availability and consumption

The first column in Table 4.1 contains the key social and economic parameters identified in the baseline survey which were recommended be taken into account when comparing the performances of the different schemes. The subsequent success of the pilot project schemes in relation to each of these parameters is thus presented in the second column of Table 4.1.

Table 4.1 *A summary of the impact of the pilot project schemes in relation to key performance indicators*

Issues identified in the baseline survey (1993)	Impact of the pilot project on this issue, as identified in the return survey (1995)
A shortage of clean and reliable water was the principal problem reported by respondents at all sites. **At Mawadze the priority was for a cleaner and more reliable source of domestic water and closer gardens.** **Secondary needs at Muzondidya and Gokota** were for more reliable sources of domestic water and cleaner water at Dekeza and Nemauka.	An estimated 489 households, or 3 882 people, now obtain cleaner and more reliable domestic water from the collector wells. This figure can be split between an estimated 238 member households and an estimated 251 non-member households. The number of people who use the collector wells increases significantly during periods of water scarcity. Thus, instead of giving members more water, the schemes are serving many more people than anticipated, particularly during periods when other water sources fail. At Mawadze, members said that the first-best benefit of the scheme is the opportunity to grow fresh vegetables to eat and the second-best benefit of the scheme is the provision of a more reliable water supply. Non-members said the first-best benefit of the scheme is a reliable water supply. Members at Muzondidya said that growing vegetables is the first-best benefit and the second best is the provision of more reliable domestic water. Non-members said that the opportunity to buy fresh vegetables is the first-best benefit, the provision of clean water is second best and the access to more reliable water is the third best. At Gokota members said that growing vegetables is the first-best benefit and provision of clean water is second best. Non-members said that the opportunity to buy fresh vegetables is the first-best benefit and the second and third-best benefits are reliable and cleaner water supplies respectively. At Dekeza members said that the first-best benefit is vegetables to eat, the second best is vegetables to sell and the third best reliable domestic water. Non-members said that the opportunity to buy fresh vegetables is the first-best benefit and more reliable, nearer and cleaner water are the second, third and fourth best benefits respectively. At Nemauka members said that, after growing vegetables, provision of nearer domestic water is the second-best benefit. Non-members said that the first-best benefit is the opportunity to buy fresh vegetables, the second best is the opportunity to meet and talk and the third best is the provision of cleaner water. At Matedze, members said that the first-best benefit of the scheme is the opportunity to grow fresh vegetables to eat, the second-best being the opportunity to grow fresh vegetables to sell. Non-members said the first and second best benefits are a more reliable and cleaner source of water respectively; the third best being the opportunity to buy fresh vegetables.

The number expected to join the community gardens was expected to vary from approximately 50 members at Dekeza to 130 at Muzondidya and Gokota.

The six schemes have an average membership of 85 members. The estimated population of those households directly involved in the six pilot project schemes is 4 461 people. In other words, it is 99% certain that the population of members' households served by the six schemes lies between 4 052 and 4 870 people.

It was recommended to compare the performances of gardens with large and small memberships in terms of their output and the extent to which non-members benefit.

The mean income generated from the collector well gardens per member in 1994 can be estimated as Z$ 255.20 pa. It seems that the size of garden membership (the smaller the better) and the length of time attached to both working in the garden and actively marketing its produce (the longer the better) can significantly improve net returns to effort. However, the schemes are only two seasons old and there may be many other important variables which emerge that can be shown to significantly influence income levels generated by the garden. For example, marketing strategies, pest control, other extension advice, effectiveness of collective action, and locational aspects, may all be critical factors in garden performance.

It was recommended to compare the social and economic circumstances of members and non-members in terms of their access to land, labour, capital, local leaders and agricultural extension to determine whether particular groups are being favoured or excluded.

There were differences in wealth between and within sites as revealed by indicators such as ownership of livestock, implements and modern housing, areas of rainfed crops and the gross incomes earned from them.

Estimating from the baseline sample about who would join a collector well and community garden scheme, 10% are likely to be "wealthy", 42% are likely to be "averagely" well off and 49% are likely to be "less wealthy" Although the project schemes having been operating for a very short time, the return survey found indications of improvement in wealth for scheme members. This is apparent at all sites regardless of the initial wealth status of the members.

It can be estimated that with an average membership of 85 members per scheme, 51 households are likely to improve in wealth by observation, 21 of those being in the very poorest bracket. Further improvements in wealth in the future may be likely as garden members improve their crop husbandry and marketing strategies. However, although an improvement in observable wealth is encouraging, it is more desirable to continue to monitor members and non-members for actual changes in income levels over time.

At all sites there was **a tradition of gardening and a demand for vegetables upon which the collector wells and community gardens were aiming to build.** However the extent and types of existing gardens and hence patterns of vegetable supply, consumption and marketing varied according to the availability of irrigation water. Mawadze was the most well endowed. At the other sites existing gardens were too small due to the shortage of water; the situation was worst at Matedze where 90 per cent of respondents were unable to garden at all for this reason.

The criteria for selection of garden members was to be referred to since different methods were favoured at different sites ranging from payment of a joining fee at Mawadze and Matedze to selection by village leaders or extension workers at the other sites.

In essence it seems that the collector well gardens have *reduced* the period of scarcity of fresh vegetables that communities in the area face by four to five months, *lowered* the number of people who feel there is a period of fresh vegetable scarcity at all by about 25%, and *decreased* the time during scarce periods that people miss out on eating fresh vegetables by about four days in every week.

In general, 67% of all members across the six sites joined the schemes through a mixture of contributing labour for the well and garden's construction and paying a reduced joining fee. 32% paid a joining fee alone. The mean payment to join a scheme was Z$22, and the number of people still wanting to join a scheme ranges from 10-22 people per site, the mean number being 16 per scheme.

The method of supplying labour to join a scheme has an advantage in that it promotes a sense of ownership. However it has to be recognised that availability of labour is a *dynamic* variable. Labour availability is greatest during the winter and at its most scarce during the summer as people are busy preparing their rainfed fields. These findings suggest that the timing of project construction within the farming calendar is critical for obtaining male labour and thus encouraging membership in this manner. However, there is also a danger that households with less spare male labour will miss out on becoming members. If these households are poor, then they will not have funds to pay a cash joining fee or alternatively hire labour.

This issue will need considerable research and input from participants and a range of project staff alike as the schemes develop and expand, before it can be resolved.

The net effects of the schemes on women were said to depend on the balance between the extra work which the schemes demand of women, the distribution of the benefits and any opportunity cost in terms of other activities which may need to be compromised such as rainfed cropping or off-farm activities. Women tended to be less involved in the management of community gardens (at Dekeza and Mawadze) where men and the Agricultural Extension Workers assumed the major roles.

80% of the sample said that the main decision maker and most labour for the community garden came from women or wives of the head of household, with the help of children. At Dekeza 62% of the garden plots have a female decision maker. At Mawadze 40% of plots have a female decision maker, and the rest are managed through joint decisions.

Evidence from the rapid increase in revolving funds would also suggest that the gardens are benefiting women and children and that women are controlling the saving and investment of cash generated from schemes. At least 49% of all members in the schemes were found to be involved in these funds. From the sample surveyed, only one fund was said to have existed before the collector well garden schemes, and that has now expanded from 10 to 33 members. As the community garden schemes progress it will be interesting to note both the development of the revolving funds themselves and the subsequent increase or otherwise in the range of income generating activities for women, based on the capital purchases derived from these funds.

Availability of labour is seen as a constraint on all schemes. Watering, pumping and queuing all take time. As yet, time spent working in the garden during winter is not perceived as a trade off against carrying out other tasks. However, it is possible that, as the gardens become more successful, the decreasing opportunity cost of gardening during the summer months as compared to working in the rainfed fields will be seen as justifying the growing of more vegetables over longer periods. Evidence for this can be seen at Dekeza and Mawadze, where women are extending their working season in the garden.

The institutions and local leaders who people regarded as influential varied between different locations and, in some cases, within the same community.

60% of respondents said that the most important person in the community was the agricultural extension worker. However, 77% of respondents suggested that in order to notify project staff about a community's desire for a *future* collector well and garden scheme, a list of names should be passed to the local councillor via the traditional kraalhead or headman. This kind of feedback suggests that all the local leaders should be consulted when implementing a collector well and garden scheme.

The **priorities for extension** were recommended to include pest and disease control, pump repair and maintenance, the need to raise money to purchase inputs, and water saving irrigation methods.	Respondents said that they *had* now received advice from the agricultural extension worker to help with the community garden, mostly on irrigation amounts and schedules for vegetables, growing vegetables in time to sell and on planting arrangements in the garden. Advice on pest control was still considered a priority. Non-members also said they had received more advice on vegetable growing, with less emphasis however on growing vegetables in time to sell. But, the most often cited pieces of extension advice both sets of respondents recalled were still to do with rainfed farming - contour ridges, winter ploughing and drainage ditches. In general, non-members of the garden schemes suggested that they got more advice from their family than from the agricultural extension worker, as compared to members.
	75% of respondents (members and non-members) were willing to pay Z$5 or less per month to maintain upkeep of the wells. Nursery plots for new seeds and communal funds for the running costs for the gardens and pumps are also commonplace.
There were variations identified both between and within communities on **the extent to which people had participated in or had knowledge of previous community development schemes**. These could be critical factors.	Implementing these community-based development initiatives has not been easy at all. This is primarily because decision making is slow and often disrupted by leadership and ownership disputes. Whether these disputes can be overcome depends on whether the potential benefits of the development are sufficient to ensure that the community maintain interest in the development during a dispute and to ensure that the community has sufficient incentive to overcome a dispute. Although it is still too soon to be sure, there is some indication that previous community development experience is a key factor in determining the success of subsequent community developments. This experience can be considered as adding to the "social capital" of the community, enabling future participative schemes to be more easily implemented.

4.2 ADDITIONAL INFORMATION GAINED FOR FUTURE COMPARATIVE ANALYSIS

It is hoped that much of the information contained in this report, either on a number of socio-economic baseline changes that have emerged as a result of the pilot project or on issues that were not included in the survey, will prove useful for many future analyses of the schemes. For example, details on the following developments may become useful baseline sources of information against which to assess the development of the schemes over the next few years.

i. The use of collector well water

It should be remembered that the use of the collector wells for domestic water was not considered as one of the main objectives of the project. Thus the information obtained in the return survey on the numbers of members and non-members using the collector wells for their

domestic water requirements, the amount they use and distances they travel to the collector well, on the "surges" identified in collector well use for domestic water during periods of water scarcity, on the split between water used for irrigation and water used for domestic consumption, and on the changes in these patterns as livestock numbers increase or more people seek to use the wells can all be compared to data on water use from the collector well schemes as recorded here after two seasons of operation.

ii. Wealth generation capabilities

It was also perceived at the start of the pilot project that the main use of vegetables grown in the gardens would be for subsistence, with the excess for sale. The degree of income generation that has occurred at some of the schemes was not expected. Thus, the information contained in this report on incomes per annum from the schemes in general and at each site, on the differences in income between members and non-members and between members before and after the schemes were implemented, in the patterns of marketing and length of selling periods in the gardens, of the level of control women have over the management and investment of capital generated, of the emergence of revolving funds in which to invest some of the new income, and of the changes in expenditure on fresh vegetables for members and non-members will all be important "yardsticks" by which to judge wealth creation and equity aspects of the schemes.

5. Recommendations

5.1 CONTINUED MONITORING OF EXISTING COLLECTOR WELL GARDENS

It is strongly recommended that funding be allocated for the continued monitoring of the six schemes implemented by the pilot project. As the institutional structures that operate and the economic incentives that influence the schemes are still changing, it will be interesting and instructive to observe their development over the next few years. It is also clear that the management of gardens is changing rapidly as garden members gain confidence and experience and look for new marketing opportunities. Furthermore, the agricultural and socio-economic data sets for each scheme are already unique and of enormous potential value for other future research studies of groundwater development in semi-arid areas. Extending the run of these data sets would increase their value further as well as being relatively inexpensive.

Continued monitoring of the wells should also consider the following:

* the impacts of increasing livestock numbers (assuming livestock numbers continue to recover following the 1991/92 drought) on the environmental sustainability of land near to schemes and the socio-economic spread of benefits of well water;

* the value of the schemes during cycles of good and bad rainy seasons in terms of how much water the schemes supply and who benefits;

* the long-term sustainability of the schemes in terms of groundwater recharge and groundwater quality;

* the changes in income levels for scheme members and non-members over time to ascertain if there are significant differences;

* the marginal opportunity cost of working in the gardens as compared to the marginal benefit of working in rainfed field, and the income elasticity of demand for vegetables and staples with a view to predicting gardening and rainfed cropping strategies;

* the land tenure systems that develop on gardens;

* the influence that the Economic Structural Adjustment Programme (ESAP) has on community gardens and, in particular, on marketing and purchasing strategies;

* the environmental benefits of groundwater-based gardens. Further monitoring will enable the total economic value of the schemes to be calculated and compared to other water supply or development projects.

The consequences of not funding continued monitoring and research are many. In essence, it would mean losing the opportunity of ensuring the long term viability of the project as a credible and sustainable water supply and agricultural development option for semi-arid areas. The information in this report has been gained after only two seasons of the gardens operating. To cease monitoring now would result in an incomplete understanding of how these or other schemes could overcome early problems and start to operate successfully and to their

maximum potential. Important long run information on wealth generation and diversification, on issues of equity and sustainability, on impacts on gender, on the importance of reliable water sources in times of stress, on the potential for communities to organise collectively to repair and maintain their own water and agricultural resources, on the social and economic benefits of improved diets, and on the wider changes to farming and natural resource management strategies would not be collated or analysed.

5.2 IMPROVED MANAGEMENT OF GARDENS

It is recommended that a research project be carried out in parallel with the NGADI Project to look at ways and means of maximising the benefits that can be realised from groundwater-based community gardens. Although the pilot project schemes are performing acceptably well, the results of monitoring and research at LVRS would suggest that there is considerable scope for improving their subsequent management. Although agricultural extension workers provide schemes with some advice, they would benefit with improved guidelines on crop husbandry, integrated pest and disease control, improved irrigation methods and cropping strategies aimed at taking more account of market demands in terms of crop quality and timing of production. These guidelines could be developed most effectively by carrying out trials on pilot project schemes with the participation of the scheme members.

5.3 GARDEN MEMBERSHIP

The pilot project has used, or rather allowed the different communities to use, different approaches to selecting the households or individuals that have plots on the community gardens. Communities have also been allowed to make their own decisions on the size of plot or holding within a garden. Size of plot determines the number of members a garden can have as well as being directly related to the returns that can be generated by a plot. Although there are definite advantages in giving communities a free hand to make decisions on garden membership, research is required on whether they should be given more guidance. The issues of garden membership and water rights are pivotal when considering the equitable distribution of benefits that a scheme can deliver. Research should be carried out on the feasibility, advantages and disadvantages of introducing water rights, permits or pricing of groundwater as a means of improving the equitable distribution of scheme benefits. This research should also consider land tenure and issues related to the expansion of the gardens whether this be size of the garden or the number of members or both.

5.4 DECISION SUPPORT SYSTEM FOR DEVELOPING WATER RESOURCES IN SEMI-ARID AREAS

The pilot project has produced a decision tree that can be used as a guideline for selecting the most appropriate design of well for a given location. It is recommended that this decision tree be developed further to include more social, environmental and economic decision support. The decision tree should also be expanded to enable rational decisions to be made between surface and groundwater resources when there is the option of developing surface water resources.

This is a critical issue as due to the variability of the physical environment on which future schemes could be placed, and the resource-poor nature of communities in more arid locations,

the marginal costs of implementing individual schemes could fluctuate by as much as three times the average. Furthermore, the erratic nature of the locational factors that affect individual scheme costs can be exacerbated by the range of social and environmental factors that may influence the level of benefits that accrue from the scheme. Disorganised communities, random feuds, unforseen environmental stresses such as pests or drought can all easily affect scheme performance and hence lower the level of quantifiable benefits. However, that should not mean that no schemes will be implemented in "difficult" areas. The resulting trade-off for both the implementing and donor agencies is whether the net benefits of the project are calculated on a scheme by scheme basis (whereby difficult sites calculated with a net economic cost for implementation would not get a scheme), or on a project wide basis (whereby across one hundred schemes net benefits are calculated to outweigh net costs, even though some schemes do not initially indicate a individual net benefit to investment). This is a fundamental problem that future replications of this project must overcome, as the very poorest communities, which the project would be keenest to target, are likely to be situated at sites where the cost-benefit margins for implementation are closest, and would thus be extremely sensitive to unforseen problems. Work on a social and environmental economic decision support system for siting schemes that is able to take account of these difficulties is considered essential.

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Appendix 1 Site Survey Information

Site 1: Muzondidya
Number of members N = 134
Number of members sampled n = 19
Number of members in re-survey *n* =5
Number of non-members in community sampled nm = 9
Number of non members in resurvey *nm* =4

Site 2: Gokota
Number of members N =109
Number of members sampled n=14
Number of members in resurvey *n* =5
Number of non-members in community sampled nm = 12
Number of non-members in resurvey *nm* = 4

Site 3: Dekeza
Number of members N = 50
Number of members sampled n= 13
Number of members in resurvey *n* = 5
Number of non-members in community sampled nm = 13
Number of non-members in resurvey *nm* = 4

Site 4: Nemauka
Number of members N = 84
Number of members sampled n= 19
Number of members in resurvey *n* =5
Number of non-members in community sampled nm = 11
Number of non-members in resurvey *nm* = 4

Site 5: Mawadze
Number of members N = 50
Number of members sampled n=18
Number of members in resurvey *n* =5
Number of non-members in community sampled nm = 11
Number of non-members in resurvey *nm* = 4

Site 6: Matedze
Number of members N = 87
Number of members sampled n=17
Number of members in resurvey *n* =5
Number of non-members in community sampled nm = 13
Number of non-members in resurvey *nm* = 4

Totals
Total number of members of CW garden schemes N = 514
Total number of members surveyed **n** = 100
Total number of members resurveyed *n* = 30
Total number of non-members surveyed **nm** = 69
Total number of non-members resurveyed *nm* = 24
Mean number of members/ scheme = 85.66 *(sd 30.08)*

Appendix 2 Information on Spreadsheet Survey Headings and Sections

Organisation of Data

To permit maximum flexibility for future analysis, the data set has been divided into groups of common data relationships. Several smaller spreadsheets have been constructed for each site that contain data at a variety of levels - household, farm and community, for both members and non members, rather than one large spreadsheet for each site. In this way errors can be easily spotted and minimised, and data can be more easily accessed and analysed. It is hoped that this strategy will permit a greater range of comparison of data sets between sites, members, and households etc. Each set of spreadsheets is on a diskette relevant to that site, available from LVRS or IH. It is planned that data will be transferred to a relational database as part of the next phase of the project.

Coding of spreadsheets

For each site there are 2 x 17 spreadsheets (for members and non members). Each spreadsheet is coded such that it may be called, for example *"3M.2.3: Household Income."* This code will refer to: 3: Site no. 3 M: members response (non members response = N) 2: survey heading 2 - in this case economic activity 3: section 3 under survey heading 2 - in this case household income; and finally a descriptive title of the spreadsheet. Information on spreadsheet survey headings and sections is outlined below and can be obtained from LVRS or IH

1. Social Aspects
   M1.1 Household Composition
   N..
   M1.2 Indicators of wealth
   N..
   M1.3 Livestock
   N..
   M1.4 Vegetable Consumption
   N..
   M1.5 Community Problems
   N..
   M1.6 Domestic Water Usage
   N..

2. Economic Activity
   M2.1 Rainfed Farming
   N..
   M2.2 Gardening
   N..
   M2.3 Household Income
   N..
   M2.4 Household Expenditure
   N...

3. Institutional Considerations
   M3.1 Critical people in the community
   N..
   M3.2 Exposure to extension advice
   N..

4. Attitude and Experience of Collector Well Scheme
   M4.1 Benefits of Collector Well
   N..
   M4.2 Determination of Membership
   N..
   MNM4.3 WTP for aspects of the scheme
   M4.4 Problems with the scheme
   N..

Spreadsheet survey headings, sections and survey questions they cover.

Spreadsheet Title	Questions it covers (members)	Questions it covers (non members)	Questions perceived not to have succeeded in eliciting required data for data set	Relation to data presented in baseline survey
Social Aspects:				
1.1 Household composition	Q1,2,3 obs 1	Q1,2,3 obs 1		Table 2
1.2 Indicators of wealth	Obs 2,3	Obs 2,3		para 3.2
1.3 Livestock	Q64	Q63		Table 3
1.4 Health	Q14,15,16	Q14,15,16	Q14,15,16	para 3.3
1.5 Vegetable Consumption	Q17,18,19, 20,21	Q17,18,19,20	Q18(M)	Tables 4&5
1.6 Community Problems	Q4	Q4		Table 6
1.7 Current Water Sources	Q8,9,10, 11,12,13	Q7,8,9,10, 11,12,13		para 3.5
Economic Activity				
2.1 Rainfed Farming	Q63	Q62		Table 7
2.2 Gardening	Q24,25,26, 27,34	Q21,23,24,25	Q28,29,30, 31(M) Q26,27 (N)	Tables 12, 13,14, 15
2.3 Household Expenditure	Q5,6	Q5		Table 17
2.4 Household Income	Q7	Q6		Table 16

Institutional Considerations				
3.1 Critical people in the community	Q58,59	Q58,59	Q60,61,62 (M&N)	Tables 18&19
3.2 Exposure to extension advice	Q55,57	Q55,57	Q56 (M&N); cross check 57 with AEW	Table 20
Attitude and Experience of Collector Well Scheme				
4.1 Benefits of Collector Well	Q32, 36	Q28		
4.2 Determination of Membership	Q22, 23, 40,41,42	Q34,37, 39,51,54	Q43-49 (M) Q32,33,35, 36,40-46 (N)	
4.3 WTP	Q53,54	Q38,50	redo as bidding games	
4.4 Problems with scheme			Q30(N) Q37 (M) - need to re ask in an open ended format.	

Appendix 3 Formulae for the calculation of statistics used in this report

i. For small (<30) random samples

$$\text{Total} = \sum X_i$$

$$\text{Mean} = \bar{X} = \sum \frac{X_i}{n}$$

$$\text{Standard deviation} = (\text{SD}) = \sqrt{\left(\frac{\sum X^2 - \frac{(\sum X)^2}{n}}{n-1} \right)}$$

$$\text{standard error} = (\text{se}) = \sqrt{\frac{\text{variance}}{\text{sample size}}}$$

where X_i is the *i*th observation of the variable X
Σ is the summation of values
n is the number in the sample
$\bar{X}$ is the mean

Confidence intervals (ci) are calculated using the standard error X t-statistic at the 95% confidence level, unless stated otherwise.

ii. For characteristic estimates at each site

$$\text{Population mean} = \hat{\bar{y}} = \bar{y} \text{ (sample mean)}$$

$$\text{Population total} = \hat{y} = \frac{1}{F} \sum y \quad \text{where } f = \frac{n}{N} \text{ (sample statistic)}$$

Population proportion = $\hat{p} = \frac{A}{N}$ estimated by $\frac{9}{n} = P$

where ^ indicates an estimate
N = number in the population
A = number of units filling in the relevant category
a = number of units in the sample

The standard error for population estimates is calculated as the square root of the corresponding variances.

Variance of population mean = $V\left[\hat{\bar{Y}}\right] = \frac{1}{n(n-1)}\left(\sum y_i^2 - n\bar{y}^2\right)$

Variance of population total = $V(\hat{y}) = \frac{N^2}{n(n-1)}\left(\sum y_i^2 - n\bar{y}^2\right)$

Variance of population = $V(\hat{p}) = \frac{P(1-p)}{n-1}$

For total population estimates (for all 6 schemes), estimated population totals for each site where summed and the subsequent statistic expressed as a population estimate of the total project population of members.

iii. Comparative analysis

To analyse the significance of statistics from two samples - eg. mean income before the scheme, and mean income now, variances were compared using an F-test to ensure homoscedasticity.

$F = S_1^2/S_2^2$ where S_1^2 and S_2^2 are the variances of the two samples and S_1^2 is the larger of the two. F has $(n_1 - 1)$ and $(n_2 - 1)$ degrees of freedom.

A t-test was then used to test the differences.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left(SE_1^2 + SE_2^2\right)}}$$

t has $n_1 + n_2 - 2$ degrees of freedom.

iv. Regression analyses

Limited Regression analyses were also undertaken, using R^2 as a "goodness of fit" measure. Expressed as a decimal, the closer the R^2 statistic is to 1 the better the independent variables "explain" the dependent variable.

APPENDIX 4

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?
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)

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

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

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

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?

57. Have you received any advice or training 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
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 the collector well garden project? If yes, how?

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

Rainfed cropping

63. 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

64. 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

Further questions as a result of the return to household surveys undertaken in June/July 1995.

Questions For Members of the Collector Well Schemes:

Site.....Kraal.....Date.....
Head of Household.....
Respondent(s).....

1. *Do you think it would be good to build more of the collector well and garden schemes? (y/n)*
If the respondant says no, ask why not?

If the respondant says yes, give the following opening statement:

> I am going to ask you some questions in order to find out if you or someone from your household would be willing to pay money to join a collector well and garden scheme, and about the vegetables and money you obtain from the scheme. These questions are to help us find the value of the projects to the community. I would like you to answer these questions at ease. There are no wrong answers.
>
> Your answers cannot change the decision about whether more schemes will be built. Nobody is going to demand any more money from those who use the schemes at the moment. You will not have to pay any money as a result of these answers. But, I do need you to tell the truth in order that the schemes will be successful as possible in the district.

2a. *If you were not a member of the scheme now, but it were possible to join and you were required to pay X Zimbabwe dollars to join the scheme, would you be prepared to join?*
(Move incrementally up/ down by Z$5 until the respondant decides. Choose 3 starting values of $20 $40 $60 for different respondants).

Starting value:

Respondant WTP to join:.....

2b. *Would you, as a member of the scheme, be prepared to pay X Zimbabwe dollars per month for maintenance and upkeep of the scheme?*
(Move incrementally up/ down by Z$1 until the respondant decides. Choose 3 starting values of $2, $5 $10).

Starting value:

Respondant WTP for maintenance.....

3. *Is it important for your household's income that people in your family obtain work elsewhere and send money back? Has the importance of this money changed since the scheme began? How much do they send back?*

4. This series of questions is to find out more about your production and consumption of vegetables.

Does the shortage of food that was mentioned as a problem for your community mean a shortage of vegetables or a shortage of cereals?

If vegetables, when is this shortage at its worst? (which months)

How often in summer and how often in winter do you manage to eat fresh vegetables (days/ month for each month)?

Has this improved as a result of the CW garden? (y/n)

If yes, probe further : *How often in winter and summer did you eat fresh vegetables before the scheme?* (days/month for each month)?

How much of your monthly grocery bill is spent on buying fresh vegetables? (Z$/month). *How much was spent on fresh vegetables before the scheme?*

Where do you buy them from in summer? In winter? Where did you buy them from before the scheme?

How good, compared to private vegetable gardens are the CW gardens in supplying vegetables to eat; supplying vegetables to sell? (worse, same, better)

Why is this? (look for reliable water, security, community help, fence, crop protection)

These questions are to do with the vegetables you sell from your plot:

Who do you sell them to? (non members, members, strangers, shops, block purchases)

When do you sell them? (months/year, in those months frequency/month)

How do you sell them? (at a market, people come to the garden)

How much do you get? (Z$/month):

Probe this answer further:

Do you make this every month?

What is the highest/lowest you make per month?

For which months?

So you make a total of XZ$ per year?

Do people want to buy more more vegetables? How much more? (no. of people/ amount of veg/ Z$)

5. This series of question is to do with the money that the sale of CW garden vegetables may supply you with. You mentioned that you get XZ$ per month from the garden (see above). I am interested to find out what do you do with this money:

How much does respondant get per month form CW garden?

Z$.....

How much of this money do you spend? (Z$/month)

What do you spend it on?

Did you buy these things before the scheme? (y/n)

How much do you save?

If respondant says none ask: *would you save some if you had access to a savings facility?* (y/n how much)

Where do you save it? (building society, post office)

Why do you save it?

Has saving money been of any use to you? (helped in emergencies, access to credit).

Do you feel it would be of use in the future?

By having savings do you feel more able (or do you hope) to branch out into other activities beyond farming? (brewing/ dressmaking/ knitting).

Do you use a revolving fund? How does it work? (Z$/week). *Do all members use it?*

Do you use the money to repay debts. What are the debts for? How much?

6. *Unfortunately, we can't get to see every community who may benefit from a CW and garden scheme, and sometimes we may see a community who say they need one, but who may not really need one or use it properly.*

We would like to help those communities who most need the schemes and who are serious about using the project properly. What do you think would be the best way for needy or interested communities to find out about these schemes and then to prove/ demonstrate that they need one and will benefit greatly from one?

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 Number who help household 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

Further questions as a result of the return to household surveys undertaken in June/July 1995.

Questions For Non Members of the Collector Well Schemes

Site.....Kraal.....Date.....
Head of Household.....
Respondent(s).....

1. *Do you think it would be good to build more of the collector well and garden schemes? (y/n)*

If the respondant says no, ask why not?

If the respondant says yes, give the following opening statement:

> I am going to ask you some questions in order to find out if you or someone from your household would be willing to pay money to join a collector well and garden scheme, and about the vegetables you may obtain from the scheme. These questions are to help us find the value of the projects to the community. I would like you to answer these questions at ease. There are no wrong answers.
>
> Your answers cannot change the decision about whether more schemes will be built. Nobody is going to demand any more money from those who use the schemes at the moment. You will not have to pay any money as a result of these answers. But, I do need you to tell the truth in order that the schemes will be successful as possible in the district.

2a. *If it were possible to join the scheme and you were required to pay X Zimbabwe dollars to join, would you be prepared to join?*
(Move incrementally up/ down by Z$5 until the respondant decides). Choose 3 starting values of $20 $40 $60 for different respondants.

Starting value:

Respondant WTP to join:.....

2b. *Would you, as a non-member of the scheme, be prepared to pay X Zimbabwe dollars per month for maintenance and upkeep of the collector well?*
(Move incrementally up/ down by Z$1 until the respondant decides). Choose 3 starting values of $2, $5 $10

Starting value:

Respondant WTP for maintenance.....

3. *Is it important for your household's income that people in your family obtain work elsewhere and send money back. How much do they send back?*

4. This series of questions is to find out more about your production and consumption of vegetables.

Does the shortage of food that was mentioned as a problem for your community mean a shortage of vegetables or a shortage of cereals?

If vegetables, when is this shortage at its worst? (which months/ year)

How often in summer and how often in winter do you manage to eat fresh vegetables (days/ month for each month)?

Has this improved as a result of the CW garden? (y/n)

If yes, probe further . *How often in winter and summer did you eat fresh vegetables before the scheme?* (days/month for each month)?

How much of your monthly grocery bill is spent on buying fresh vegetables? (Z$/month). *How much was spent on fresh vegetables before the scheme?*

Where do you buy them from in summer? In winter? Where did you buy them from before the scheme?

How good, compared to private vegetable gardens are the CW gardens in supplying vegetables to eat; supplying vegetables to sell? (worse, same, better)

Why is this? (look for reliable water, security, community help, fence, crop protection)

How much do you spend on buying vegetables from the CW garden (Z$/ month)

How do you buy CW vegetables? (go to garden/ in town from markets)

To whom do you think that most of the CW vegetables are sold? (outsiders/ non members)

Would you buy more from the CW garden? (y/n)

What is stopping you? (not enough veg/ not enough markets/not enough money)

5. This series of question is to do with the money that the sale of vegetables or other activities supplies you with. I am interested to find out what you would do with this money:

How much money do you get from selling vegetables/ other activities (ie **not** from rainfed crops or remmittances)

How much of this money do you spend? (Z$/month)

What do you spend it on?

How much do you save?

If respondant replies none ask: *Would you save some if you had access to a savings facility? How much?*

Where do you save it? (building society, post office)

Why do you save it?

Has saving money been of any use to you (helped in emergencies, access to credit).

Do you feel it would be?

By having savings do you feel more able to/ do you hope to branch out into other activities beyond farming? (brewing/ dressmaking/ knitting).

Do you have to repay debts. What are the debts for?How much?

6. Unfortunately, we can't get to see every community who may benefit from a CW and garden scheme, and sometimes we may see a community who say they need one, but who may not really need one or use it properly.

We would like to help those communities who most need the schemes and who are serious about using the project properly. What do you think would be the best way for needy or interested communities to find out about these schemes and then to prove / demonstrate that they need one and will benefit greatly from one?

Appendix 5 Details of the calculation of the number of people using the collector wells for their domestic water requirements

(see appendix 3 for the methodology used in calculating estimates of population proportions from sample proportions).

i. How many members are using the CW for domestic water at each site?

Site 1:
Estimated population of members using scheme: 13 households
Estimated population mean no. per household at site 1: 9.15 *(se 0.58, ci 1.22)*
Estimated population mean amount of water used per household: 120 litres/ day *(se 12.9 ci 27.2)*

Therefore can estimate that at Site 1, 119 people (ci 25.8) from members' households are using 1 424 (ci 577) litres of water per day from the CW.

Site 2:
Estimated population of members using the scheme: 78 households *(se 13.6; ci 29.5)*
Estimated population mean no. per household at site 2: 7.71 *(se 0.72; ci 1.55)*
Estimated population mean amount of water used per household: 78.6 litres/ day *(se 2.8; ci 6.22)*

Therefore can estimate that at Site 2, 601 people (ci 121) from members' households are using 8 541 (ci 486) litres of water per day from the CW.

Site 3:
Estimated population of members using the scheme: 19 households *(se 7.02; ci 15.2)*
Estimated population mean no. per household at site 3: 7.46 *(se 1.21, ci 2.64)*
Estimated population mean amount of water used per household:115.4 litres/day *(se 16.6; ci 36.1)*

Therefore can estimate that at Site 3, 142 people (ci 50.6) from members' households are using 2 081 (ci 693) litres of water per day from the CW.

Site 4:
Estimated population of members using the scheme: 27 households *(se 9.2; ci 19.3)*
Estimated population mean no. per household at site 4: 9.11 *(se 0.80; ci 1.69)*
Estimated population mean amount of water used per household: 93.9 litres/day *(se 5.56; ci 11.7)*

Therefore can estimate that at Site 4, 246 people (ci 44.8) from members' households are using 2 957 (ci 310) litres of water per day from the CW.

Site 5:
Estimated population of members using the scheme: 39 households *(se 5.11; ci 10.7)*
Estimated population mean no. per household at site 5: 9.16 *(se 0.89; ci 1.9)*
Estimated population mean amount of water used per household: 119.4 litres/day *(se 9.68;ci 20.3)*

Estimate that at Site 5, 357 people (ci 74.1) from members' households are using 4 271 (ci 792) litres of water per day from the CW.

Site 6:
Estimated population of members using the scheme: 62 households *(se 9.91; ci 20.8)*
Estimated population mean no. per household at site 6: 9.18 *(se 1.03; ci 2.16)*
Estimated population mean amount of water used-per household: 129.4 litres/day *(se 9.42; ci 19.7)*

Therefore can estimate that at Site 6, 569 people (ci 134) from members' households are using 6 789 (ci 1221) litres of water per day from the CW.

Estimate overall that 2 034 people from 238 members households are using 26 063 litres per day from the collector wells.

ii. How many non-members are using the collector well for domestic water at each site?

The calculation of this estimate proved to be a little more complex, as there was no information as to the size of the total number of non-members in the environs of each collector well scheme. However, from the return survey we know the average distance travelled by non-members to the collector well. We also know the percentage of the sample of non-members who use the collector well for their domestic water requirements.

From the 1992 Population census for Masvingo (Central Statistical Office, Harare), we can obtain a figure for the mean population density of Zaka district where the scheme sites are located. The population density is stated as 61.29 people / km^2 (Table 2.1 p25 Census 1992).

Let the mean distance to the collector well travelled by non-members at each site represent the radius of a "sphere of influence" of each site. The relative percentage of the population who use the collector well from the sample within this area can be taken to represent the mean number of non-members using the CW for domestic water. Despite the obvious existence of other water sources at each site, the assumption of a "sphere of influence" exerted by the CW that attracts a percentage of the population is not unreasonable. Indeed, the 1992 census for Masvingo states that 73% of people in Zaka district walk at least 500m to their nearest source of water, and that 32% of these walk further than 1000m. The radii for each site range from 642m at site 3 to 3100m at site 5. Return survey results also indicate that people walk further, on average, to obtain water from a CW.

Calculating the area of this "sphere of influence" and multiplying by the population density of the district will give the number of people living, on average, within the collector well's sphere of influence. Multiplying this figure by the relevant proportion of people who use the collector well at each site (taken from the sample) can give us an estimate of the number of non-members who use the scheme for domestic water at each site. Amounts of water and numbers of households, taken from the return survey, can then also be calculated.

Population estimates for the number of non-members using the CW for domestic water.

Site 1:
From the survey sample 0 non-member households use the CW for domestic water.
Explanation and insert diagram.

Site 2:
8% of the population in the area use the CW for domestic water *(se 0.08; ci 0.18)*
Mean distance travelled to the CW = 1500m
Mean no. per non member household at site 2 = 8.16 *(se 0.83; ci 1.85)*
Average consumption of domestic water = 100 litres *(se 9.5; ci 20.9)*

Area of catchment = 7. 069 km^2
No. of people = 433
No. of households = 53
8% use cw = 4.2
4.2 x 100 = 420 litres/ day
4.2 x 8.16 = 34 people.

Estimate that at Site 2, 4.2 non-member households *(ci 9.4)* use 420 litres/ day *(ci 87.7)* from the collector well

Site 3:
54% of the population in the area use the CW for domestic water *(se 0.14; ci 0.31)*
Mean distance travelled to the CW = 642.8m *(se 94.8; ci 205)*
Mean no. of people per nm household at site 3 = 7.15 *(se 0.94; ci 2.0)*
Average consumption of domestic water = 92.3 litres/day *(se 22.4; ci 48.5)*

Area of catchment = 1.298 km^2
No. of people = 79.5
No. of households = 11
54% use cw = 5.9
5.9 x 92.3 = 548 litres/ day
5.9 x 7.15 = 42 people

Estimate that at site 3, 5.9 non-member households *(ci 3.41)* use 548 litres/ day *(ci 286)* from the collector well.

Site 4:
36% of the population in the area use the CW for domestic water *(se 0.15; ci 0.32)*
Mean distance travelled to the CW = 850m *(se 102; ci 215)*
Mean no. of people per nm household at Site 4 = 7.14 *(se 2.25; ci 4.7)*
Average consumption of domestic water = 82.7 litres/ day *(se 7.6; ci 16.1)*

Area of catchment = 2.269 km^2
No. of people = 139
No. of households = 19.5
36% use the CW = 7.0
7.0 x 82.7 = 580 litres/ day.
7.0 x 7.14 = 50 people

Estimate that at site 4, 7 non-member households ***(ci 6.2)*** **use 580 litres/ day** ***(ci 112)*** **from the collector well.**

Site 5:
45% of the population in the area use the CW for domestic water *(se 0.15; ci 0.33)*
Mean distance travelled to the CW = 3100m *(se 291; ci 612)*
Mean no. of people per nm household at Site 5 = 8.27 *(se 0.27; ci 0.57)*
Average consumption of domestic water = 132.7 litres/ day *(se 21.3; ci 44.8)*

Area of catchment = 30.2 km^2
No. of people = 1850
No. of households = 223
45% use the CW = 100
100 x 132.7 = 13 270
100 x 8.27 = 827 people

Estimate that at site 5, 100 non-member households ***(ci 76)*** **use 13270 litres/ day** ***(ci 4480)*** **from the collector well.**

Site 6:
76% of the population in the area use the CW for domestic water *(se 0.10; ci 0.22)*
Mean distance travelled to the CW = 1480m *(se 459; ci 974)*
Mean no. of people per nm household at Site 6 = 6.54 *(se 0.45; ci 0.96)*
Average consumption of domestic water = 92.3 litres/ day *(se 5.0; ci 10.5)*

Area of catchment = 6.81 km^2
No. of people = 417
No. of households = 63
76% use the CW = 47.8
47.8 x 92.3 = 4412
47.8 x 6.54 = 313 people

Estimate that at site 6, 48 non-member households ***(ci 13)*** **use 4412 litres/ day** ***(ci 504)*** **from the collector well.**

Thus, on the basis of these calculations an initial estimation of population numbers using the collector wells for domestic water usage was drawn up. Table A1 below presents these initial findings.

Table A1 *Initial Population Estimates of Domestic Water Usage from the Collector Wells*

Site		No. of Households	No. of people	Litres/ day
1	*M*	13	119	1424
	NM	0	0	0
2	*M*	78	601	8541
	NM	15	110	1460
3	*M*	19	142	2081
	NM	6	44	584
4	*M*	27	246	2957
	NM	15	110	1460
5	*M*	39	357	4271
	NM	33	241	3211
6	*M*	62	569	6789
	NM	48	350	4670
TOTALS		**356**	**2909**	**37557**
Members		*239*	*2034*	*26171*
Non-members		*117*	*854*	*11385*

Initial findings suggested that 356 households, or 2 909 people were utilising 37 557 litres per day from the collector wells for domestic purposes. However, these are statistical estimates and have not incorporated any dynamic fluctuation or other site specific features that may alter the estimate.

As a result it was felt that these estimates for domestic water usage somehow needed to be validated to see whether they were in fact realistic. It was decided to cross reference them with the actual metered abstraction rates from each of the wells, and growing periods in the gardens when irrigation amounts taken from the wells were also recorded. In this way, an estimated water budget for each of the schemes could be constructed. Domestic usage plus irrigated usage should be equal to total abstracted for a given period. Irrigation estimates for the growing season in 1994 for sites 1, 2, 3, 4 and 5 were recorded in the 5th Progress Report. These estimates were compared to the total abstracted during the same period. The remainder was hoped to be equal to the estimated amount of water used for domestic consumption.

However, based on the gardeners' estimates, amounts used for irrigation were almost equal to and in some cases higher than the total abstracted during the same period. Table A2 presents these data. These figures left little or no room for the water that is used by both members and non-members for domestic consumption. Account was taken of the presence of other sources of water for irrigation (for example a nearby river at site 1), but the estimates still remain too high.

Table A2 *Amounts used for collector well garden irrigation, based on the gardeners' estimates*

Site	Total Amount Abstracted (m^3)	Estimated Amount used for Garden Irrigation
1	1489000	2308440
2	3069001	1654200
3	2715000	3164340
4	1405000	1337280
5	1806000	1071680

The implication seems to be that the respondents are over reporting the amounts they say they use for irrigation. On this basis a second approach was used to calculate water used for irrigation during the recorded period. Based on data from FAO 24 (crop water requirements), an average water requirement for vegetables of 0.45m /100 day growing season was used. Assuming 0.3ha of the garden was the wetted area (the remaining 0.2ha being paths etc) the theoretical minimum water consumption per day for the garden would be 13500 litres / day. This figure was multiplied by the extent of the measured period (in days) for each site. The results are presented in table A3. However, again these data leaves little or no water for domestic consumption at most sites.

Table A3 *Amounts needed for collector well garden irrigation, based on FAO 24 minimum water requirement*

Site	Total Amount Abstracted (m^3)	Estimated Amount used for Garden Irrigation
1	1489000	2470500
2	3069001	3172500
3	2715000	2605500
4	1405000	1228500
5	1806000	1917000

In this case, it must be the *total wetted area* that is less than 0.3ha - in other words not all of the garden area available for growing is being used over the growing period. Thus, the actual cropped area over the growing season as recorded in the 5th Progress Report was calculated. This was done using the "duration" (and where applicable "number of beds") columns, which indicate the length of time each crop was grown, from the *"Estimated total irrigation water applied"* tables for each site(pp xx 5th Progress Report). The average wetted area per garden per day for the recorded periods are shown below in table A4. It is interesting to note that the maximum average wetted area / day for the gardens during the growing season was 0.258ha.

Table A4 *Average wetted area per collector well garden per day for the recorded period*

Site	Average Wetted Area (ha)
1	0.231
2	0.121
3	0.180
4	0.258
5	0.230

Thus, a minimum water requirement for irrigation for each garden during their respective growing periods can be calculated, using these figures for wetted area, and a benchmark of 0.45m / 100 days for water requirements. A summary of the water budgets for each site is shown below. The irrigated figure has 3 estimates - the peoples' estimate, the minimum benchmark figure and an abstraction amount from a pump originally designated to be used only for the garden water. (Unfortunately this designation system collapsed in most cases, but the figure is still shown in brackets where applicable). The domestic consumption figure is the calculated population estimate drawn from the data in the return to household surveys. The total abstracted is the pump meter reading for the period (the most reliable figure).

Water Budgets for the collector well at each site (litres).

Site 1: Study Period 185 days *(15/3 - 14/9 1994)*

	Irrigation		Domestic		Abstracted
min. reqd	1902285	*Survey est.*	470640	*Pump*	1489000
comm. est.	2308440				
(pump)	-				

It is clear for the vegetables to grow at all that Site 1 had an external source of irrigation water, considering the total amount abstracted. In fact, members from site 1 were supplementing the collector well water with that of a nearby stream for irrigation. This stream dried up in early July. Thus, for the remaining 29% of the period a water budget that contains only water from the collector well can be constructed. For this period the budget is estimated to be the following:

Site 1 collector well water budget for the period when the river was dry:

	Irrigation		Domestic		Abstracted
min. reqd	543510	*Survey est.*	134261	*Pump*	633001
comm. est.	659000				

The parameters for this budget look to be more stable. The estimates are out by +44 770 (860 litres/ day). This could be attributed to either statistical error (improving the number of households who use the collector well for domestic water by 8) or to overwatering by the community. Water taken from the river for irrigation can be estimated to approximate 4 746 litres/ day. Improving the number of non-members who use the collector well would make sense and correct for the survey error of not capturing any non-members who use the collector well. This correction would add 52 people to the total of those using the collector wells.

Site 2: Study Period 235 days *(28/2 - 5/11 1994)*

	Irrigation		Domestic		Abstracted
min. reqd	1274288	*Survey est.*	1528158	*Pump*	3069000
comm. est.	1654200				
(pump)	(1795000)	*(pump)*	(1274000)		

The estimates are out by + 693554 (1134 litres/ day). This could be due to statistical error (improving the number of households who use the collector well for domestic water by approximately 14 households), or to overwatering by the order of approximately 20%. Overwatering could be likely, as members at the site were reported as having overwatering problems.

Site 3: Study Period 193 days *(25/3 - 5/11 1994)*

	Irrigation		Domestic		Abstracted
min. reqd	1490400	*Survey est.*	530750	*Pump*	2715000
comm. est.	3164340				
(pump)	(1212000)	*(pump)*	-		

The estimate is out by + 693850 (3370 litres / day). The low domestic figure reflects the fact that the well lies inside the fence at the site with the door locked. Members are rather particular about the well being used for domestic purposes, and a nearby borehole provides most with their domestic water requirements. As site 3 required an average minimum of 8 100 l/ day during the period, it could be assumed that members were overwatering by approx 46%. Alternatively, the excess could translate into an extra 35 non-member households using the well (250 people). Considering the "surges" in usage that occur, at site three this scenario could be likely.

Site 4: Study Period 91 days *(1/8 - 30/10 1994)*

	Irrigation		Domestic		Abstracted
min. reqd	1056510	*Survey est.*	282703	*Pump*	1405000
comm. est.	1337280				
(pump)	-	*(pump)*	-		

The estimate is out by + 65787 (7226 litres/day). This could be due to statistical error (improving the number of households who use the collector well for domestic water by approx. 74 households) or to overwatering. The garden required on average 11610 l/day, so overwatering would have occurred at a magnitude of 62%. The average water depth figures per crop are quite efficient (0.38 - 0.62m; our benchmark = 0.45). It is suggested therefore that the figure for domestic water consumption at site 4 is an underestimate, perhaps by a magnitude of 2.5. This readjustment would boost the number of non-members who use the collector well by 74, or by 518 people. This may be a seasonally adjusted figure as there is an unreliable borehole nearby and a seasonally flowing river. In dry periods when these sources fail, non-members could be using the collector well.

Site 5: Study Period 142 days *(17/6 - 6/11 1994)*

	Irrigation		Domestic		Abstracted
min. reqd	1115978	*Survey est.*	1884340	*Pump*	1806000
comm. est.	1071680				
(pump)	-	*(pump)*	-		

The estimated figure for domestic consumption is clearly too high. The difference between the amount needed for irrigation of the wetted area (in this case larger than the estimated amount) and the total abstracted = 690022, or 4859 l/day. The model estimated domestic consumption of 13270 litres per day. It is suggested that the estimate for domestic water consumption at site 5 is out by approximately 2/3, particularly the estimate for non-members. This adjustment lowers the estimated number of non-member households who use the site 5 collector well from 100 to approximately 50, or from 827 people to 414.

Insert diagram and explanation.

Table A1 readjusted *Revised Population Estimates of Domestic Water Usage from the Collector Wells*

Site		No. of Households	No. of people	Litres/ day	
1	*M*	13	119	1424	
	NM	8	52	860	
2	*M*	78	601	8541	+ 1 134 l/day overwatering
	NM	15	110	1460	
3	*M*	19	142	2081	
	NM	41	294	3954	
4	*M*	27	246	2957	
	NM	89	628	8686	
5	*M*	39	357	4271	
	NM	50	414	4859	
6	*M*	62	569	6789	
	NM	48	350	4670	
TOTALS		**489**	**3882**	51686	
Members		*238*	*2034*	*27197*	
Non-members		*251*	*1848*	*24489*	

Revised findings suggested that 489 households, or 3882 people were utilising 51686 litres per day from the collector wells for domestic purposes during the sample period.