In-Field Rainwater Harvesting and Water Conservation Techniques:

Assessing the Impact of Fifteen Years of WRC-Funded Research in Thaba Nchu

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WATER RESEARCH COMMISSION

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IN-FIELD RAINWATER HARVESTING AND WATER CONSERVATION TECHNIQUES: ASSESSING THE IMPACT OF FIFTEEN YEARS OF WRC-FUNDED RESEARCH IN THABA NCHU

Report to the
Water Research Commission

by

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ASSET Research

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EXECUTIVE SUMMARY

The Water Research Commission (WRC) had been supporting the Agriculture Research Council (ARC) at Glen near Bloemfontein and various other organisations over the past fifteen years to conduct research and development on in-field rainwater harvesting (IFRWH) techniques and the dissemination thereof among the members of 42 villages surrounding Thaba Nchu. The WRC approached ASSET Research to conduct an investigation, using the McMaster University's research impact assessment tool, as to the uptake and impact of IFRWH in those villages. Two surveys, one quantitative and one qualitative, were undertaken to meet this objective.

The quantitative survey revealed that the uptake and impact of IFRWH is indeed positive. It also revealed that the respondents were aware of and able to apply IFRWH in homestead food gardens. IFRWH has improved their social wellbeing and has created a common focus in the community. Concerns were the ability and the lack of clarity on the possibility of applying IFRWH on the croplands. Investigating villagers' willingness to apply IFRWH in the croplands therefore became the objective of the second survey.

From the qualitative survey it became evident that social and leadership issues are the determining factors regarding the future success and expansion of IFRWH to the croplands. It is clear that in villages which exhibited a strong social cohesion and leadership – especially from the headman – the uptake of IFRWH has advanced and the possibility of expansion is better than in those villages where that is not the case.

To summarise, the uptake of IFRWH in food gardens is encouraging in some selected villages. The key to advance IFRWH is to provide well-focused help and demonstration models for and in those villages where a good cohesion and strong social capital exist. In such a way the advances made in illustrating the benefit of IFRWH in the past can be combined with the keenness and intention as well as expectation to transfer the technique to the croplands, thereby expanding the impact of IFRWH to the betterment of people's lives.

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A special word of thanks goes to the WRC for funding this study and making it possible. The guidance, support and collective wisdom of especially Dr Gerhard Backeberg and Dr Andrew Sanewe are noteworthy. This study was commissioned by the WRC and the WRC requested ASSET Research, after an initial meeting, to submit a proposal. During the aforementioned meeting, the WRC provided clear leadership and strategy, and requested that ASSET Research use the McMaster tool as described herein. After contacting the McMaster University, ASSET Research developed the questionnaires used during this study. The WRC provided invaluable assistance and insights in refining the questionnaires during a highly-interactive, iterative and constructive process. The study benefited a great deal from the interactions with the WRC and the individuals mentioned.

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1 INTRODUCTION

The Water Research Commission (WRC) has dedicated a large number of resources over the past fifteen years to the development of in-field rainwater harvesting (IFRWH) in the municipal area of Thaba Nchu, and to the transfer of this knowledge to the local communities to apply these techniques. At the time of writing, at least 12 extensive scientific reports have been produced and four are still in preparation on the subject. The questions now are, given this research and resource input, what was the impact of the research and development on the targeted communities, and how good was the uptake of these techniques and the impact thereof on the lives of the people?

While the research conducted has been scrutinised and subjected to the conventional peer review process for quality, now is an appropriate time to evaluate the impact of the research and development. Therefore, the WRC commissioned this study (see Annexure A for the proposal which includes the terms of reference) to quantify and assess the impact its research funding has had to date by considering the uptake success and the impediments towards expanding the uptake of IFRWH.

This study was never intended to act as an evaluation or a review of the quality or excellence of the research conducted by various research organisations. Rather, the objective of this study was to measure and assess the impact of the research. The need for such a study is emphasised by the fact that researchers and research-funding agencies very often operate in a research vacuum since the decision-makers or practitioners who implement the research output are often not organisationally linked to those who conducted the research. While the quality of research is often assessed through the conventional peer review process, the research impact is not. When the impact is assessed, it is done in terms of the number of citations the research received in other research outputs. Therefore, the link between the research and its implementation remains broken. The WRC, through this study, expressed a sincere interest to re-connect the research with the research impact through a deliberate attempt of measuring such an impact.

This report first considers the research method applied to measure the research impact, thereafter it provides a synthesis of the results followed by a conclusion. Since this study was completed in three phases resulting in three separate products (listed here as Annexures B-D), the main section of this document considers the synthesis of all three components. The products are as follows:

- A literature study and description of the McMaster University's research impact assessment model (see Annexure B).
- A quantitative assessment of the research impact applying the McMaster University model (see Annexure C).
- A qualitative assessment about the prospects of applying IFRWH in the croplands using a semi-structured questionnaire (see Annexure D).

2 RESEARCH METHOD

From the outset, it was decided to conduct two surveys in the study area (see Annexure A). The study area is defined as the villages practising IFRWH surrounding Thaba Nchu (see Annexure C.B for a complete list of these villages). The aim of these surveys was to quantify the impact of the research and development work concerning IFRWH conducted within the study area. The first survey was a quantitative analysis and the second was a qualitative one.

2.1 Quantitative Assessment

In selecting the most appropriate tool for measuring the impact of the IFRWH research and development work in the study area it was decided, in consultation with the WRC, to use the McMaster University's tool developed for this purpose. This tool is described in Lavis et al. (2003b) and Lavis et al. (2006), as well as on the website of the McMaster University, Centre for Health Economics and Policy Analysis (http://www.chepa.org). This tool was decided upon due to its good track record in various research assessment applications and the fact that it provides a consistent framework for deciding the most appropriate research assessment technique within different conditions (Abelson et al. 2007, Bowns et al. 2003, Giacomini et al. 2004, Lavis 2002, Lavis et al. 2002, Lavis et al. 2003a, Roper et al. 2004, Sendi et al. 2002, Tassey 2003 and Tepper 2003). The details of the tool and what it comprises are captured in Annexure B but, in essence, it implies a matrix outlining the assessment options to the assessor given a variety of circumstances (see Table 1 below).

Table 1: Summary of the McMaster assessment tool

For any given target audience, e.g. policy-makers, communities, professionals*:

Category ↓ **Measure** →	**Process**	**Intermediate output**	**Output**
Producer-push	Researcher's CVs, etc.	Surveys measuring awareness	Surveys measuring use
User-pull	Number of data requests by data users	Audience's awareness of data availability	Audience's use of data
Exchange process	Combination of the above	Combination of the above	Combination of the above

*** Note:** Entries in boxes are examples and are by no means definitive.

When applying the McMaster matrix to the WRC's stated request to assess the impact of the research funded and conducted by them concerning the uptake and use of IFRWH in Thaba Nchu, the following considerations emerge:

- The target audience is the residents in the 42 villages around Thaba Nchu where the research has been conducted over the past 15 years. The data source, therefore, is the villagers.
- The category is producer-push. The WRC has funded the research and the researchers involved in the research have made a concerted effort to make the research results available to the villagers.
- The specific operational measure chosen is an output-driven measure.

Given the above, the most appropriate strategy to assess the impact of the research is to conduct a survey among the decision-makers, i.e. the villagers, about both their knowledge of the research results and whether they make use thereof and how. Following the McMaster model, we used a five-point Likert scale in determining the respondents' perceptions/answers (see also http://www.socialresearchmethods.net/kb/scallik.php). This is a very powerful way to assess and quantify the perceptions concerning the usefulness and uptake and, hence, the impact of any given research programme or policy. The questionnaire used to assess the impact of the WRC-funded IFRWH research is provided in Annexure C.A.

Respondents were selected from the 42 villages surrounding Thaba Nchu. To provide structure to the selection process, the villages were clustered into three categories in terms of their IFRWH performance by the Institute for Soil, Climate and Water of the Agriculture Research Centre (ARC) at Glen (see Annexure C for a detailed discussion about the selection process). The three categories that were distinguished are **Good**, **Average** and **Poor**. These classifications were based on the performance of the community-based in-field rainwater harvesting committee for each of the villages. Essentially, the categorisation hinges on good governing structures within the villages themselves and the relationship between the committee and the village – i.e. the social capital. It was decided to link the categorisation of the committee's performance to the performance of IFRWH in general since IFRWH as a technique is unlikely to perform well without a good governing structure. It was also decided not to conduct the survey in all 42 villages, only asking a handful of people in each, but rather to cluster the villages and select a few villages per cluster. In doing so, one assumes that the selection of villages within each cluster is representative of the entire cluster. This method allows for more interviews per village and, therefore, more responses since less time is spent on travelling among the villages and more focused attention can be given to conducting the interviews.

As indicated in Annexure C.B, there are a total of 935 members or official participants using IFRWH in the 42 villages. Of these, 25 per cent are in so-called "Good" villages, 42 per cent are in "Average" villages and 33 per cent are in "Poor" villages (see Table 2). To keep the proportion of villages selected comparable to the number of people participating in IFRWH, a total of 12 villages were selected – three from the good cluster, five from the average cluster, and four from the poor cluster.

Table 2: Selection of total number of villages to conduct survey

Total participants	**935**	**Number of villages to survey**
Proportion of Good participants	25%	3 villages
Proportion of Average participants	42%	5 villages
Proportion of Poor participants	33%	4 villages
	100%	**12 villages**

Once the clustering of the villages was complete, each cluster is assumed to be one sample. This implies that there are essentially three samples. Yet, each sample had to contain farmers using IFRWH, those not using it, and non-farmers as well, to provide insight as to the difference among the various categories. The portions of farmers with IFRWH, farmers without IFRWH, and non-farmers are determined in the same manner as the number of total villages. The targeted number for each sample was 70 observations. Within these 70 observations, 42 are farmers with IFRWH, 18 are farmers without IFRWH, and ten are non-farmers. Therefore, the overall sample size (as illustrated in Table 3) is 210 observations. In practice, seven more interviews were conducted, favouring the average cluster. Important, however, is that 126 people who use IFRWH were interviewed – 15% of the total – and hence the sample can be considered as sufficiently large enough among this sector to be representative. The results of the survey are discussed in Section 3.1.

Table 3: Portioning of each sample: Number of surveys conducted*

	Poor	Average	Good	Total
Farmers with IFRWH	42 (36)	42 (53)	42 (50)	126 (139)
Farmers without IFRWH	18 (18)	18 (16)	18 (16)	54 (50)
Non-farmers	10 (8)	10 (13)	10 (7)	30 (28)
	70 (62)	70 (82)	70 (73)	210 (217)

* The values outside the parenthesis were the targeted number of surveys. The values inside parenthesis are the actual number of surveys conducted.

2.2 Qualitative Assessment

After analysing the results of the quantitative assessment, conducted during November 2007 and presented to the WRC, the study team and the WRC decided that it would be in the best interest of the research programme to focus on clarifying specific issues emanating from the quantitative research. These issues include aspects relating to the relationship between crop and cattle farmers, the possibility of extending the impact of IFRWH to the croplands, and the role and impact of the traditional leaders and institutional structures to improve and enhance the impact of IFRWH. Whereas the quantitative assessment focused on determining the impact of the past research, the qualitative assessment focused on how the impact of IFRWH could be expanded.

To clarify these issues a qualitative assessment, conducted during February 2008, using a semi-structured questionnaire (Annexure D.A) in a single focus group meeting with each of the 12 villages selected for the first survey, was performed. The questionnaire was developed by both the research team and the WRC. The ARC was asked to comment on it and their comments have been incorporated in the final questionnaire used.

The focus group meeting was arranged by the IFRWH co-ordinator in Thaba Nchu two weeks before the same enumerator who conducted the quantitative research visited the study area to conduct the qualitative assessment. All the IFRWH members of the villages in which the quantitative assessment had been conducted were informed about the date and the venue of the focus group meeting. The enumerator, assisted by the IFRWH co-ordinator, conducted all the focus group meetings in person. A summary of the results of this assessment is captured in Section 3.2 while the detailed results are given in Annexure D.

3 SYNTHESIS OF THE RESEARCH FINDINGS

3.1 Quantitative Assessment

Using the McMaster University's research impact assessment tool described above, the study team conducted 217 interviews during November 2007 in 12 carefully-selected villages from the 42 villages around Thaba Nchu that practice IFRWH. The study team assessed the impact the WRC-supported research and development of IFRWH has had from a villager's perspective. The assessment details are given in Annexure C.

It has been found that the majority of the respondents are aware and knew of IFRWH. They also apply it and IFRWH has improved their socio-economic wellbeing. Interestingly, there is a statistically significant difference between the responses of respondents from villages within the good cluster and those in the poor cluster. The impact of IFRWH is much more significant in the former than in the latter and this impact is reflected in the perceptions of the respondents interviewed. It is therefore important to note that the classification of the villages, as indicated in Section 2.1, into good, average or poor is mainly linked to governance and not to technical ability.

The respondents indicated, categorically, that IFRWH has improved their food security and that they prefer using it in their food gardens because it is easy to implement and saves water. This is an important consideration given that, though most of the villages do have access to a regional water supply scheme, water reliability is very low.

Access to land, land tenure and land security is not a concern. Almost all the respondents have access to land, secure tenure, and are convinced that that will be the case for at least another five years. The respondents are also keen to up-scale their current farming activities from the current food gardens to the croplands. Although respondents think IFRWH can work and are willing to apply it themselves in the croplands, they think ploughing is a better farming practice in the croplands than IFRWH. This is despite indicating the opposite when asked similar questions with respect to the food gardens – which is their current frame of reference. The use of cattle as draught-animals is, however, not acceptable to them.

In summary, the practice of IFRWH is most encouraging and is viewed by the respondents as having a positive and constructive impact on their wellbeing. The up-scaling of the technique to the croplands, however, is a subject of further research and awareness-raising.

Given the encouraging outcome of this assessment, namely that IFRWH is improving the quality of life of people and significantly more so in those villages where well-functioning governance structures exist, it was considered important to explore the ways in which IFRWH can be made more effective and have a greater impact by expanding it to the croplands. This is the topic of the next section.

3.2 Qualitative Assessment

To qualitatively assess the possibility of improving and expanding on the impact of the IFRWH research conducted to date, it is necessary to consider the impediments and/or ways to unlock the opportunities related to transferring the knowledge and learning experiences gained through working in the home gardens to the croplands. Important aspects to consider in facilitating this transfer is i) the relationship between the crop farmers, the IFRWH practitioners, and the cattle farmers, ii) the relationship between the crop farmers and the headman, iii) the pulling of resources towards reducing the input cost, and iv) the possibility of collectively marketing the produce.

These were the aspects considered in various focus group meetings during February 2008 dedicated towards this objective as discussed in Section 2.2. The detailed outcome of this assessment's results can be found in Annexure D.

As indicated during the quantitative assessment, there is an overwhelming keenness to move to the croplands. Respondents are also convinced that IFRWH can be practiced in the croplands and they are keen to apply this technique there. There are, however, the following concerns:

- They have limited skills to operate the croplands using IFRWH and would appreciate a demonstration and/or model to this effect. The power of demonstrative examples is also clearly illustrated in the one village where villagers embarked on using the croplands because of one person's initiative.

- They would not use draught-animals to prepare the land, but tractors, since farming with cattle is old-fashioned. It was also mentioned that draught-animals are scarce in the villages.
- Very few, however, have access to a tractor and even collectively they will not be able to buy a one.
- The threat of crop theft is very real and an issue mentioned by all groups. They consider fencing, community participation and forming community policing forums as solutions to this threat in the croplands.
- In addition to theft, damage by cattle – if the croplands are without fencing – is a major concern, although in one village where the croplands have been used a penalty of R20 per paw-mark in the cropland is enforced by the headman on the owner of the cattle. Again, fencing is seen as the solution. However, this is not necessarily a sign of current/future communal tensions since cattle farmers are generally seen as being part of the community and not as a "bad element".
- The role of the headman is very important. Where he is strong, active and respected, there is cohesion among the community members. They also seem more willing to take on risk. Where the headman is weak, not respected or old, there is no community cohesion and no trusted mechanism to resolve disputes. Leadership is therefore a key variable in taking IFRWH to the croplands.
- The young are involved in only in a few cases. The failure of the older generation in creating sustainable agricultural opportunities has led to the youth generally viewing farming as a last option for economic survival.
- The youth also generally tend to be sceptical about any government agricultural initiatives as previous initiatives have not lived up to the intended objectives. This makes it difficult to evoke significant youth participation in any agricultural initiatives.
- The croplands also tend to be far from the villages, making access on a daily basis difficult – especially for the elderly. This matter is aggravated by the bad condition of the roads.
- The croplands are currently dilapidated and used as grazing grounds for cattle.
- In most communities the level of communal interaction is not such that allows the formation of institutions such as co-operatives. In most cases, however, respondents are willing to collaborate with one another, but they have no idea how to establish a co-operative and how to manage such – contributing to the perception that their current situation does not require a formal co-operative. They see, however, the usefulness in such collaboration concerning the marketing of the produce in places such as Bloemfontein and Thaba Nchu.
- The headmen who were interviewed are in strong support of taking the IFRWH to the croplands as it is likely to improve the wellbeing of the people – taking into account that the headman may not necessarily base this on merit. The lack of resources, such as fencing material, equipment and training, however, are obstacles. The lack of the necessary motivation among the villagers to embark on farming the croplands is also mentioned, something that is related to the risk of losing the harvest due to damage or theft.
- The cattle farmers are willing to co-operate with the crop farmers and graze their animals elsewhere. In certain instances the cattle farmers apply IFRWH in their own gardens as well, but they also think that fencing is essential to protect everyone. They do not, however, think that using rainwater harvesting in the rangelands will work, but some are keen to try, albeit they are currently very sceptical.

4 CONCLUSION

After conducting both a quantitative and a qualitative assessment of the impact of IFRWH among the villages surrounding Thaba Nchu it can be concluded that where being practiced and where there are good governance systems, it has a statistically significantly greater impact on the welfare and livelihoods of the people than in areas where it is not applied or where poor governance structures exist. This indicates that the qualifying factor for IFRWH to have a significant impact is much more related to internal organisational and institutional issues than technocratic issues. Where the institutional and organisational aspects are sound, IFRWH research has had a meaningful impact.

As aspects such as coherent institutions, leadership and demonstration models are important determinants of success, so are knowledge, skills and resources. While the knowledge and skills obtained to apply IFRWH in the gardens exist, such skills do not exist to enable the villagers to transfer that knowledge to the croplands. The resource and management requirements of both the farming activity itself (like knowing what to plant, how and when) and the community relationships (like with the cattle farmers, with other community members and even managing the relationship among the farmers themselves) are seriously lacking. To broaden the impact of IFRWH the logical next step would be, given the success and the demonstration models in operation with regard to the use of IFRWH in the gardens, to move to the croplands. It is a step that will enjoy much support from the people, but such a transfer is likely to face significant obstacles. It is recommended that a demonstration of IFRWH in the croplands be done, but together with a willing and able village where the internal organisational structure and cohesion is good and where there are strong local leadership and buy-in.

While the research into and development of IFRWH over the past 15 years has had a significant impact on people's lives in villages where the IFRWH-committees and local leadership are well-established, the challenge would be to take these lessons to the next level. This transition is likely to be a challenge for both the community and those who will have to coach them, but indications are that the people are keen and willing to make this work should some very specific obstacles be addressed.

ANNEXURE A: PROPOSAL AND TERMS OF REFERENCE

This proposal serves as a follow-up to a preliminary meeting held between Dr Andrew Sanewe and Dr Gerhard Backeberg of the WRC and Prof. James Blignaut of ASSET Research on Tuesday 31 July 2007 at 11:00 at the WRC offices. During this meeting the WRC asked ASSET Research to produce this proposal as an outcome.

Over the past 15 years, the WRC has funded research into the viability and practicality of various rainwater harvesting and conservation techniques in the municipal area of Thaba Nchu and is eager to know the impact of the funding provided for this research to date. This proposal provides a roadmap for evaluating the impact a decade of WRC-funded research has had. We emphasise that this study is not intended as an evaluation or a review of the research as such. Although the research reports will be studied, as indicated in Section 4 of this proposal, no critical evaluation will be made. Our goal will be to measure the impact of the research, not to evaluate the quality or excellence thereof. We assume that the research has been peer-reviewed and that the results can be considered robust.

It is widely recognised that expenditure on the development of science and technology (S&T) through research and development (R&D) is essential to usher in development. But what is the impact of such expenditures? How successful is the conversion of S&T type R&D spending into economic development, especially within a rural, semi-arid, poor, subsistence economy context?

The WRC has dedicated a large amount of resources over the past 15 years to the development of rainwater harvesting and conservation techniques in the municipal area of Thaba Nchu, as well as on the transfer of this knowledge to the local community to apply these techniques. At least 12 extensive scientific reports have been produced and four are still in preparation on the subject. The questions now are: Given this research and resource input, what was the impact on the targeted communities in terms of economic, social, environmental and health indicators? How good was the uptake of these techniques and how did that impact on their lives?

To conduct this task, the first couple of weeks will be dedicated to developing the most appropriate research impact-measuring tool for this specific programme. While several tools exist, as highlighted by Bozman and Melkers (1993), Kostoff (1994a, 1994b & 1997), and Geisler (2001), the tool to be used here will be based on one used by the McMaster University, Centre for Health Economics and Policy Analysis (http://www.chepa.org/). It has been decided to use this tool since it has a proven track record. This tool comprises six steps, namely:

1. the identification of the target audience for research knowledge
2. the selection of the appropriate category measure (whether producer-push, user-pull, or exchange measures)
3. the operationalisation of the measures given the target audience and/or research knowledge
4. the identification of the data sources
5. the analysis of whether the research knowledge was used in decision-making, especially in the context of competing influences, and
6. the analysis of how the research knowledge was used in decision-making.

The research impact measurement tool that will be developed should be generic enough to be duplicated and applied by the WRC on other research sites elsewhere as well as Thaba Nchu. The research tool should be quantitative, but with appropriate qualitative support. It should also be objective insofar as possible, replicable, and – not unlike multi-criteria analysis – it should provide a weighted outcome of the results of the various categories of indicators.

It is foreseen that based on this preliminary research a questionnaire will be designed and a Sotho-speaking person under the supervision of an established researcher will conduct the fieldwork. The questionnaire will be designed in accordance with the McMaster research impact method described above. In all cases the McMaster tool will act as guide to enable the study team to determine, and quantify, the impact of the research that has been conducted in Thaba Nchu. This research is to be conducted during early November, which is during the early summer and the time the rainy season is due to commence. It is hoped to use this opportunity to determine the retained knowledge from the past projects/research/sessions and to assess the possible application of the rainwater harvesting and conservation techniques. This early assessment will also be used to establish a baseline in terms of socio-economic demographic factors and local people's perceptions of the rainwater harvesting and conservation techniques. The results of this first round of questions will be analysed statistically and followed-up with another questionnaire. This follow-up survey will be conducted in late January, i.e. near the (anticipated) end of the rainy season with the goal of considering the actual uptake of the technology and the impact it has had socially, environmentally, economically and on health. It is anticipated that similar surveys will be conducted in a complementary area where the WRC has not been active to act as a reference. These latter surveys will focus mainly on crop production and crop yields to compare the production in Thaba Nchu with that elsewhere. Ideally one would like to include the analysis of soil quality tests, water runoff and change in sediment load between the two areas, but this will not be done under this study. Here we will concentrate on analysing the socio-economic aspects only of the "with" and "with-out" WRC presence.

The questionnaires and the ensuing results are to be validated and weighed through focus group meetings with the various researchers as well as with local leadership. After the final survey and team meetings, which will include meetings with the WRC in Pretoria and the principal researchers in Bloemfontein, a final report will be drafted and submitted to the WRC.

It is anticipated that the research team will work in close collaboration with the WRC and view this not as a product for the WRC, but as a study carried out in collaboration with the WRC. It is, therefore, also anticipated that, should it be deemed feasible and appropriate, an academic paper co-authored by the research team and participating members of the WRC encapsulating the research results will be prepared. This will take place after the formal conclusion of this research project and contractual period and without entailing any further costs to the WRC.

ASSET Research is a Section 21, not-for-profit, R&D company whose principal aim is capacity-building in the fields of environmental resource and ecological economics. Based on this, ASSET has the following points of departure:

- It is a research centre and think-tank driven by people who live and work on the African continent. They will match the skills and insights from Africans, and other people worldwide, with the challenges at hand in Africa.
- It is not constrained by political agendas.
- It distinguishes itself from consultancy firms who often do what the market wants and fail to address issues of context, social impact and sustainability.
- It cooperates before it competes. The objective is quality, and other institutions and organisations are welcome to bring in elements that will enrich the programme.

- It views capacity-building as an integral feature of its operation and not as an adjunct or imposed consideration and activity.
- As an R&D outfit, it strives to be innovative rather than to duplicate or replicate.
- Its focus is on the interface between economics and the environment, and adopts the notion that we need an economy in which nature matters and applied ecology in which people matter.

The principal members of ASSET Research are Prof. James Blignaut, Dr Martin de Wit (extraordinary association professor at the Sustainability Institute of the University of Stellenbosch) and Dr James Aronson (head of the restoration ecology team of the CEFE laboratory (CNRS) in Montpellier, France, lead coordinator of the global RNC Alliance (www.rncalliance.org) and curator for restoration of the Missouri Botanical Garden, St Louis, USA). Research collaborator for this project is Mr Xolani Sibande, an honours student in Economics at the University of Pretoria.






ANNEXURE B: LITERATURE REVIEW

1 INTRODUCTION

Over the past 15 years, the Water Research Commission (WRC) has funded research into the viability and practicality of various rainwater harvesting and conservation techniques in the municipal area of Thaba Nchu and is eager to know the impact of the funding provided for this research to date.

ASSET Research has been tasked to apply the McMaster research impact measurement tool to conduct this research.

Here we provide a synthesis of the research conducted thus far, followed by a description of the research method and the questionnaire to be used.

2 LITERATURE REVIEW

See Appendix B.A for a summary of the all the research reports produced under the WRC in-field rainwater harvesting research initiative in Thaba Nchu. Here, however, we provide a brief synopsis covering the entire research effort.

In-field Rain Water Harvesting (IFRWH) has proven to be far superior to conventional soil tillage. Many trials have taken place over the years to ascertain this fact. During 1997-1999, for example, an experiment was conducted at the Glen experiment station where annual cropping with conventional total soil was compared to annual cropping employing a combination of a no-till type mini catchment runoff farming and basin tillage. The latter was found to be superior – as in many other experiments.

Extensive efforts have been made to quantify risk associated with rain water harvesting as compared to conventional soil tillage. The PUTU crop model – a combination of runoff, rainfall intensity and deterministic models – was developed and applied with some success. Further simulation models such as the Water Erosion Prediction Project (WEPP) and the Agricultural Catchment Research Unit (ACRU) were employed in dealing with the challenges of runoff and erosion. Long-term risk environment associated with IFRWH was found to be significantly lower than that of conventional soil tillage.

Studies have been conducted into the economic and social sustainability of IFRWH, employing techniques such as the Participatory Action Research (PAR) and Participatory Rural Appraisal (PRA) for social sustainability, and Cost-Benefit analysis for economic sustainability. PAR and PRA involve communities from the outset of any project and high levels of community participation have been achieved. Economic profitability – with proper small farmer support – is significantly higher than with conventional soil tillage.

3 RESEARCH METHOD

Various research impact assessments exist, three of which will be discussed here. The first method discussed here is by Eliezer Geisler of the Stuart Graduate School of Business of the Illinois Institute of Technology. Geisler (2001) suggests one uses a stage-process method when estimating and measuring the benefits accrued to government, the economy and society-at-large from state-funded research and development investments. Four stages of outputs and four stages of transformation can be identified. The output stages are the following:

- Intermediate outputs
- Intermediate
- Pre-ultimate
- Ultimate

The process approach suggested by Geisler traces, retrospectively and prospectively by estimation, the flow of research through the four stages of the innovative continuum. This model allows the researcher to develop probabilities of transformation and transfer from stage to stage. This model, being both qualitative and quantitative, offers two specific attributes. The first is the ability to have core and organisation specific indicators. The second is the ability to have transition indicators, i.e. indicators that measure the transition of the R&D between stages.

The second method was developed and described by Kostoff (1994c) and distinguishes between three approaches, namely qualitative, semi-quantitative and quantitative methods. The qualitative approach involves peer review. Here a panel of experts are appointed to review the outputs of research conducted and evaluate the impact such research has had on the scientific community and the uptake of the R&D. This is an approach most often used to evaluate research funding proposals and to evaluate, a priori, what possible update of the R&D there might be. The semi-quantitative method makes minimal use of mathematical tools, but draws on documented approaches and results. Three types of semi-quantitative research techniques exist, namely that of Project Hindsight, TRACES and Accomplishment Books. The first two techniques reflect on the history of a project seeking the most influential scientific advances that has taken place to make that project possible. It is retrospective, in other words, viewing the R&D impact from the project perspective. The third technique, Accomplishment Books, details the impact R&D has had on project advancements, in other words seeking scientific accomplishments as a result of R&D. Long-time series information is required and a clearly-demarcated project to use any of these techniques. Lastly, the qualitative method uses cost-benefit analysis, whereby the social internal rate of return of the R&D is calculated, and bibliometrics. Bibliometrics involves the number of counts of publication citations, number of hits in searches, and the different applications of the R&D in other fields of research. This type study includes patent citation analysis and the application of co-occurrence techniques whereby phenomena that co-occur with the R&D is considered to seek insight as to the development of the R&D and the much needed uptake thereof.

The third method, and also the preferred method of research impact assessment, was developed by the McMaster University. The McMaster University's research impact assessment tool is describe in Lavis et al. (2003b) and Lavis et al. (2006) and on the website of the McMaster University, Centre for Health Economics and Policy Analysis (http://www.chepa.org/). This tool has been decided upon due its good track record in various research assessment applications and the fact that it provides a consistent framework for deciding the most appropriate research assessment technique given different conditions. In this way it is much more flexible, but also broader, than the previous two methods mentioned. It is less data-intensive, but without losing rigour and robustness.

This tool comprises the following six steps:

1. The identification of the target audience for research knowledge, which could be any of the following:
   - policy-decision makers
   - the media
   - professionals
   - private sector
2. The selection of the appropriate category measure (whether producer-push, user-pull or exchange measures):
   - In producer-push cases, it is the producers of knowledge that actively push for the uptake of the research knowledge.
   - In user-pull cases, it is the users of knowledge that eagerly seek to acquire knowledge and the uptake thereof. This usually occurs when users of data are confronted with a situation and believe that their decision will be improved through research outputs.
   - Exchange measures imply a combination of both producer-push and user-pull.
3. The operationalisation of the measures given the target audience and/or research knowledge. These measures are, from a producer-push perspective:
   - Process measures, i.e. the number of products published, meetings with the various stakeholders and interactions with the stakeholders. This technique is a desktop-based analysis whereby the assessor only counts the number of actions during the process of knowledge distribution.
   - Intermediate outcomes, i.e. considering the target audience's awareness of the research and its source.
   - Outcomes, i.e. case study-based evidence of decision-makers actual use of the research products. This option provides for the highest confidence in the research outcome and in assessing the research impact.
4. The identification of the data sources:
   - Given the operational method selected above, the data sources could vary from the researcher's CV, his diary, telephone calls to the target audience and/or surveys. Surveys are only used within a case study-based approach and could be either structured or semi-structured interviews.
5. The analysis of whether the research knowledge was used in decision-making, especially in the context of competing influences:
   - From the measure selected and the data extracted, it is necessary to establish whether the research data was used.
6. The analysis of how the research knowledge was used in decision-making:
   - From the research conducted it is important to determine how the research knowledge was used.

The McMaster research impact assessment tool, in essence, implies a matrix (see Table 4 below) outlining the assessment options to the assessor given a variety of circumstances.

Table 4: Summary of the McMaster assessment tool

For any given target audience, e.g. policy-makers, communities, professionals*:

Category ↓ Measure →	Process	Intermediate output	Output
Producer-push	Researcher's CVs, etc.	Surveys measuring awareness	Surveys measuring use
User-pull	Number of data requests by data users	Audience's awareness of data availability	Audience's use of data
Exchange process	Combination of the above	Combination of the above	Combination of the above

* Note: Entries in boxes are examples and are by no means definitive.

When applying the McMaster matrix to the WRC's stated request to assess the impact of the research funded and conducted by them concerning the uptake and use of in-field rain water harvesting techniques in Thaba Nchu, the following aspects emerge:

- The target audience is the residents in the 42 villages around Thaba Nchu where the research has been conducted over the past 15 years. The data source for the villagers, therefore, is the WRC reports.
- The category is producer-push. The WRC has funded the research and the researchers involved in the research have made a concerted effort to make the produced research results available to the villagers.
- The specific operationalising measure chosen here is an output-driven measure.

Given the above, the most appropriate strategy to follow to assess the impact of the research is that of conducting a survey among the decision-makers, the villagers, about their knowledge of the research results, whether they make use thereof, and how. Following the McMaster model, we deploy a five-point Likert scale in determining the respondents' perceptions/answers (see also http://www.socialresearchmethods.net/kb/scallik.php). It has been decided to do two separate surveys. The first survey will be conducted during the end of November, which is during the early summer and the time the rainy season is due to commence. It is hoped to use this opportunity to determine the retained knowledge from the past projects/research/sessions and to assess the possible application of the rainwater harvesting and conservation techniques. This early assessment will also be used to establish a baseline in terms of socio-economic demographic factors and local people's perceptions of the rainwater harvesting and conservation techniques. The results of this first survey will be analysed statistically and followed-up with another questionnaire. This second survey will be conducted in February, i.e. near the (anticipated) end of the rainy season with the goal to consider the actual uptake of the technology and the impact it has had socially, environmentally, economically and on health. It is anticipated that similar surveys will be conducted in a complementary area where the WRC has not been active to act as a reference. These latter surveys will focus mainly on crop production and crop yields to compare the production in Thaba Nchu with that elsewhere – assessing the impact of the "with" and "with-out" WRC scenarios.

Next we provide a sample copy of the questionnaire to be used during the first survey period.

4 QUESTIONNAIRE TO BE USED

Please see Annexure C.A.

5 CONCLUSION

The WRC has funded a number of research activities concerning in-field rainwater harvesting, concentrating on Thaba Nchu. McMaster University has developed a research impact assessment tool that can be used to measure the impact of research and development funding under various circumstances. Here we developed a questionnaire within this context to determine the uptake and impact of the research conducted within the farming community of Thaba Nchu and its surrounding villages.

The underlying principles used to compile this questionnaire, and the method to determine research impact, though custom-made for this particular case, could be used within any other research setting as well. It, therefore, has some value in a generic sense as well.






APPENDIX B.A: SUMMARY OF THE RESEARCH FUNDED BY THE WRC CONCERNING IN-FIELD RAINWATER HARVESTING IN THABA NCHU

Optimising Rainfall Use Efficiency for Developing Farmers with Limited Access to Irrigation Water
WRC Report No. 878/1/00
ARC Institute for Soil, Climate and Water
January 2000

Background

Food security has been earmarked as one of the important factors in the eradication of poverty and as a result agriculture (small scale) is vital in this regard. A large area in east Bloemfontein (in particular, Thaba Nchu and Botshabelo) has been earmarked by the Water Research Commission for the use of a then new agricultural practice called Rain Water Harvesting. This report defines Water Harvesting as the process of concentrating rainfall as runoff from a larger area for use in a small concentrated area. In Thaba Nchu and Botshabelo a hybrid of water harvesting, no till, basin tillage, mulching and long fallow because of its advantages, i.e.: a) basin tillage will minimise overall runoff from the land; b) water harvesting from untilled areas will improve infiltration; c) mulch in the basin will minimise evaporation from the soil surface; and d) long fallow will serve to get the root water content as high as possible at planting and by so doing increase the chance of attaining sustainability.

Aim of the Report

The report deals with three issues. The report calls the first issue a technical problem. The technical problem encompasses low crop production in a large in the east of Bloemfontein has occurred as a result of erratic (marginal rainfall) rainfall and largely clay soil on which low precipitation use efficiency (PUE) occurs as a result of high runoff and evaporation from the soil surface. The second involves the socio-economic benefits that would flow from the investigation. The socio economic benefits involve two previously disadvantaged young stars will benefit from their involvement and ultimately qualify as technical assistances. This would involve the obtainment of a tertiary Diploma in the relevant field. However, prior to that the young stars needed to be assisted to obtain their grade 12 certificates. Lastly, the third issue deals with the transfer of technology which has been developed.
The aims of the report are therefore:

- To identify for selected benchmark ecotopes, in marginal cropping area, the crop production techniques that will result in optimum PUE and sustainable productivity being achieved.
- To develop capacity of two previously disadvantaged young people, with the aim of their becoming effective technical assistants.
- To embark on an effective technology transfer programme to ensure optimum application of the results by farmers, by including the farmers' committees as role players in the project.

Procedure Followed

Figure: Process followed

Identifying Benchmark Ecotopes

Initially a reconnaissance soil survey of the targeted area was done. This relied on information from the Land Type Survey. Flowing from this was the identification of two ecotopes in Glen Experimental Station, and an identification of two suitable ecotopes in the target area – on farms- for demonstration purposes. Permission from the Free State Department of Agriculture was obtained for the Glen Experimentation Station. Mr. C. Ramagaga and Mr. R Thekiso were consulted for the demonstration plots.

Therefore four areas were identified: 1) Glen / Swartland-Rouxville; 2) Glen/Bonheim-Onrus; 3) Khumo/Swartland-Amandel; 4) Vlakspruit/Arcadia-Lonehill. The first two areas constitute the Glen Experimentation Station and the last two constitute the demonstration plots – situated between Thaba Nchu and Excelsior.

Experimental Plan

The experiments ran for three calendar years (1997, 1998, and 1999) as this period included two complete summer seasons.

A partially randomised statistical design with tillage treatments and three repetitions was employed in Glen. The tillage treatments used were:

- TST (Total Soil Tillage): Annual cropping with conventional total soil tillage methods
- WHB (Water Harvesting with Basin Tillage): Annual cropping employing a combination of a no till type mini-catchment runoff farming and basin tillage.

The experiment was repeated for each of the crops, i.e. maize, sorghum, sunflower and wheat in four separate blocks. Blocks were 39m by 48m which contained 12 plots (each 12m by 13m).

The demonstration plots employed a semi statistical design consisting of 2 treatments with 3 repetitions. The treatments were essentially the same as those the on station trials.

Measurements Made

Climate measurements were made by means of an automatic weather station for the Glen sites. Rain gauges were used for the demonstration plots situated between Excelsior and Thaba Nchu. Neutron Water Meter (NWM) was made for each of the soils. Runoff measurements on 3m by 20m log run off plots on each of the Glen ecotopes using an automatic tipping bucket. There were two separate run off plots to represent the two different tillage arrangements.

Conclusions

The results of the experimental were that WHB in the long term produced average yields increased as compared to TST. A 50 per cent increase could be expected from maize and sunflower on the tested ecotopes. Furthermore of the success of the WHB technique essentially depended on suppressing water loss and evaporation from the soil surface in a reliable way, and type of crop chosen.

The two young stars underwent in service training and as a result are able to prepare harvesting/ basin tillage plots, plant maize (and sorghum, sunflower, and wheat) by hand, among other things. They were registered (in 1998) at Damelin Correspondence College to improve their grade 12 results. Although their marks were not good at the end of that year, they were accepted into a Diploma course in Agriculture Management at Technikon SA.

On the transfer of technology for developing farmers' front, two decisions were made. The first was to keep the demonstration plots between Excelsior and Thaba Nchu running to demonstrate the impressive yields as a result of the WHB techniques. Information days were organised on the demonstration plots and Glen experimental site. These information days catered for 20 to 30 people at a time. Their purpose was to show up close the produce at the peak of it growth and of course to explain the technique to developing farmers. Once the crops had been reaped, they were shown -by extension officers of the Free State Department of Agriculture- at gatherings organised at Thaba Nchu and Bosthabelo.

Estimation of Rainfall Intensity for Potential Crop Production on Clay Soil with In-field Water Harvesting Practices in a Semi Arid Area
WRC Report No. 1049/1/02
Department of Soil, Crop and Climate Sciences
The University of the Free State
February 2003

Background
One of the recommendation of a Water Research Commission report (Report No. 878/1/100) – prepared by the Institute for Soil, Climate and Water – was that detailed rainfall intensity runoff studies should be conducted to try and quantify risk different crop production techniques. This report follows up on this and tries to achieve this.

Aim of the Report
Rainfall intensity data is essential for planning purposes for agricultural development programmes and in particular food security. It is important to establish appropriate relationships between precipitation and runoff amounts using statistical techniques, this assists in predicting runoff for water harvesting in micro-catchments to stabilise food production. As a result the aims of this report are:

- To do statistical analysis of rainfall intensity and runoff data
- To test the various theoretical relationships particularly those previously identified as good in South Africa
- To generate rainfall intensity data from the historic record of daily rainfall, at selected benchmark ecotopes, and therefore the expected amount of runoff
- To conduct a risk analysis of water harvesting techniques at selected sites using a climate crop model.

Rainfall and Runoff Analysis
Rainfall event is defined as a continuous precipitation without a dry moment, separated by a length of time (usually less than 3 hours). Critical duration is the duration that separates events from preceding and succeeding rainfall. Rainfall intensity is the rate at which rain falls per unit of time. Rainfall intensity is measured using automatic recording instruments (such as tipping bucket and siphon type of rain gauges).

Rainfall-runoff process is defined as water which travels over the ground surface to a channel. Runoff is expressed in terms of volume per unit of time. There are several factors that affecting runoff: 1) long term relationship between the amount of water gained in the catchment area (due to rainfall) to the amount of water loss in that catchment area (evapotranspiration); 2) structure of the catchment area (choice is affected by the prevailing climate regime); 3) the duration of the run off especially in low lying areas; 4) ecotope (that is, topography, geology, soil, vegetation, etc.).

Rainfall intensity (includes peak rainfall intensity, event rainfall amount, rainfall duration, and daily rainfall amount) data at Glen (1992- 2001) was used for statistical analysis. This was compared to rainfall intensity data at Bloemfontein (1962-1992) and rainfall intensity data at Pretoria (1966-1996). The data from the Glen, Bloemfontein and Pretoria weather stations was found to be similar. The relationship between peak rainfall intensity to event rainfall was found to be similar at Glen and Bloemfontein. Pretoria was different. Overall it was found that it was not possible to use conventional statistical techniques (linear regression) to estimate rainfall intensity. This was due to seasonal variability in rainfall intensity (higher peaks during rainy seasons, conversely lower peaks during on rainy seasons).

Rainfall intensity Models

Four methods were used to estimate rainfall intensity-runoff:

- The area under rainfall intensity curve method → daily runoff estimation
- Stepwise generation techniques (with surface data)→ rainfall intensity estimation
- Artificial Neural networks (with meteorological satellite data)→ rainfall intensity estimation
- Stochastic rainfall intensity modelling→ daily runoff estimation

The rain intensity curve provided acceptable daily runoff estimation from daily rainfall than the simple linear regression model. Stepwise regression technique showed no relationship between rainfall intensity and other meteorological factors. The artificial neural networks model found strong relationship between rainfall intensity and wind speed at 700hPa however it was necessary to improve data generation based on the artificial neural networks model. The stochastic rainfall intensity model was reasonable in generating the amount of daily runoff.

Rainfall – Runoff Yield Simulation

Three run off models were used as inputs to the Putu Growth Model (Putu is used for risk assessment for maize yield under different scenarios – water harvesting/basin tillage/no till/mulching (WHBM) and total soil tillage). Input runoff models used include the Putu runoff sub model, area under the rainfall intensity curve model, and a combination of an empirical deterministic rainfall intensity model by Morin and Cluff (1980) and the stochastic rainfall intensity model.

The results of the Putu Growth Model found that the lower the initial soil water content at planting, the greater the yield difference between the water harvesting/ basin tillage/ no till/ mulching (WHBM) and total soil tillage. With low soil water content the WHBM yielded 50 per cent more than conventional total soil tillage production technique.

PUTURUN: A Simulator for Rainfall with In- Field Water Harvesting
WRC Report no. KV 142/03
Department of Soil, Crop and Climate Sciences
The University of the Free State
March 2003

This report builds on Water Research Commission Report No.1049/1/02. In that report it was recommended that a complete computer simulation model for long term crop production risk with different production techniques (water harvesting and conventional total soil tillage), be built. The PUTURUN Model – a simulator for rainfall-runoff – yield processes with in-field water harvesting – was the result.

A comprehensive simulator for crop yield was build by combining rainfall-runoff processes to the crop model. The simulator is user friendly and is available to crop scientists, soil scientists, agrometeorlogists and agronomists who are not computer literate.

The PUTU (which means maize porridge in Zulu) crop growth model was developed by Prof J.M. de Jager of the Department of Agrometeorology, University of the Orange Free State. Conditions under which the model was developed were semi arid (South African). The model demonstrated an acceptable degree of reliability in simulating crop yields.

Included in the report are model description and a user manual (installation and simulation run).

Modelling the Water Balance on Benchmark Ecotopes ARC – Institute for Soil, Climate and Water WRC Report no. 508/1/97

Background
In Water Research Commission Reports KV 142/03 and report No. 1049/1/02 a PUTU Growth Model was developed to predict crop yield. The PUTU Growth Model uses a combination of rainfall intensity and runoff models as inputs. The PUTU Growth and DSSAT3 models were generally found to be unreliable. This report attempts to address this because of the importance of this model in making land use decisions. The study took place over the 1993/94, 1994/95 and 1995/96 seasons.

Aim of the Report
The aim of this project was to try and improve the reliability of crop models currently used in South Africa – especially their water balance subroutines – and then to use them to make long term predictions to quantify risk – in a more reliable way. Succinctly the aims of the project were:

- To obtain data over a three year period at eight benchmark crop ecotopes, and then to test and adapt the selected crop models so that they are capable of making reliable long term predictions of the water balance and crop yield.
- To use the improved models together with long term climatic data to obtain, for each benchmark ecotope:
  Long term cumulative distribution functions of yield to assist with quantifying risk
  Long term predictions of runoff and deep drainage to provide surface and subsurface hydrological information
- To accumulate knowledge about how to adapt crop models to give reliable results for ecotopes with a wide range of characteristics.

Brief Description on Benchmark Ecotopes
Setlagole/Clovelly: situated in semi arid area close to the edge of the Kalahari.
Main crops are maize, groundnuts and cotton. Soil is brown and sandy.
Wolmaransstad/Hutton: possess red textured shallow soil. Climate is slightly less arid than in Setlagole.
Kroonstad/Avalon: climate is between semi arid and sub humid. Rains early in the season followed by dry months.
Bethal/Hutton: climate is sub humid with deep, red and medium to fine textured soil.
Bethal/ Avalon: similar characteristics to Kroonstad/Avalon ecotope, but somewhat wetter.
Ermelo/longlands: sub humid climate. Water-logging is the main limiting factor fro maize production.
Bulfontein/Clovelly: semi arid climate. Deep yellow brown sandy soil. Wheat and maize are grown successfully in the area.
Petrusburg/Bloemdal: semi arid climate. Sandy, red brown soil. Too dry for dry land maize production, however wheat can be grown – especially with long fallow

The first six are maize ecotopes and last two are wheat ecotopes. The benchmark ecotopes were chosen because they represent a wide range of ecotope characteristics. **The first name in is the geographical name of the place, and the second is the classification of the South African Soil Classification System.**

The Procedure

Measurement (accurate) of evaporation from the crop, precipitation, water extracted from the root zone, evaporation from the soil, Runoff and deep drainage, were taken from the benchmark ecotopes in order meet the objectives of the project. Climatic variables needed for the crop models were measured with automatic weather stations at all the ecotopes except for Setlagole/Clovelley (rainfall was measured by the farmer).

Water extracted from the root zone was measured by neutron water meters. Runoff was measured with automatic tipping bucket runoff meters. Deep drainage was estimated from drainage curves. Grain yields were measured at the end of each season. Evaporation from the crop is closely related to crop yield, making the above procedure adequate to test the performance of the crop models.
Risk assessments were conducted by means of predicted cumulative yield probability functions (same as cumulative distribution functions).

Model Testing and Adaptation

Model testing and adaptation of the DSSAT3 (MAIZE) model was conducted by M. Prinsloo and A. Du Toit of the Grain Institute. PUTU (MAIZE) model was adapted and the PUTU (WHEAT) models was conducted Prof. A. Singles of the Department of Agrometeorology (University of Orange Free State). Adaptations on DSSAT3 still had to be done.

Experiment

Experiments run on the benchmarks ecotopes include single plot, farmer's plot, and a randomised block. The treatments consisted of three populations (15000, 30000 and 45000 plants per hectare). On these experiments water balance measurements were also taken.

Conclusions and Recommendations

Collection of data on water balance and yield data was collected (over the three seasons). However runoff data was a bit more difficult due to instrument failure and long distances to testing sites (benchmark ecotopes).
Comparisons made between the measured and simulated results revealed the following weakness in the crop models which need to be addressed:

- A lack of a subroutine to deal with water logging in maize ecotopes.
- The lack of a subroutine for the absence of secondary roots in wheat.
- Inability of PUTU to predict high yields in certain ecotopes.
- Excessive maize root water extraction rate frequently simulated by DSSAT 3 during the last part of the growing season.
- Unsatisfactory runoff subroutines for both models.
- Unsatisfactory stress prediction subroutines, especially in DSSAT 3.
- The lack of subroutine to cater for lateral water movement in the root zone.
- The long term cumulative distribution yields computed needed to be improve (model reliability) before they could be used reliably. The same applied to long term predictions for runoff and deep drainage.

On the positive side, great experience as result of the wide range of ecotopes studied especially with regard to the functioning of water balance processes, how to measure them and their long term influence on soil, chemical and morphological characteristics on these ecotopes.

Water Conservation Techniques on small plots in semi arid areas to enhance rainfall use efficiency, food security, and sustainable crop production
WRC Report 1176/1/03
ARC Institute for Soil, Climate and Water
Department of Soil Science, Department of Agricultural Economics, Department of Sociology (all departments from the University of the Free State)

Background
Food security is essential in the livelihoods of all and for many in rural areas of South Africa food security is threatened by water scarcity. Therefore there is a serious for rain water management skills in order to improve efficiency. Rain Water Harvesting (specifically in-field water harvesting) provides a solution to this problem through a range of innovative farming techniques.

This project was earmarked for a large area east of Bloemfontein; in particular the large population that resides between Thaba Nchu and Botshabelo. This area is subject to erratic rainfall and as a result it has marginal crop production. The project ran for the 1999/2000-2001/2002 growing seasons.

Aim of the Project
- To study quantitatively within field rain water harvesting (IRWH) system, different combinations of mulching techniques aimed primarily at reducing evaporation from soil surface, soil fertility aspects with focus on nitrogen, and sustainability of the system.
- To develop capacity of three previously disadvantaged technical assistance.
- To transfer the technology to developing farmers and to the Department of Agriculture.

The Experiment
Four experimental plots were set up in the Glen/ Bonheim ecotope (i.e. A, B, C and D blocks).A and B were statistical design experimental plots, while C and D were semi statistical experimental plots. An on farm demonstration plot was set up in Thaba Nchu. Maize, sunflower and dry beans were grown on the plots.

On the experimental plots four different IRWH systems and conventional tillage were compared in the field experiments at Glen and on farmers' fields in Thaba Nchu. The were four IRWH treatments : 1) organic mulch in the basins with bare runoff(ObBr); 2) organic mulch in the basins with organic mulch on the runoff area(ObOr); 3) organic mulch in the basins with stones on the runoff area(ObSr); and 4) stones in the basins with organic mulch on the runoff area(SbOr).

A Crop Yield Stress (CYP-SA) model was developed to predict long term yields, and this in conjunction with the measurements taken over the three seasons revealed that IRWH produced higher yields. On all the ecotopes, organic mulch with stones in the runoff area was found to be the best technique.

Precipitation Use Efficiency (PUE) Measurements

PUE was measured on the on station experimental plots (A and B). The mean values of PUE for maize indicated that the ObOr and SbOr were more efficient in converting rainwater in staple food than ObBr. For sunflower, SbOr was slightly better than ObBr treatment.

On the C and D PUE was proved to be the highest on SbSr treatment, followed by ObBr, with conventional tillage being the least productive.

Sustainability of Productivity

Sustainability of productivity encompasses agronomic productivity, a reduction on the level of risk, conservation of natural resources, economic viability and social acceptability. The results showed that IRWH increased crop yields significantly compared to conventional tillage. The CYP-SA crop model was used to construct long term yield simulations to quantify risk. The results indicated that ObBr was the best treatment in terms of low risk, followed by SbSr, ObOr and SbOr. Conventional tillage had the highest risk probability.

On conservation IRWH system stopped runoff and hence soil erosion. Carbon cycle process is influenced by conventional tillage, causing it towards a lower equilibrium with long term cultivation. IRWH treatments have the potential to be more beneficial for carbon conservation than conventional tillage.

The CPY- SA model was used to construct two enterprise budgets (one for IRWH and the other for conventional tillage – on the Glen ecotope) for an 81 year period. Rands per hectare calculations showed that (for the three crops) over the long term IRWH provided greater profit margins than conventional tillage.

Specific social indicators were used to monitor social acceptability of IRWH. The indicators included the following: community mobilisation, capacity building, empowerment, human well being, self reliance and community participation. All these indicators revealed that there is a strong movement towards building and active learning process amongst small farmers.

Development of the three technicians

Mr D. Thuthani, Mr. E. Sebolai and Mr. D. Thamae were part of the 1997-1999 WRC project. Then they received in service training – in which they excelled. They were also registered for at Technikon SA for academic training. Sadly they did not perform well in academia. Regardless they have been an asset and will continue to play a vital role in the future success of IRWH in rural areas.

Technology Transfer

Technology transfer was done effectively as a result of the demonstration plots and information day organised by the Department of agriculture officials and the owners of small areas of land.

Recommendations

Farmers

Farmers should adopt IRWH (with mulch) because of its higher yield, and they should plant later in the season.

Administrators and Policy makers

The development of formal educational material for primary, secondary and tertiary institutions needs to be addressed. Technology exchange and training (concerning results) should take place in the future. Future focus should rest on the development of croplands in rural villages into sustainable enterprises.

Researchers
Other was to reduce evaporation should be investigated. Future research is needed regarding the introduction a permanent crop into IRWH. In depth study to determine the economic viability and socio acceptability of different treatments used in the study, needs to be conducted.

Predicting the impact of farming systems on sediment yield in the context of integrated catchment management
WRC Report No. 1059/1/03
Agricultural Research Council in association with the University of Natal
December 2003

Background
Historically loss of top soil and, agricultural potential and reductions in reservoir storage were associated with erosion. However, lately, off site (water) sedimentation has become increasingly a significant factor contributing to erosion. Therefore the current sentiment is that erosion control should incorporate both on site erosion and off site sedimentation conservation initiatives. Models that predict (with some degree of confidence) the on and off site impacts of agricultural practices and the impact of erosion control measures, are essential.

Aim of the Report
The overall aim of this report is to verify the performances of selected models in predicting the impact of farming practices on sediment yield on the small catchment scale in order to ascertain the degree of confidence with which on and off site agricultural practices and erosion control measures can be predicted using selected models.
Therefore the objectives of this report are:

- To improve international and South African methodologies for predicting the impact of selected land uses on sediment yield in local catchments.
- To assess the impact of communal grazing, communal cropping, commercial grazing and pristine area on sediment yield.
- To asses the impact of quality, availability of spatial distribution of input data on the accuracy of sediment yield prediction results

Integrated Catchment Management (ICM)
ICM represents a systems approach to the management of natural resources within the bounds of the geographical unit that is based on the catchment area. It views components of the hydrological cycle as intimately linked to one another.

Study Sites
There were three study sites: Weatherley and Zululand research catchments and Kokstad research site. Weatherley is situated near Umzimvubu in the Eastern Cape. The topography in Weatherley is simple; however it has a complex soil pattern. The Zululand catchment is located in the Ngoye hills near Empangeni. The foot slopes and valley bottoms in Zululand are most susceptible to because of

the storm flow generated through runoff from these areas. Kokstad Agricultural Research Station is on the eastern coastal escarpment of South Africa. The geology mainly consists of grey, green and brownish red mudstone and yellow, grey fine grained sandstone.

Selected Models
The two models selected for verification were The Water Erosion Prediction Project (WEPP) erosion model and the Agricultural Catchment Research Unit (ACRU) modelling system. WEPP was developed by the United States Department of Agriculture and ACRU was developed the School of Bio resources Engineering and Environmental Hydrology of the University of Natal.

Results and Discussion
Model Verification
Model verification was conducted in the follow way:

- Simulated evapotranspiration was compared to that of measured using the Bowen Radio Technique over a stretch of grassland in the Weatherly catchment.
- Soil water content status was compared to that measured using a neutron probe as well as that converted from tensiometer measurements at selected soil profiles soil profiles.
- Simulated and observed runoff responses the catchment outlet were compared.
- Simulated sediment yields were compared against those derived from runoff related concentrations of suspended solids discharged at the catchment outlet.

Conclusions
The study showed that sediment yield models that ignore soil saturation encountered at the of the foot of the hill slope due to saturation excess overland flow may well fail to predict important erosion features within a catchment.
The intensity of the rainfall event is significant in determining the resulting sediment yield, particularly in small catchments.
Neither WEPP, nor ACRU were designed to take account of the head cut erosion, sloughing of gully sidewalls and pipe erosion, among others.
The focus of sediment yield predictions at the small catchment is to evaluate the severity of erosion under different management systems and may be intended as design tools for the selection of conservation practices.
WEPP is a powerful tool in predicting the impact of agricultural practices scenarios.
Both WEPP and ACRU models (adapted version of ACRU specifically for the project) predicted a small increase in sediment yield when land in a pristine condition was utilised fro animal production. A dramatic increase was predicted when rangeland was converted into arable land.

Socio-Economic Study on Water Conservation Techniques in Semi-Arid Areas
WRC Report No. 1267/1/04
Department of Agricultural Economics and Sociology, University of Free State
July 2004

Background
In a Water Research Commission Report (Report No. 1176/1/03) the Institute for Climate, Soil and Water developed the in-field water harvesting technique (at Glen Research Station). This technique was found to be more successful than conventional techniques. This report aims to assess the social and economic impacts of this technique on the community of Thaba Nchu.

The infusion of new technologies on communities is likely to enhance material well being, however this can only happen (in sustainable manner) if there is acceptance of new technologies at no material level (that is, it is in harmony with the beliefs, norms and values of that particular community). Such an acceptance is vital in ensuring the success of any project that involves human beings.

Aim of the Report

With the aforementioned in mind, the objectives of report were:

- To develop and appropriate methodology for assessing social acceptability and for guiding the transfer of new technologies and production practices to small farmers.
- To assess the economic viability of in-field rainwater harvesting techniques with potential applicability to semi arid areas.
- To assess the sustainability of the new production systems based on water harvesting practices, in terms of its impact on the physical environment, its affects on farm incomes and economic contribution to the local communities, and on the social well being of the people.
- To develop a simulation model as an extension tool that will enable agricultural researchers and extension to determine the impact of profitability, risk and resource use requirements when there are some changes to some of the farm management variables of the in-field rainwater harvesting systems.

Social sustainability of IRWH

Two participatory tools were used in assessing social sustainability: Participatory Action Research (PAR) and Participatory Rural Appraisal (PRA). Both of these methods promote community participation in the research and use of new technologies- a bottom up participative approach. PAR, for example, is characterised by the principle of self development, direct research that is directed at practical problem solving, amongst others. While the application PRA has been likened to sentiments such as total well-being, opportunities for creativity, possibility of self realisation and the possibility of self inspiration exist. PAR and PRA techniques allowed women, youths and even the poorest members of the community to in the process, without fear of intimidation.

Participation included farmers selecting their own management to assist in managing the trial plots and farmers being actively involved in the trial plot processes (gaining practical skills), all of this directed toward ensuring that the project continues after the research was completed.

Economic Sustainability of IRWH

An index growth in total factor productivity which took into account the changes in the levels of input use (including changes in the natural environment) can be used in determining economic sustainability. Different indices also can be used to achieve the same objective (for example that combines input use and growth in output).

This report calculates the net present value (NPV) of changes in income (output) was compared to the NPV of changes in costs (inputs) over a period of 15 years. Obviously this was a simulated exercise.

Riskiness of production (IRWH) was calculated using cumulative distribution functions (CDFs) of farm income using projected data.

It was generally found (after the economic analysis) that IRWH showed much higher levels of profitability than conventional tillage technique.

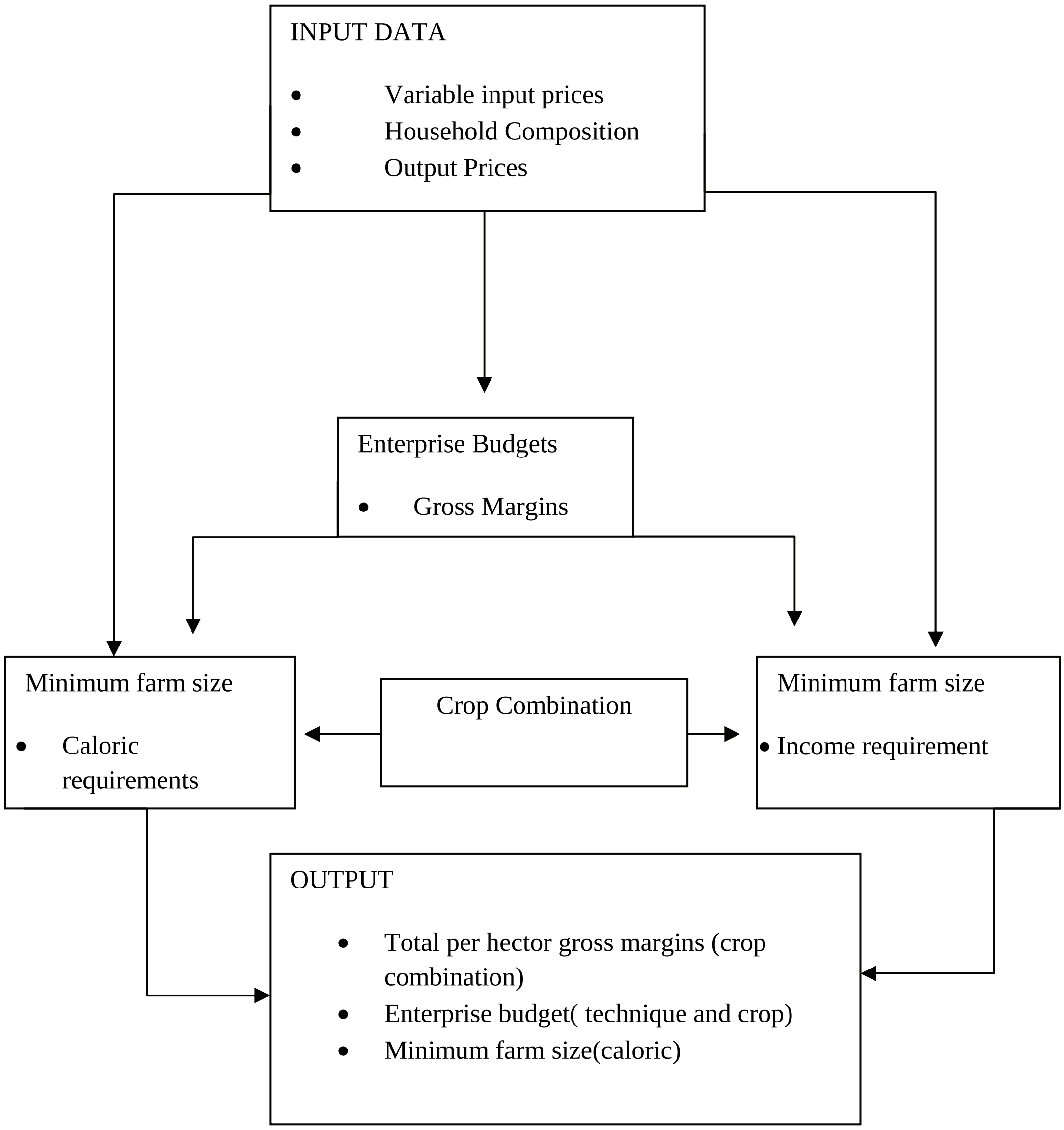
Environmental Sustainability of IRWH

The natural environment is a crucial input in farming and it vital the natural environment be utilised in a sustainable manner. IRWH increases water availability for crops on farmers' fields. In cases were IRWH is used with mulching, soil erosion is reduced since run off is also reduced. IRWH also allows intense use of farm lands without any damage; whilst concurrently enabling farmers to over come moisture constraints.

IRWH Economic simulation model

This model was developed to calculate minimum farm size, total gross margin from crop mix, then determines enterprise budgets for crop and production technique, when a specific variable is changed.

Figure: Schematic Diagram of the Economic simulation model



Research Impact Assessment: lessons to be learned from cost benefit analyses of WRC research projects
WRC Report no. TT226/04
Conningarth Economists
September 2004

Background

The Water Research Commission (WRC) was founded in 1971 under the Water Research Act of No.34 of 1971. Owing to the fact water would be one of South Africa's limiting factors in the future, the WRC was formed to promote and build new knowledge on water use efficiency. Funding of the WRC is received from the Department of Water Affairs and Forestry.

The current WRC focuses are: 1) water resource management; 2) water linked ecosystems; 3) water use and waste management; 4) water utilisation in agriculture; and 5) water centred knowledge.

To achieve the above mentioned objectives the WRC focus on key strategic areas, and these are: 1) promoting co-ordination, co-operations and communication in the area of water research and development; 2) establishing water research needs and priorities; 3) stimulating and funding water research according to priority; 4) promoting effective transfer of information and technology; and 5) enhancing knowledge and capacity building within the water sector.

It therefore becomes necessary to evaluate the WRC on the achievement of its objectives (since it is part of the broader public sector). There are two broad areas of assessment: social impact of the projects undertaken and their cost effectiveness.

Aim of the project

This project aimed to achieve the following:

- Determine the economic contribution of selected WRC Research projects.
- Salient features of the impact of the selected WRC research projects.
- Synthesis of positive and negative factors enabling the WRC to identify appropriate WRC projects in future.

A sample of six projects was chosen for the study: 1) ACRU Model development; 2) Hydro salinity System Models; 3) Surface Water Research of South Africa; 4) Biological Nutrient Removal; 5) Dry Cooling in Power Generation; 6) Combined Services Model.

Methodology

Cost Benefit Analysis (CBA) was used to assess the selected projects. Essentially CBA is a comparison of cost and benefit that accrue from a specific project. Logically a project that produces more benefit than costs would then be regarded as successful.
The first step in CBA is to establish a scenario analysis – identify the economic sectors and communities that will be affected. Then a study of the benefits and costs associated with the project (under investigation) are studied and monetary values are assigned to them. Lastly, present values are used as assessment criteria. Present value measures used are: 1) Net Present Value (NPV); 2) Economic (or Internal) Rate of Return; and 3) The Discounted Benefit- Cost Ratio.

Salient Features of CBA analyses
The six models were assessed in terms of how the meet the WRC objectives (mentioned above). It was generally discovered that the WRC projects selected achieved the WRC objectives. This is (for an example) a summary of the economic viability of the six selected projects.

Table: Present value at 8%, R millions

Project, 1999 economic prices	**Cost of research**	**Benefits**	**NPV**
ACRU Model Development	16.9	117.9	101.0
Hydro salinity System Models	4.5	16.8	12.3
Surface Water Resources	5.7	34.4	28.7
Biological Nutrient Removal	0.5	163.0	162.5
Dry Cooling Power Generation	14.4	558.3	543.9
Combined Services Model	0.4	146.1	145.7
Total	**42.4**	**1036.5**	**994.1**

The above table clearly demonstrates the economic viability of all the WRC projects.

Lessons for Future WRC Research Projects
Although the study was limited to only six WRC projects, the researchers felt confident about the sample being representative of the population. Furthermore the project did not study (limited by the brief) the WRC institutional performance levels such as technical soundness of the research processes and outputs, financial management, etc.
Despite these limitations lessons can be drawn for future research projects, from this analysis. These are that:

- WRC research outputs have made a significant contribution to improving the economic welfare of South Africa.
- That the growing importance of research projects dealing with water conservation and demand management is in line with the WRC' strategic focus and the government's development prerogatives.
- Agriculture remains the largest water use and therefore requires that a substantial amount of resources still be devoted to research activities that would promote more efficient use of water for irrigation purposes.
- Research into new technologies and the transfer thereof to the operational level provides handsome dividends.
- The projects in question show that proportionally larger benefits can be obtained from research directed at reducing operational costs.

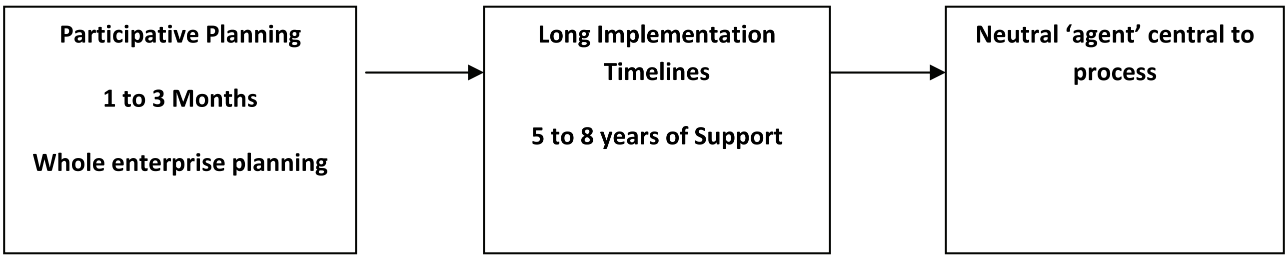
Principles, Approaches and Guidelines for the Participatory Revitalisation of Small holder Irrigation Schemes
Volume 1 → WRC Report TT 308/07: A Rough Guide for Irrigation Development Practices
Volume 2→ WRC Report TT309/07: Concepts and Cases
March 2007

WRC Report TT 308/07 and WRC Report TT309/07 deal with the same topic (the revitalisation of smallholder irrigation schemes). WRC Report TT 308/07 is focused at the practitioner, as a quick reference. WRC Report TT309/07 is a theoretical rationale for the guidelines based on field research. The two are therefore combined.

Background
Smallholder irrigation schemes in South Africa are common practice. However most operate well under potential and are characterised by: 1) underutilisation of land; 2) underutilisation of water; 3) under production; 4) land conflict and policy mis-focus; 5) weak institutions; 6) degraded infrastructure; 7) poor intergovernmental relations. As a result the Water Research Commission has developed a set of rough guidelines to address some of these challenges. To build a bridge to transformation of the current schemes; to those characterised by profitability, land trading, mix of farm enterprises, functional infrastructure, farmer involvement and increased production. These guidelines were developed for Department Officials (Agriculture, Land Affairs, etc), District Municipal Officials, Irrigation Scheme leadership and Constants.

The Guidelines
Policy
Policies play a critical role as a starting point for revitalisation. Provincial policies (revitalisation) are characterised by capital expenditure and infrastructure development and rely heavily on the concept of commercial partnerships. Provincial policies need to be reviewed to accommodate a much wider range of solutions because of widely differing technical, social and historical situations of the schemes. The adaptation of provincial policies would bring them closer to meeting the needs of irrigation schemes.

Revitalisation Process
Figure: The Revitalisation Process



Feasibility Planning
The feasibility planning process in a nutshell includes: 1) resource evaluation; 2) consultative planning of a range of agricultural enterprises and support interventions; and 3) cost benefit analysis of options that lead to change.

Land exchange Strategy
As mentioned above, land on smallholder irrigation schemes is currently not being fully utilised. This is as a result of (inter alia) of the high risk nature of farming in unregulated market environment, low profitability and difficulty gaining market access and lack of motivation to risk available capital.
A strategy is set out in the guide lines which essentially give plot-holders (who are not farming) two options – either lease to farmers consolidating large holdings or commercial agri-business. The entire process underpinned by contract and marketing arrangements.

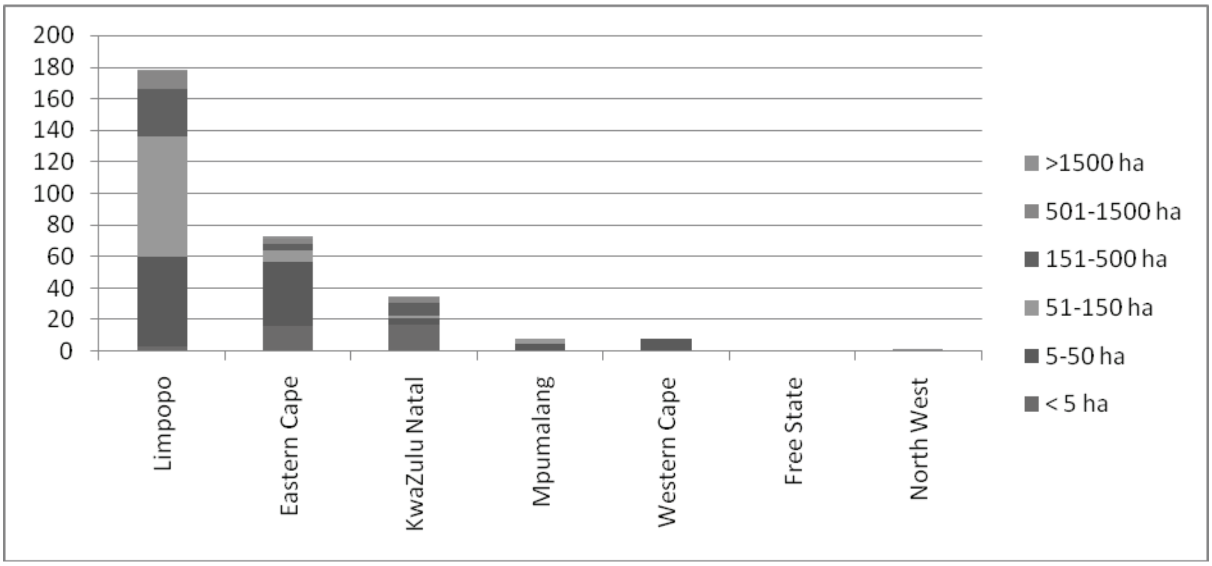
Five Key Areas in the Development of Guidelines

The guidelines were developed over a period of 3 years and the main focus areas over this period were:

Compilation of a National Database

Schemes included in the database included schemes developed in the former homelands, schemes initiated by previously disadvantaged farmers and Schemes that are 5 ha in size. Limpopo has the highest number of schemes (183) and the North West (the lowest) with 3 schemes. The irrigation types include flood, overhead sprinklers, centre pivot and a drip. North West, Free State, Western Cape, Mpumalanga and KwaZulu-Natal all use a combination of the irrigation types, but Limpopo and Eastern use all the types of irrigation.

Figure: Number of Schemes and Size Distribution by Province



Field Research and detailed documentation

These include current and recently completed programmes. Programmes include the Limpopo Revitalisation Programme, Limpopo WaterCare Programme and a number of initiatives in the Eastern Cape that were funded by the Department of Water Affairs and Forestry and the Eastern Cape Department of Agriculture.

Action Research in Participative Irrigation Planning

This lead to the development of a clear, stepwise and time efficient technique called ICON (Iterative Consultative) Approach. ICON maximises the two way transfer of expect technical knowledge from the intervention teams to the community members. Central to this approach is the presumption that the best solutions will be found by allowing the community members to fully understand the range of choices that they may wish to take, and for the intervention to inform the community members.

Comparative analysis of South African and International approaches

The key success factors of the in East African revitalisation programmes – that is, the River Basin Management and Smallholder Irrigation Improvement Programme in Tanzania and the Irrigation Performance in Africa Project in Kenya and Ethiopia. The Key success areas include a comprehensive intervention strategy; interventions which invested heavily in human capital; institutional elements and infrastructure; and land tenure strategies which facilitate a land leasing market leading to feasible irrigation landholding.

Field research into five case studies of farmer support approaches

This was done in four provinces (Limpopo, Mpumalanga, KwaZulu-Natal and Eastern Cape). The five chosen projects were: 1) Maluleke Irrigation (Limpopo); 2) Noko Development Trust (Mpumalanga); 3) Giba Community Trust (Mpumalanga); 4) Ezemvelo Farmers Organisation (KwaZulu-Natal); and 5) Tyhefu Irrigation Scheme (Eastern Cape).

The support approaches were categorised into commercial agri-business partnerships, partnerships with academic institutions and non governmental institutions. In all cases knowledge relating marketing, financing, crop production and institutional development and conflict resolution, were essential.

ANNEXURE C: FIRST SURVEY RESULTS

1 INTRODUCTION

Over the past 15 years the Water Research Commission (WRC) had funded research into the viability and practicality of various rainwater harvesting and conservation techniques in the municipal area of Thaba Nchu. The WRC is eager to know and understand the impact of the funding provided for this research to date. ASSET Research has been tasked to apply the McMaster research impact measurement tool to conduct this research. The McMaster research technique is discussed and described in a companion document under the same primary title as this one, but with secondary title: *Literature Review and Research Method Defined*.

Here we report on the application of the McMaster research impact assessment technique following a survey (see Annexure C.A for a copy of the questionnaire) conducted in Thaba Nchu during the week of 20-24 November 2007. Individual interviews were conducted by a team of three native Tswana speakers under the leadership of a Zulu/Sotho/Tswana-speaking postgraduate student of the Department of Economics, University of Pretoria. A structured questionnaire, based on a five-point Likert scale, was used. A target of 210 interviews was set and, in the end, 217 interviews were conducted.

Before presenting the results of the survey, we provide an overview of the demographic profile of the Municipality at the hand of various socio-economic indicators. Thereafter, the research method is described, followed by an analysis of the profile of the 217 respondents and their responses, with some concluding remarks furnished.

1.1 Profile of the Research Area

Thaba Nchu comprises the town itself and 42 small villages scattered around the town, mostly within 15km from the town, but also as far away as 40km. The predominant economic sector in these villages is that of subsistence agriculture. These villages are also the site of fifteen years of research by the Agriculture Research Council at Glen near Bloemfontein in the science, practice and community participation in In-Field Rainwater Harvesting (IFRWH).

Thaba Nchu resorts in the Mangaung Local Municipality. This municipality includes the city of Bloemfontein and one can, therefore, not use the municipality’s socio-economic and demographic profile to gain an understanding as to Thaba Nchu’s profile. Its profile, therefore, has to be considered on ward-level. As will be discussed below, the 42 villages were divided into clusters and 12 villages were selected for the survey as representative of the total number of villages. These 12 villages are located in two wards (Wards 38 and 41) of the local municipality. Ward 38 comprises five of the 12 selected villages, namely 1) Springfontein, 2) Rietfontein, 3) Gladstone, 4) Yorkford, and 5) Nogas Post. The remaining seven villages are located within Ward 41 and are 1) Merino, 2) Morago, 3) Talla, 4) Potsane, 5) Kgalala, 6) Thubisi, and 7) Feloane. The socio-economic and demographic profile of these two wards will now be discussed. All information was obtained from the South African Municipal Demarcation Board (http://www.demarcation.org.za), which based their data on the national census conducted by Statistics South Africa in 2001.

1.1.1 Profile of Ward 38 of Mangaung Municipality

Population

Indicated in Figures 1 and 2 is the population of Ward 38. The total number of people is 13 500 and comprises mostly young Black Africans (99%), with 62% under the age of 20.

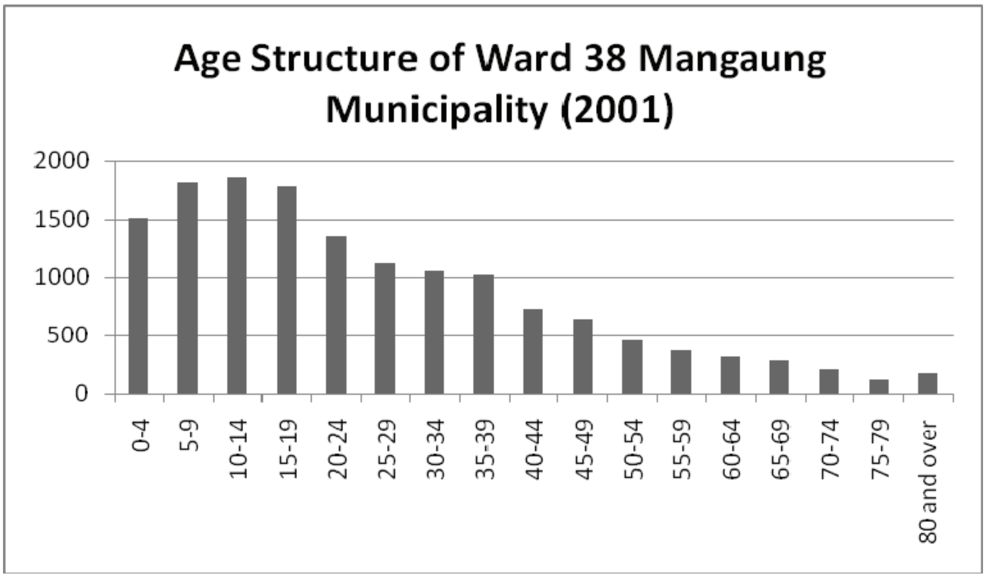


Figure 1: Age Structure of Ward 38 Mangaung Municipality

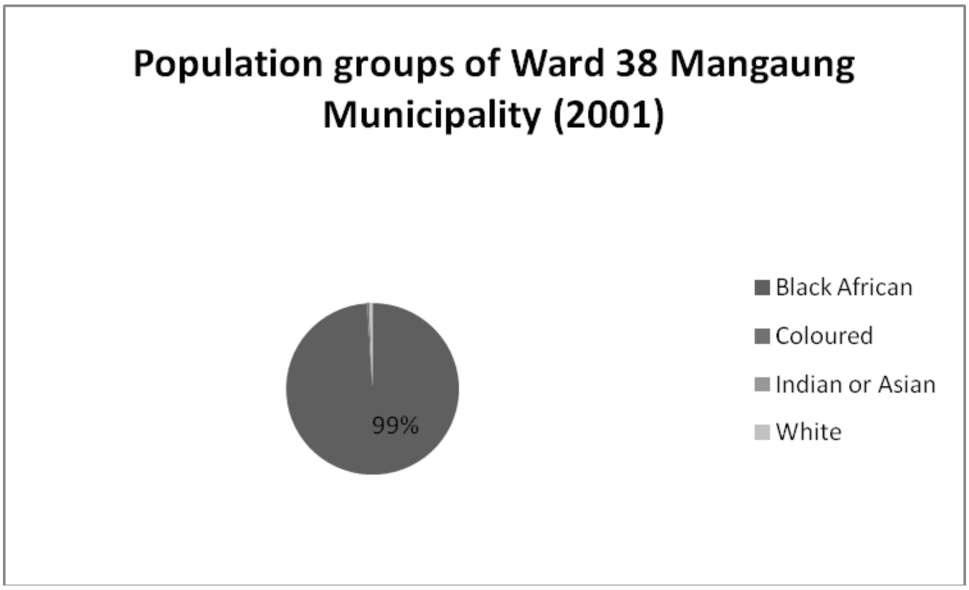


Figure 2: Population Groups of Ward 38 Mangaung Municipality

Education, household income and employment

Figure 3 illustrates that 16 per cent of the population in Ward 38 have no schooling, 29 per cent have some primary education, 10 per cent completed primary education, 32 per have some secondary education and 11 per cent completed Grade 12. It is startling to note that only 2 per cent has a post-school qualification. As indicated in Figure 4, not only does the population have limited education, but the levels of income are also very low. It is shocking to note that the largest single household income group is "no income", indicating that the majority of the population in Ward 38 have no formal income. The second largest income category is between R4 801-R9 600 per year. It is, therefore, not surprising to note, in Figure 5, that 47 per cent of the population is not economically active, 29 per cent are unemployed and only 24 per cent are formally employed.

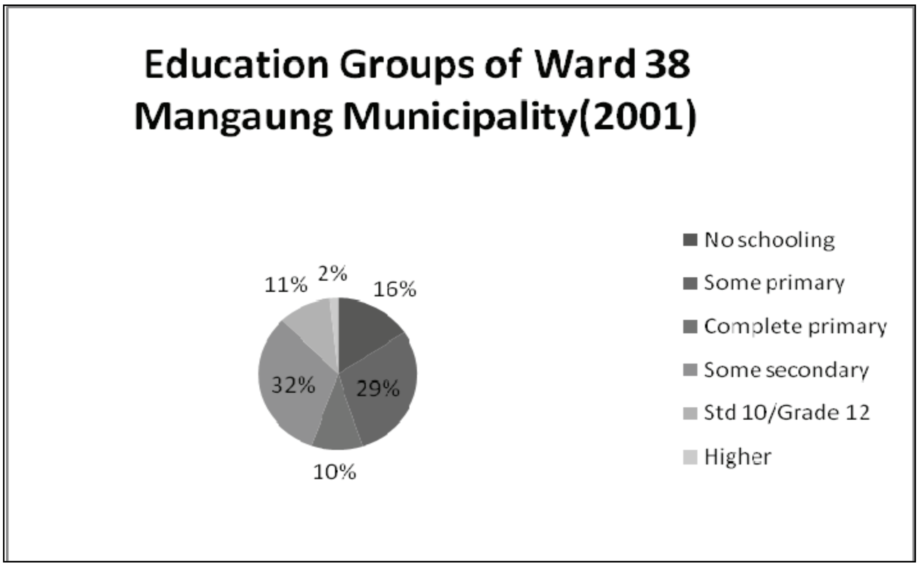


Figure 3: Education Groups of Ward 38 Mangaung Municipality

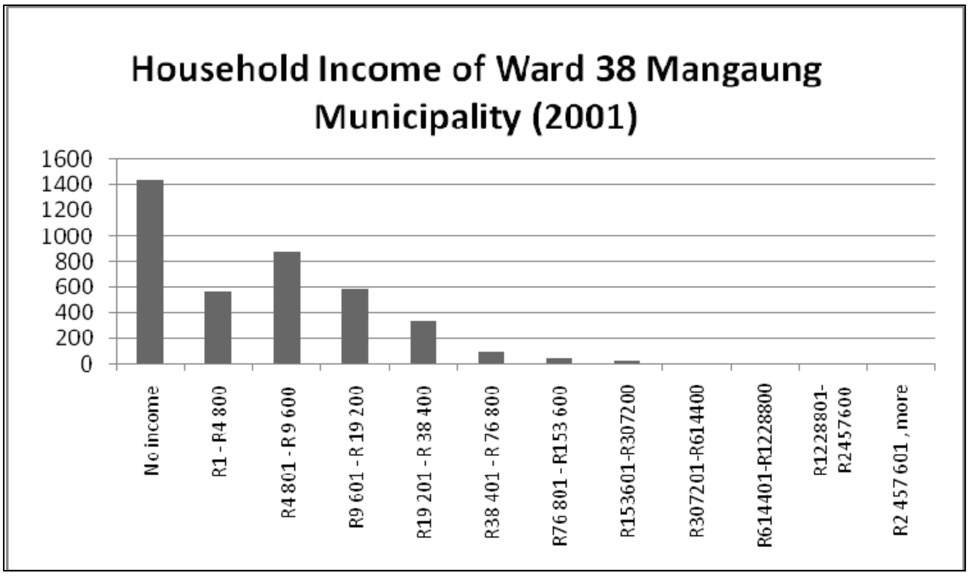


Figure 4: Annual Household Income of Ward 38 Mangaung Municipality

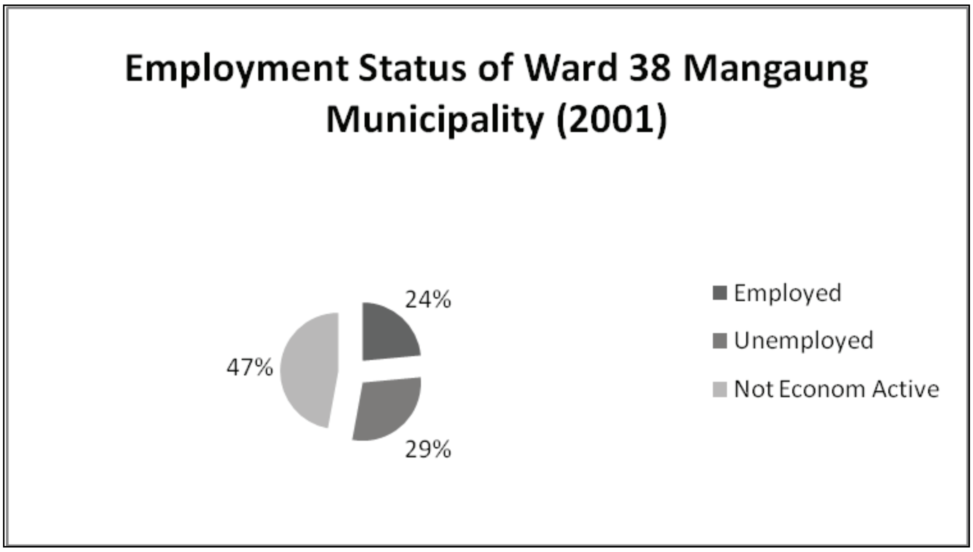


Figure 5: Employment Status of Ward 38 Mangaung Municipality

Water access and land tenure

Most households have accesses to piped water in the yard of their dwelling through a regional water provision scheme, as indicated in Figure 6. Most of the plots (51 per cent) are owned and fully paid for by the residents (see Figure 7), whereas 7 per cent is owned but not yet fully paid for. Of the total number of plots, 2 per cent is rented and 40 per cent is occupied rent free. Land tenure is therefore secure, so is water provision.

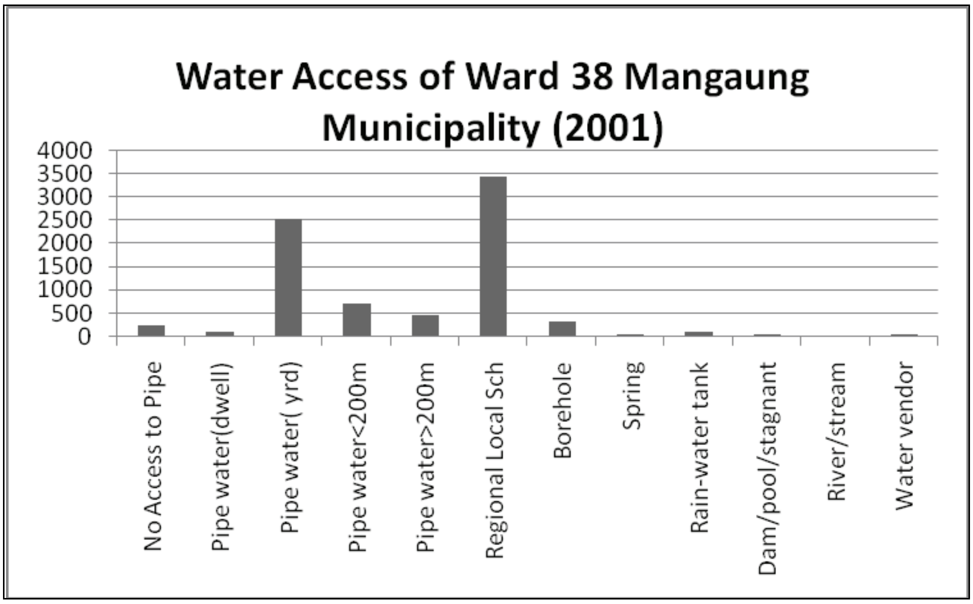


Figure 6: Water Access in Ward 38 Mangaung Municipality

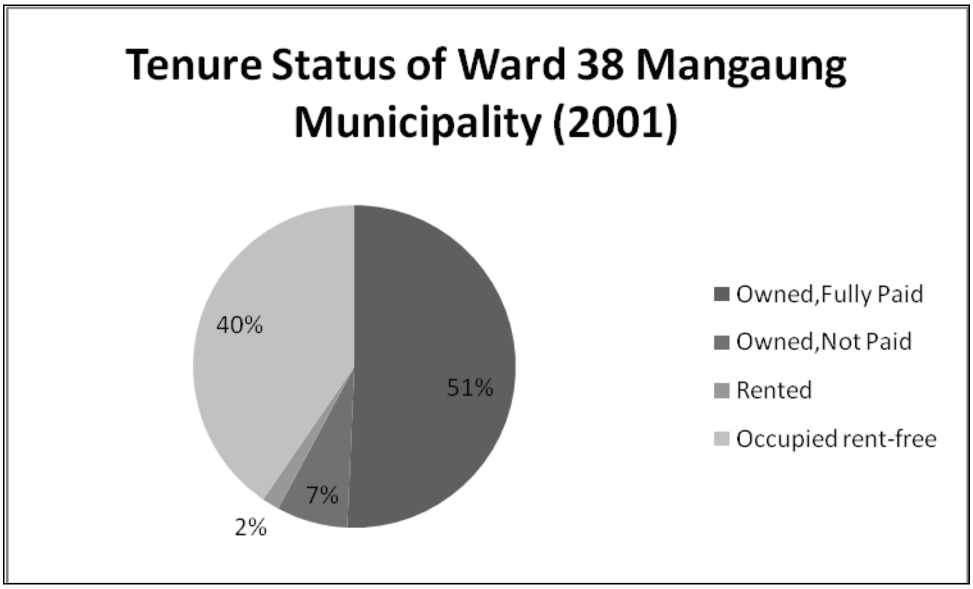


Figure 7: Tenure Status of Ward 38 Mangaung Municipality

Conclusion

Ward 38 has a largely uneducated, yet mostly young, population of approximately 13 500 Black Africans, with a very low basic income and high level of unemployment. The villages in the ward enjoy some basic infrastructure, but few opportunities to make use of it. In this context, IFRWH can do much to reduce the vulnerability of households by providing an in-kind form of income through food production and by diversifying income-generating opportunities through farming.

1.1.2 Profile of Ward 41 of Mangaung Municipality

Population

As indicated in Figures 8 and 9, most (45%) of the almost exclusively Black African population of approximately 13 250 in Ward 41, are below 20 years old. This ward's population, however, is older than that of Ward 38.

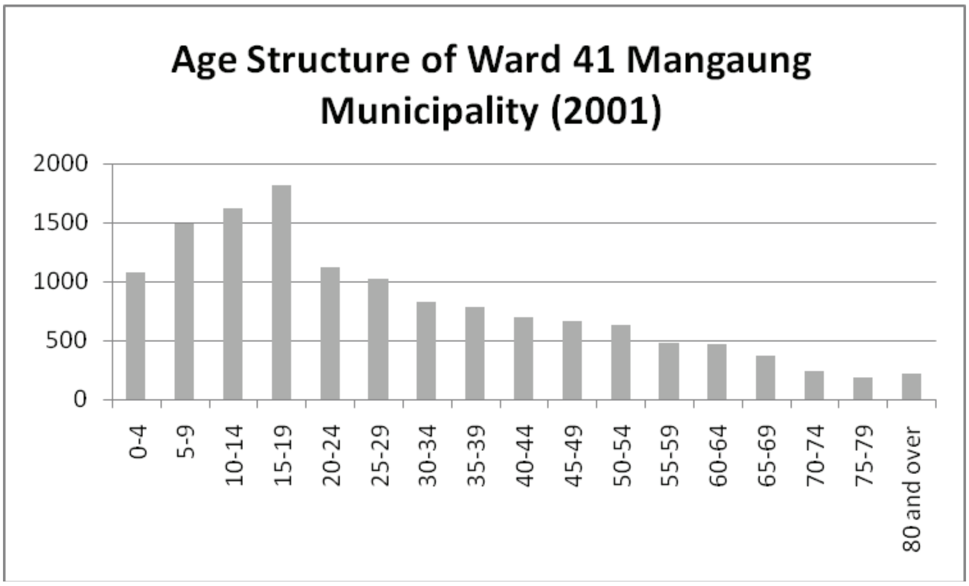


Figure 8: Age Structure of Ward 41 Mangaung Municipality

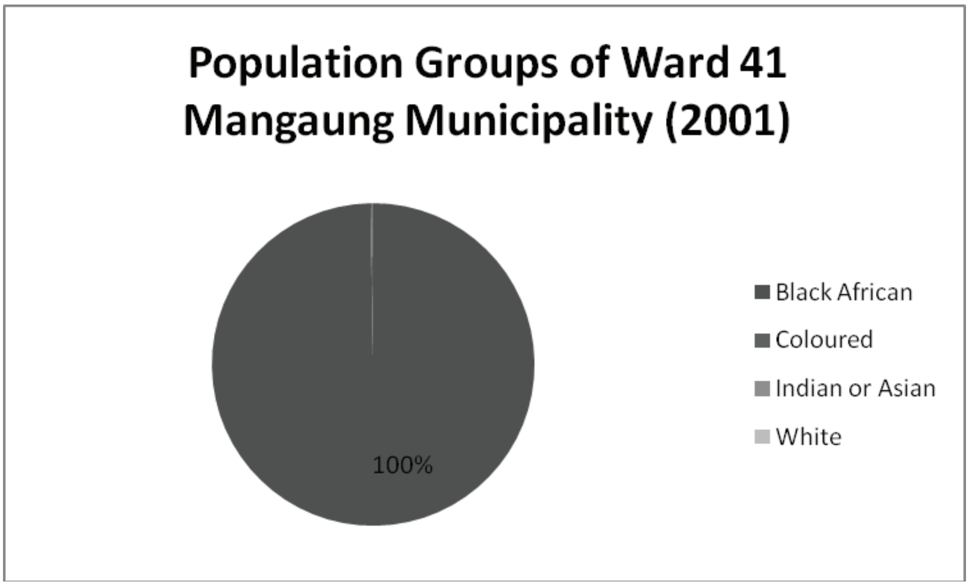


Figure 9: Population Groups of Ward 41 Mangaung Municipality

Education, household income and employment

Figure 10 shows that 14 per cent of the population of Ward 41 of the Mangaung Municipality have no schooling, 29 per cent have some primary education, 10 per cent completed primary education, 31 per cent have some secondary education, 12 per cent have a senior certificate, and only 4 per cent have a post-school qualification. The majority of the households also have no formal income – as shown in Figure 11. The rest of the households have incomes of R1-R38 400 per year with, as was the case in Ward 38, the category R4 801-R9 600 being the second largest income cluster. As indicated in Figure 12, 54 per cent of the population are not economically active, 28 per cent are unemployed and only 18 per cent of the population have formal employment. It is, therefore, a predominantly unemployed, poor, young and uneducated community.

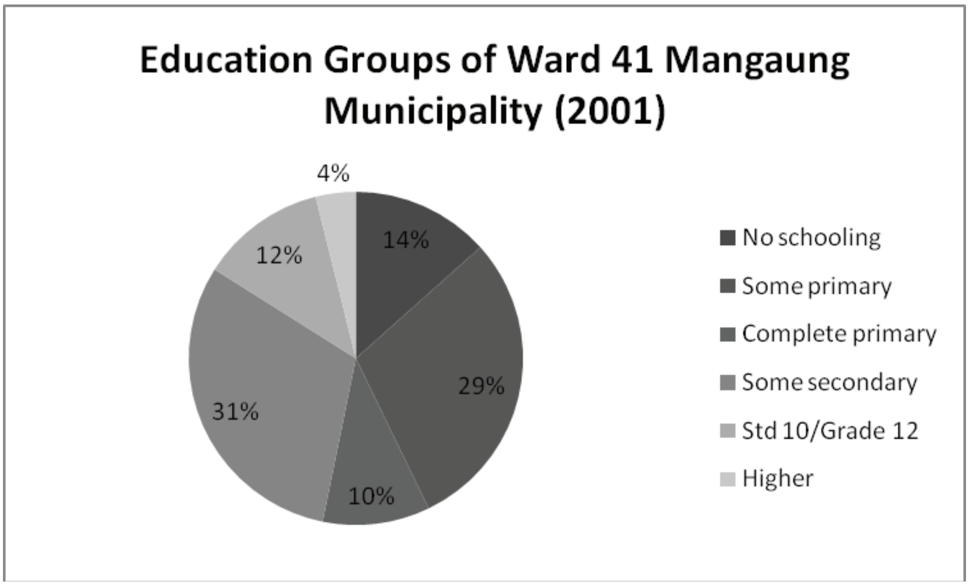


Figure 10: Education Groups of Ward 41 Mangaung Municipality

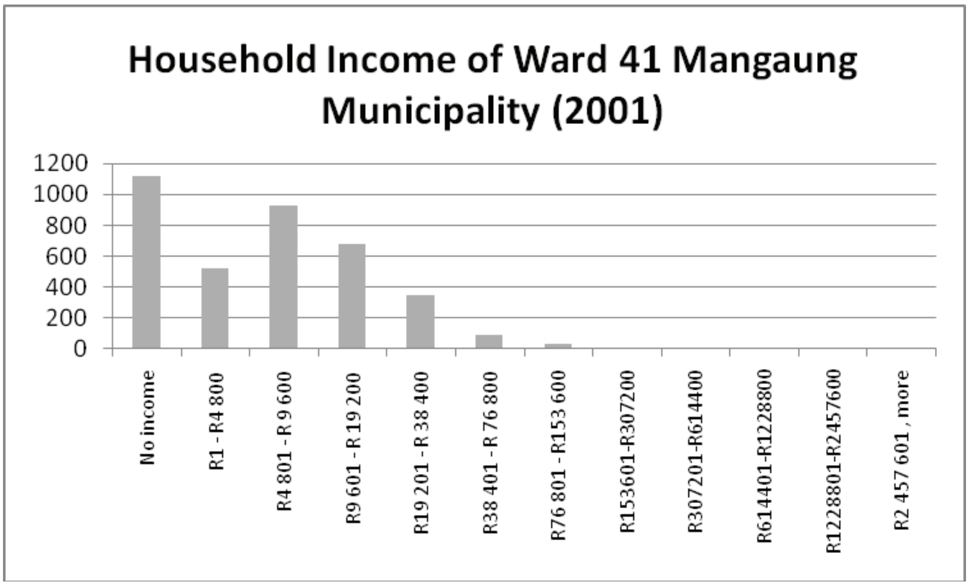


Figure 11: Household Income of Ward 41 Mangaung Municipality

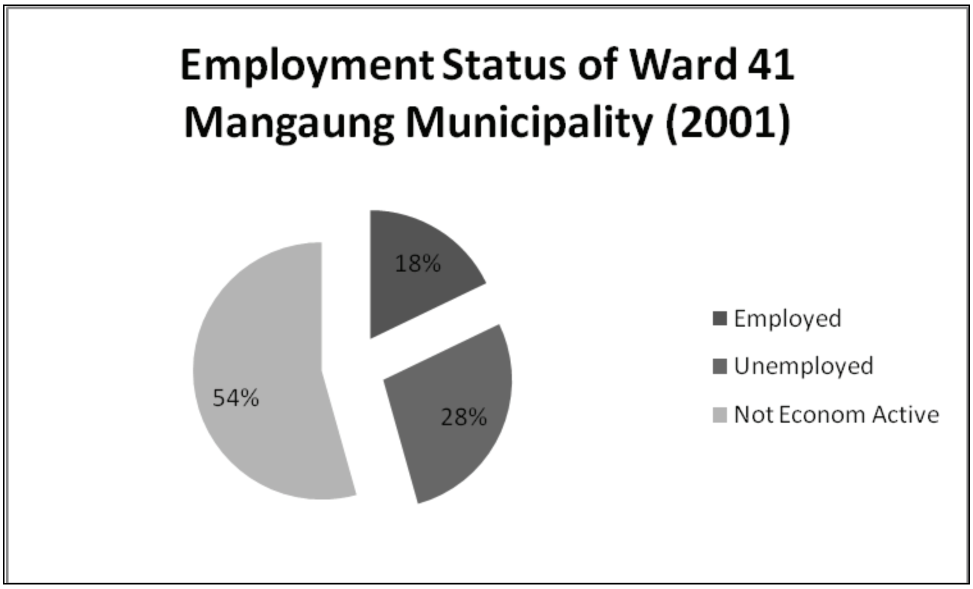


Figure 12: Employment Status of Ward 41 Mangaung Municipality

Water access and land tenure

Most households have access to piped water, but not in their yard as in Ward 38. Water is, similar to Ward 38, provided by a regional scheme. The majority of the properties (49 per cent) are owned and fully paid for. Only 3 per cent is owned but not yet fully paid, 2 per cent is rented and 46 per cent occupied rent free.

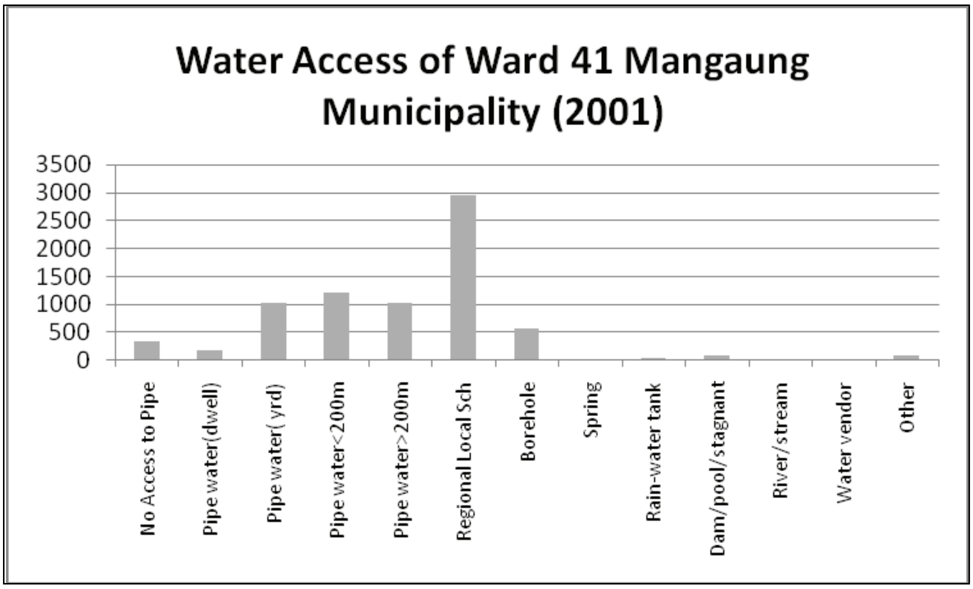


Figure 13: Water Access in Ward 41 Mangaung Municipality

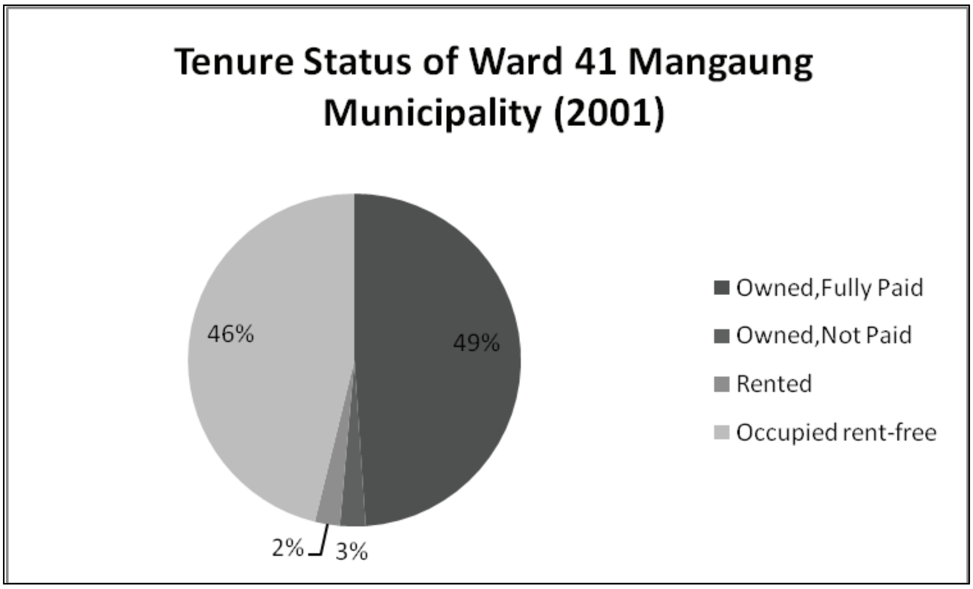


Figure 14: Tenure Status of Ward 41 Mangaung Municipality

Conclusion

Ward 41 of the Mangaung Municipality has a largely uneducated and young population of about 13 250 people, with a very low basic income and a high level of unemployment. Given the low degree of economic development and the low level of employment, the people have little options at their disposal to escape from the poverty trap and, hence, are very vulnerable. As was the case with Ward 38, IFRWH can, in principle, do much to mitigate households' vulnerability with regard to food security.

1.2 Clustering of Villages according to their IFRWH Performance

As mentioned above, Thaba Nchu is surrounded by 42 villages. These villages have been clustered into three categories in terms of their IFRWH performance by the Institute for Soil, Climate and Water of the Agriculture Research Centre (ARC) at Glen. This is also the establishment primarily responsible for the science, practice and community participation in IFRWH – informally known by the villages as "matangwane", that means "little dams" – in the villages mentioned. They have a long-standing relationship with the people of the villages and know and understand the conditions very well. The three categories distinguished are **Good**, **Average** and **Poor** based on the performance of the community-based in-field rainwater harvesting committee for each of the villages. The categorisation of the villages according to the committee's performance was based on several indicators as listed in Table 5. Essentially the categorisation hinges on good governing structures within the villages themselves and the relationship between the committee and the village – i.e. the social capital. It has been decided to link the categorisation of the committee's performance to the performance of IFRWH in general since, without a good governing structure, IFRWH as a technique is unlikely to perform well either. The outcome of the clustering of all the villages into Poor, Average and Good can be found in Annexure C.B. It has also, informally, been established that much of the practical success of IFRWH, or lack thereof, can be relayed to the role and functioning of the village headman. This is the case since the village headman is responsible for the governance of the village and, therefore, the village headman and his leadership are crucial to the success of IFRWH in each village.

Table 5: Selection criteria

	Good	Average	Poor
Criteria	• Regular meetings held • Organised • Good relationship between the IFRWH committee & community • Pay the necessary fees • Active committees • Obey their own group constitution • Willing to learn & work • Teamwork very good • Plan & stick to plan	• Community more active than the committee • 60% attendance of meetings • 5% participation on activities & learning • Planning but not implementing plan • Just follow instructions without inputs (Just do what they are told to do without proper engagement)	• Lack of communication • Doing things aimlessly • Like free things • Only join to join something • Criticise other people's suggestions

1.3 Selection of the Villages to be Surveyed

It was decided not to conduct the survey in all 42 villages, only asking a handful of people in each, but rather to cluster the villages and select a few villages per cluster. In so-doing, one assumes that the selection of villages within each cluster of villages is representative of the entire cluster. This method allows for more interviews and more responses since less time is spent on travelling among the villages and more focused attention can be spent on conducting the interviews. Given the overall profile of the villages, as described in Section 1.1, it is evident that there is a large degree of homogeneity among the villages already and that the selected set of villages can indeed be viewed as representative of all villages in the cluster.

As indicated in Annexure C.B, there are 935 members or official participants using IFRWH in the 42 villages. Of these members, 25 per cent are in so-called "Good" villages, 42 per cent are in "Average" villages and 33 per cent are in "Poor" villages (see Table 6). To keep the proportion of villages selected comparable to the number of people participating in IFRWH, 12 villages were selected, but three from the good cluster, five from the average cluster and four villages from the poor cluster.

Table 6: Selection of total number of villages to conduct survey

Total participants	**935**	**Number of villages to survey**
Proportion of Good participants	25%	3 villages
Proportion of Average participants	42%	5 villages
Proportion of Poor participants	33%	4 villages
	100%	**12 villages**

Once the clustering of the villages was complete, each cluster is assumed to be one sample. This implies that there are essentially three samples. The names of the 12 selected villages, which has been identified with the help of Dr Botha of the ARC, are provided in Figure 15. Yet, each sample had to contain farmers using IFRWH, those not using it, and non-farmers as well in order to provide insight as to the difference among the various categories. The portions of farmers with IFRWH, farmers without IFRWH, and non-farmers are determined in the same manner as the number of total villages.

The targeted number for each sample was 70 observations. Within the 70 observations, 42 are farmers with IFRWH, 18 are farmers without IFRWH and ten are non-farmers. Therefore (as illustrated in Table 7), the overall sample size is 210 observations. In practice, seven more interviews were conducted, favouring the average cluster. Important, however, is that 126 people who use IFRWH were interviewed – 15% of the total – and, hence, the sample can be considered as sufficiently large enough among this sector to be representative.

Table 7: Portioning of each sample: Number of surveys conducted*

	Poor	**Average**	**Good**	**Total**
Farmers with IFRWH	42 (36)	42 (53)	42 (50)	126 (139)
Farmers without IFRWH	18 (18)	18 (16)	18 (16)	54 (50)
Non-farmers	10 (8)	10 (13)	10 (7)	30 (28)
	70 (62)	70 (82)	70 (73)	210 (217)

* The values outside the parenthesis were the targeted number of surveys. The values in parenthesis are the actual number of surveys conducted.

Springfontein Yoxford Feleone Merino Morago	Average	42 (53) 18 (16) 10 (13)	FARM WITH IFRWH FARM WITHOUT IFRWH NON-FARMERS

Rietfontein Gladstone Potsane	Good	42 (50) 18 (16) 10 (7)	FARM WITH IFRWH FARM WITHOUTH IFRWH NON-FARMERS

Nogas Post Talla Kgalala Thubisi	Poor	42 (36) 18 (18) 10 (8)	FARM WITH IFRWH FARM WITHOUT IFRWH NON-FARMERS

Figure 15: Illustration of selection process

* The values without parenthesis were the targeted number of surveys. The values in parenthesis are the actual number of surveys conducted.

2 ANALYSIS: PROFILE OF RESPONDENTS

Questions 1-33 of the questionnaire deal with socio-economic and demographic issues and the respondents' replies are documented in Annexure C.C in tabular form, and presented here as Figures 16-21.

From Figure 16 one can deduct that the majority of the respondents are female, over the age of 55 and the head of the respective household. In general, interviewed households comprise three to five people. As indicated in Figure 17, by far the majority of the respondents are not formally employed; most of them have some degree of secondary school education but with no further skills training. This is consistent with the socio-economic and demographic profile discussed earlier. Also consistent with that profile is the fact that the overwhelming majority of the surveyed households earn less than R1 000 per month.

As indicated in Figure 18, Eskom-generated electricity is the main source of electricity provision, yet it is not very reliable. The average expenditure on electricity is less than R50 per month. Importantly, as shown in Figure 19, it can be seen that the major source of water for irrigation is rainwater. Other irrigation options are limited and the other sources that exist, notably municipal water, are not at all reliable. This emphasises the significant role rainwater plays as a source of water for irrigation. Although most respondents indicated a tap in the street as their primary source of tap water for domestic purposes, even that water is not reliable. This information is very valuable and is additional to that provided by the socio-economic profile discussed earlier where it was noted that a large number of households do have access to piped water through a regional water provisioning scheme. The villagers might have access to a piped water distribution system, but that does not imply that there is water in the pipes. Furthermore, most respondents live in brick houses, have a vegetable garden and use it to produce vegetables. Other crop production is very limited.

From Figure 20 it transpires that in most households the children are engaged and participate in attending to the vegetable garden. They are also actively being trained to and are by far the dominant group of people taking care of the garden during the absence of the principal gardener. This is indeed encouraging given that the population of the two wards studied comprises mostly young, and unemployed, people. Lastly, from Figure 21 it is clear that most people do have access to croplands and have permission to farm there, but almost none of them use the croplands. This is despite the fact that by far the majority have a formal PTO (permission to occupy). Most respondents are aware of IFRWH, increasing from 61 per cent in the poor cluster to 68 per cent in the average cluster to 78 per cent in the good cluster, while 58 per cent in the poor cluster applies IFRWH, 65 per cent in the average cluster and 68 per cent in the good cluster.

Given this description of the background and profile of the respondents, their responses, per cluster, to the specific questions pertaining to IFRWH will now be discussed.

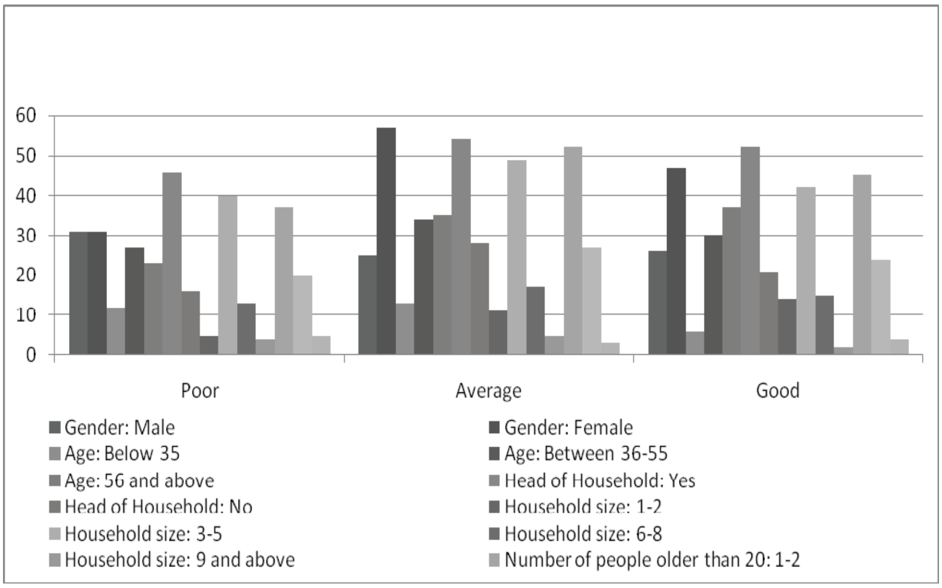


Figure 16: Respondents' gender and household size

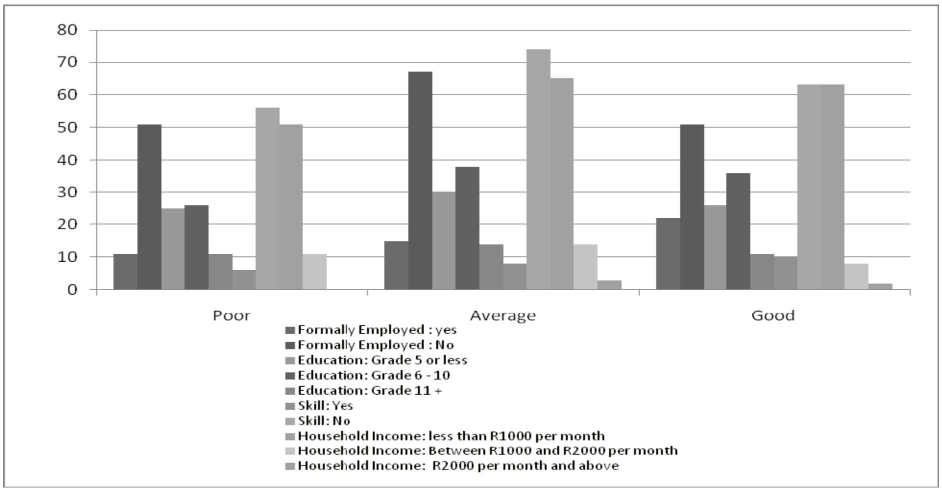


Figure 17: Respondents' level of education, employment status and income level

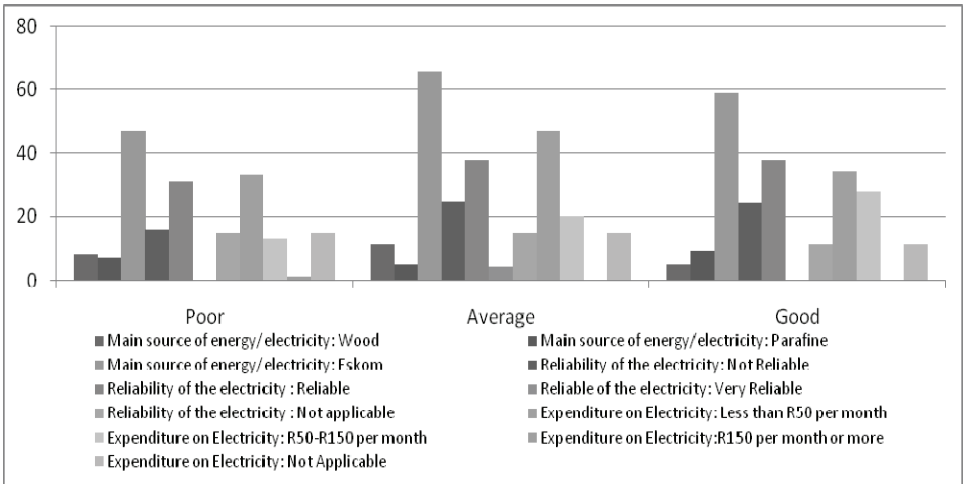


Figure 18: Respondents' source and reliability of electricity

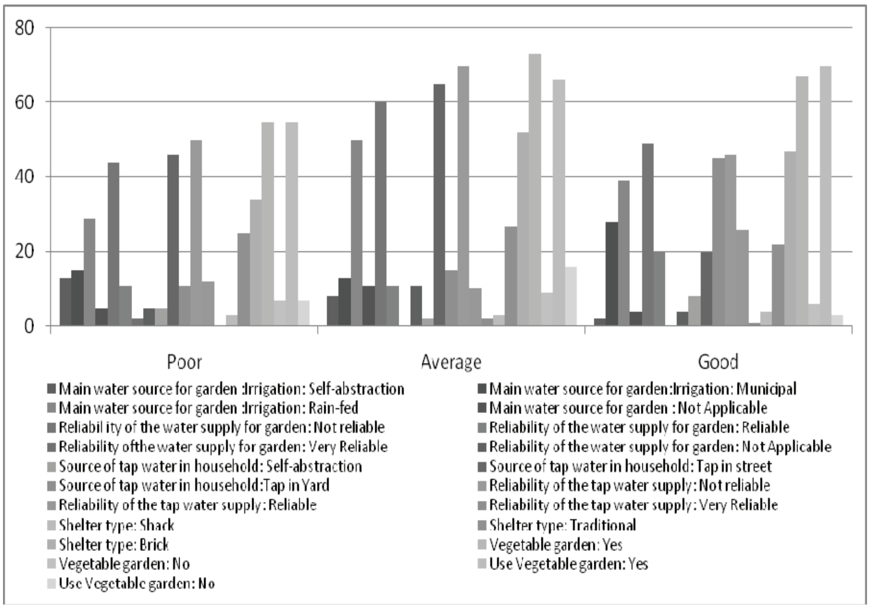


Figure 19: Respondents' source of water, its reliability, their type of dwelling and use of vegetable garden

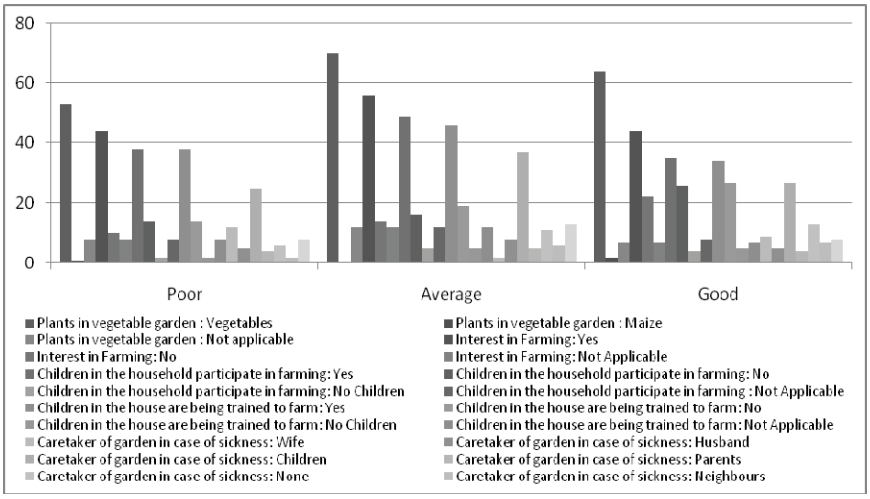


Figure 20: Respondents' views concerning gardening and the role of children

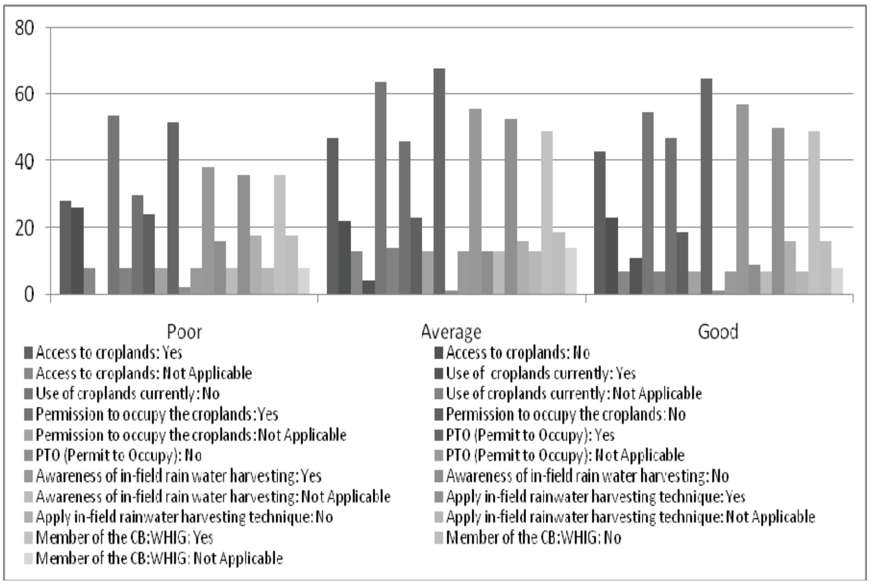


Figure 21: Respondents' access to and use of croplands, and awareness and use of IFRWH

3 ANALYSIS: OUTCOMES BY CLUSTER OF VILLAGES

Questions 34-71 of the questionnaire (refer to Annexure C.A) deal with the views of the respondents with regard to IFRWH research, practice and community participation. The responses follow the five-point Likert scale (Strongly Agree, Agree, Neither, Disagree and Strongly Disagree) (see also http://en.wikipedia.org/wiki/Likert_scale and http://www.socialresearchmethods.net/kb/scallik.php) as per the McMaster research impact assessment tool. The responses are presented below as Figures 22-33.

3.1 In-Field Rainwater Harvesting Research

Questions 34-39 address the view of respondents with regard to their awareness of the research team (GLEN ARC team tasked with overseeing IFRWH in Thaba Nchu) and their overall performance. As seen in Figures 22-23 there is an overwhelmingly positive response (in all clusters) regarding the performance of the research team. The majority of respondents agree that IFRWH research has taken place during the past three years, that the research team has demonstrated adequately how IFRWH works, and that they have been able to communicate and involve themselves with the research team.

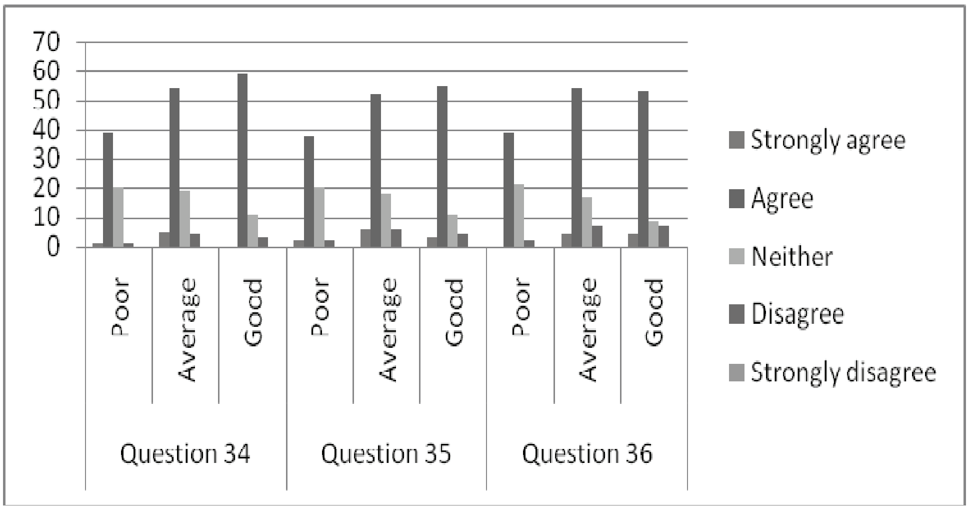


Figure 22: Respondents' views regarding IFRWH research

Question 34: In-field rainwater harvesting research has been in ongoing in my village for three years or more.
Question 35: The in-field rainwater harvesting research team has demonstrated how the technique works.
Question 36: In-field rainwater harvesting has been explained to me.

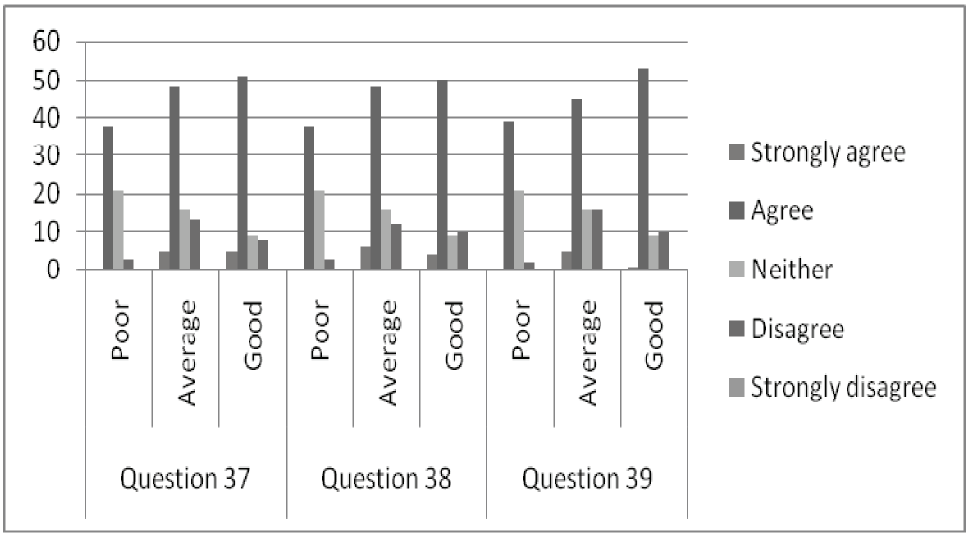


Figure 23: Respondents' views regarding IFRWH research (cont.)

Question 37: I was able to talk to the in-field rainwater harvesting research team at any time.
Question 38: The demonstration was convincing and I accepted it after one demonstration.
Question 39: The research team involved me in and during the research process.

3.2 The Practice of In-Field Rainwater Harvesting

There is a very consistent view among the respondents, as illustrated in Figure 24, that IFRWH practice did not commence prior to the start of research, but that IFRWH practice only started when research commenced.

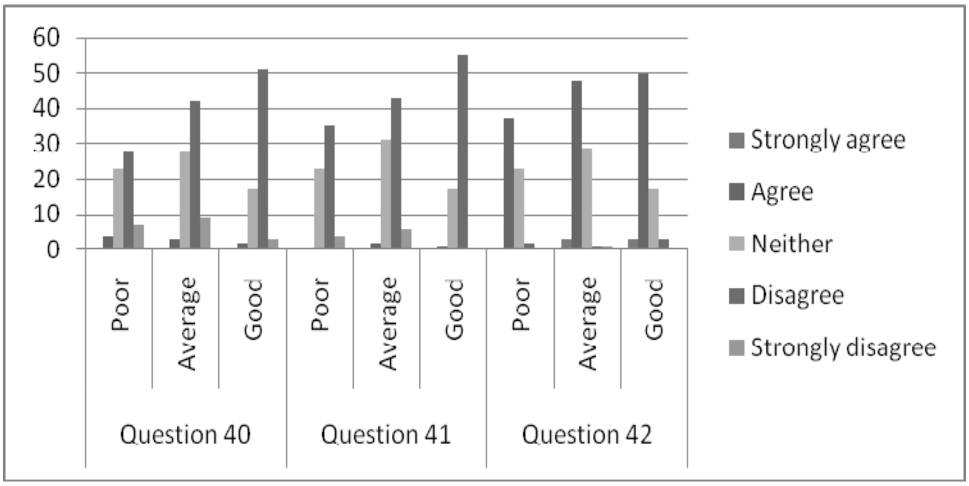


Figure 24: Respondents' awareness of IFRWH prior to commencement of research

Question 40: I knew about in-field rainwater harvesting before the start of the research project in 2002.

Question 41: In-field rainwater harvesting in my village has taken place BEFORE the research team started their research.

Question 42: In-field rainwater harvesting has only started since the research team's involvement.

Indicated in Figure 25 is the outcome of the responses with regard to questions related to whether the respondents understand IFRWH and whether it is easy to apply and duplicate. In all cases the respondents indicate their agreement with the various statements. Clearly the majority understand IFRWH and indicate that it is easy to use and duplicate.

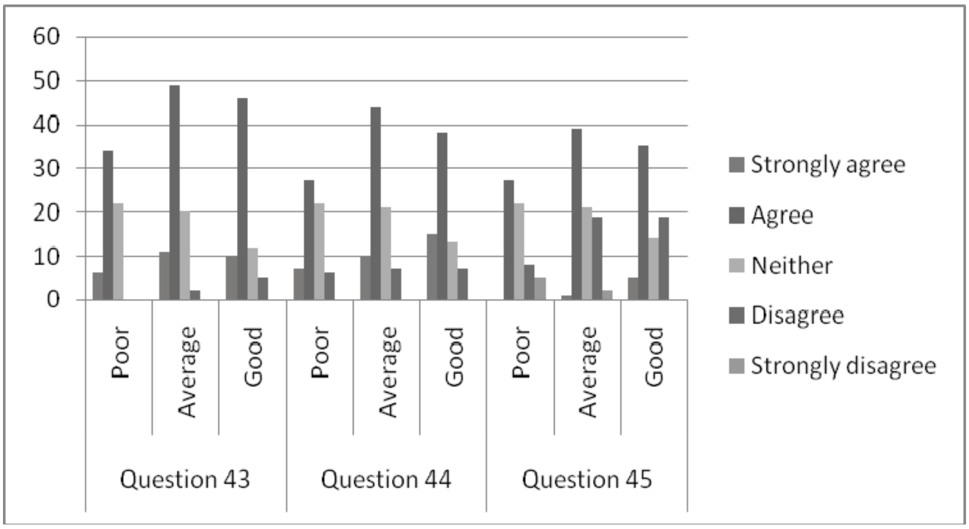


Figure 25: Respondents' understanding of IFRWH

Question 43: I understand in-field rainwater harvesting.

Question 44: In-field rainwater harvesting is easy to apply.

Question 45: In-field rainwater harvesting can easily be duplicated.

Figure 26 illustrates that the majority of respondents do not prefer alternative farming methods, such as conventional farming practices (ploughing) or hydroponics, to IFRWH.

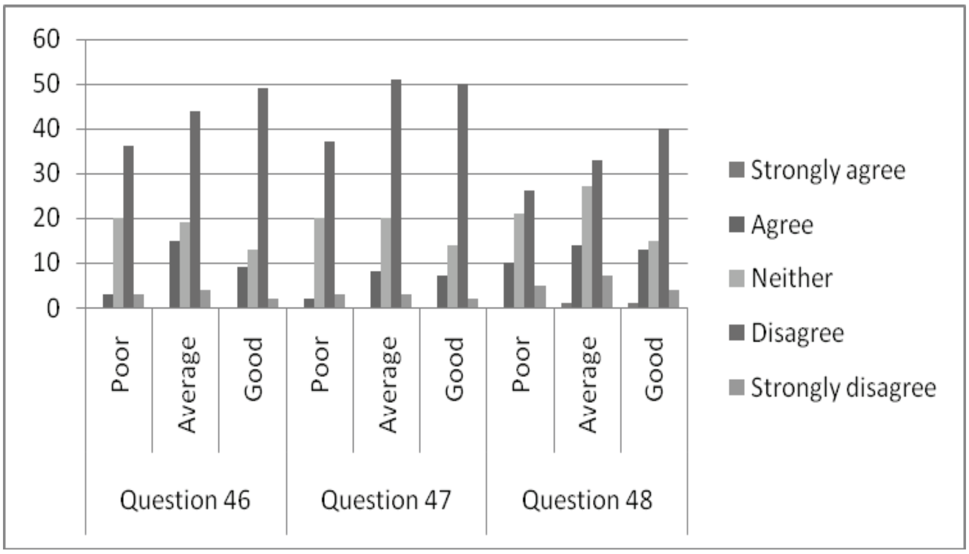


Figure 26: Respondents' preference for alternative farming methods

Question 46: I prefer alternative ways to farm and to produce food to using in-field rainwater harvesting.

Question 47: The conventional way of cropping is better than in-field rainwater harvesting.

Question 48: Hydroponics is better than in-field rainwater harvesting.

Figures 27 and 28 illustrate the views of the respondents regarding the productivity of IFRWH compared to the other farming methods. The majority of respondents are of the view that IFRWH is easy to use and that IFRWH produce higher yields compared to the conventional method and hydroponics. The majority also agree that farming tools are easily available but indicate the availability of seeds as a problem.

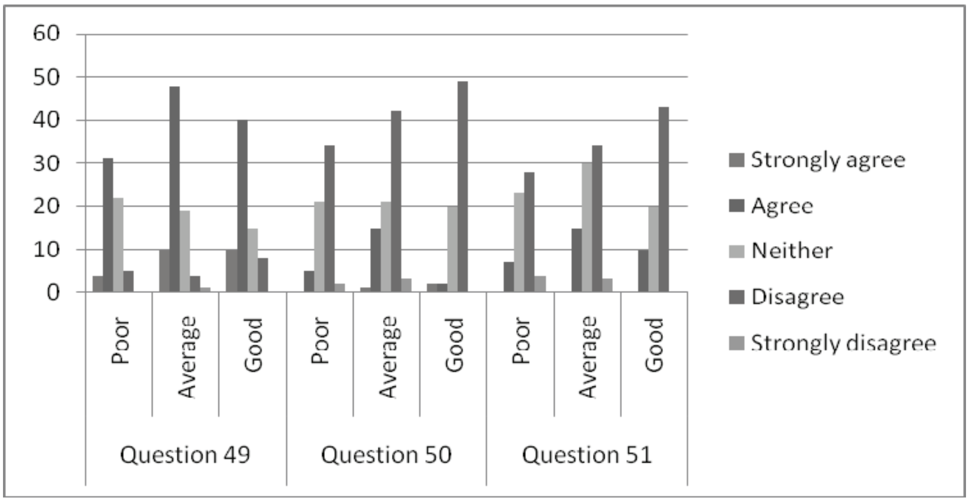


Figure 27: Respondents' views concerning the productivity IFRWH

Question 49: It is easy to switch to in-field rainwater harvesting.

Question 50: In-field rainwater harvesting yields fewer crops than the conventional method.

Question 51: In-field rainwater harvesting yields fewer crops than hydroponics.

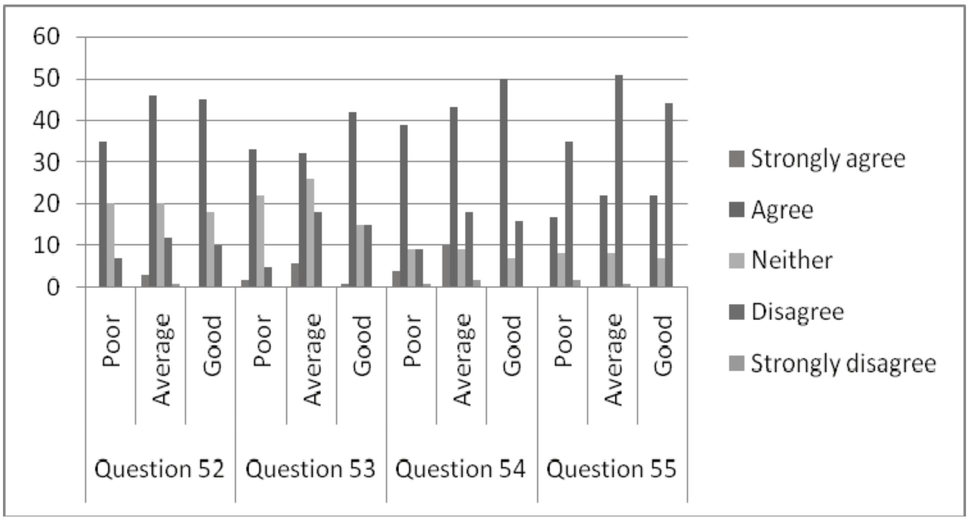


Figure 28: Respondents' views concerning the productivity IFRWH and access to farming utilities
Question 52: In-field rainwater harvesting yields more crops than the conventional method.
Question 53: In-field rainwater harvesting yields more crops than hydroponics.
Question 54: Tools such as spades and forks are easily available.
Question 55: Access to seed for crops is easy.

The next set of questions was asked only to those applying IFRWH activity. Those not applying IFRWH are indicated as "not applicable" every time in the next set of figures.

Figure 29 shows that IFRHW has helped by far the majority of those applying IFRWH to improve their social and economic wellbeing through improved food and financial security as a result of better crop yields. This is an incredibly important outcome, which will be returned to in the next section as well. It does strongly suggest that the respondents that apply IFRWH are convinced that by applying the technique they reduce their food and income vulnerability and, in doing so, improve their socio-economic wellbeing.

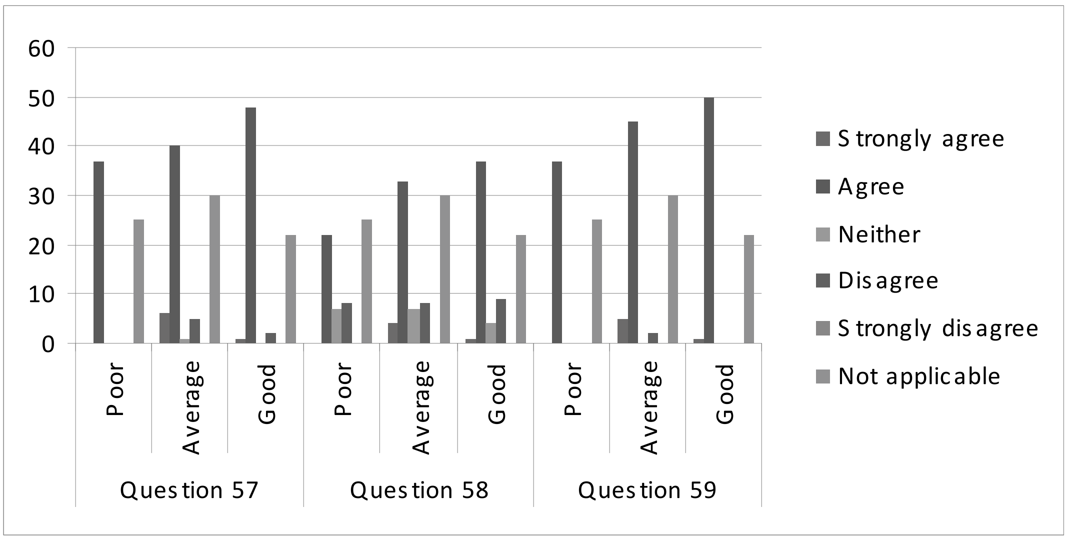


Figure 29: Respondents' views on effect of IFRWH on social and economic wellbeing
Question 57: In-field rainwater harvesting has improved my crop yields.
Question 58: In-field rainwater harvesting has helped me financially.
Question 59: In-field rainwater harvesting has made me more food secure.

Interestingly and importantly, as indicated in Figure 30, the respondents are convinced that IFRWH can be applied in the croplands and most of the respondents are willing to do so, quite a few of them feel very strongly about it. There is a consistent view, however, that not all people apply IFRWH. This does not detract those applying it to consider expanding to the croplands. On the contrary, they are very much in favour of such an expansion.

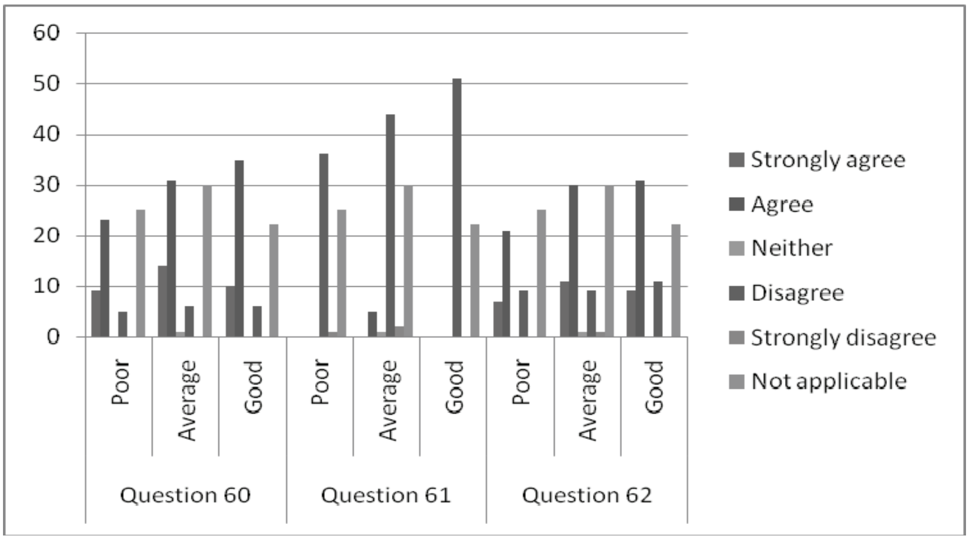


Figure 30: Respondents' views on application of IFRWH in croplands

Question 60: In-field rainwater harvesting can be applied in the croplands.

Question 61: All the people with vegetable gardens in the village apply in-field rainwater harvesting methods.

Question 62: I will apply in-field rainwater harvesting in the croplands.

Although the majority of the respondents indicate, in Question 62, that they will apply IFRWH in the croplands, by far the majority thinks that IFRWH is not better than ploughing when operating in the croplands (Question 63), as indicated in Figure 31. This is an interesting outcome, especially when compared to Question 64 – very few people are willing to use cattle as draught-animals. This implies that the respondents will much rather consider using mechanical means to operate the croplands. They disagree strongly with the statement that they will only plant maize in the croplands, implying a diversified use of the land.

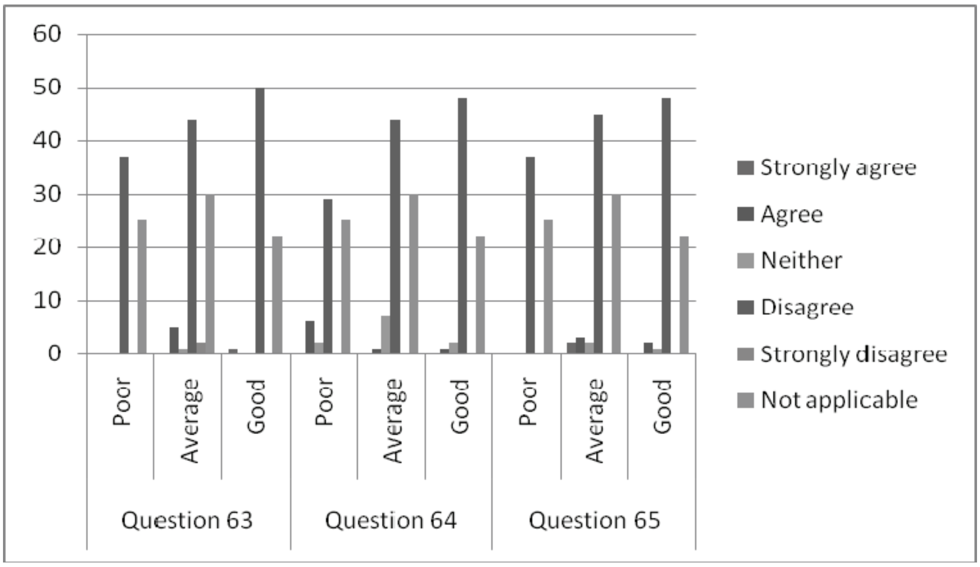


Figure 31: Respondents' views on various possible uses of croplands

Question 63: For the croplands, in-field rainwater harvesting is better than ploughing.

Question 64: I will use cattle to plough the croplands.

Question 65: I will only plant maize in the croplands.

As indicated in Figure 32, and supporting the outcome of the previous question, people will use the croplands for the production of various crops. Excitingly, also, is that the majority of the respondents intend not to produce only for their households, but to produce a surplus.

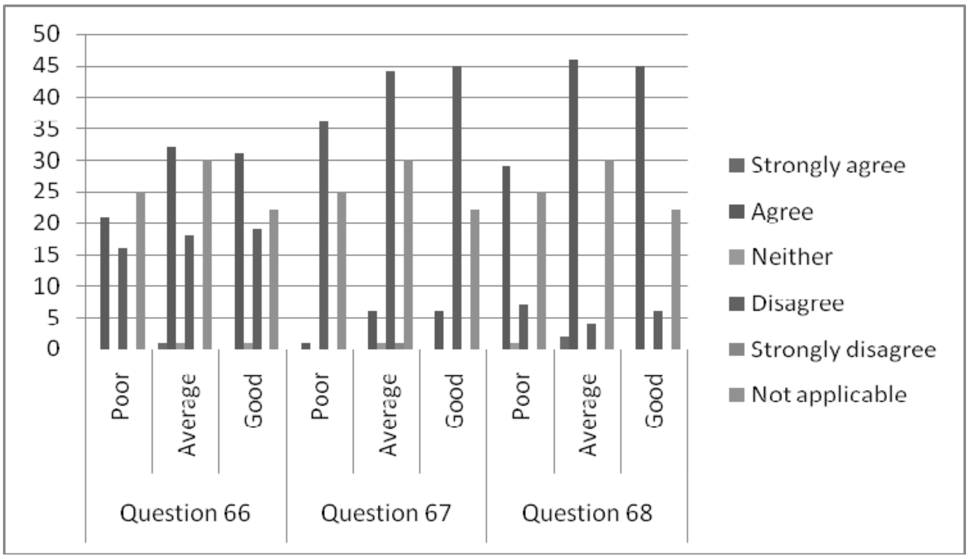


Figure 32: Respondents' views on produce in croplands

Question 66: I will plant maize plus vegetables in the croplands.

Question 67: I will only produce for my own household.

Question 68: I will try my best to produce a surplus of crops.

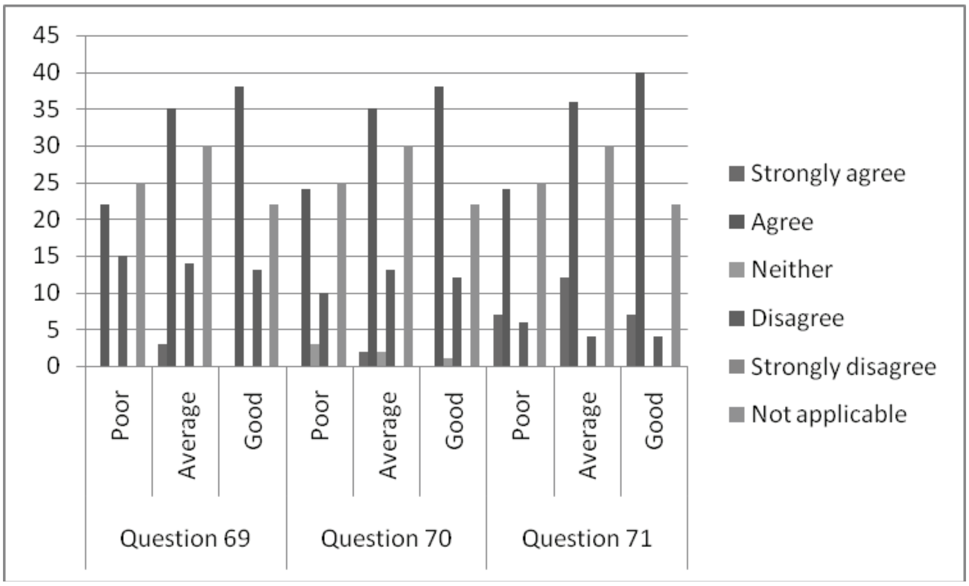


Figure 33: Respondents' views on creation of produce markets
Question 69: Should I have a surplus, I will sell my crops.
Question 70: I will not use any of the harvest from the croplands, but sell all of it.
Question 71: I will work with other people in my village and sell a larger volume to the market.

The produced surplus will, according to the majority of the respondents, be sold, many of them indicating that they will not even use some of it for their own consumption (see Figure 33). Overwhelmingly the respondents who do apply IFRWH indicate their willingness to pool their resources and produce, and to sell that produce to the market.

The results depicted in Figures 21-33 are summarised in Table 8. Here the sum of the number of respondents that have indicated "agree" or "strongly agree" to a statement is expressed as a percentage to the total number of observation by cluster and for the entire sample. From the first set of questions, it is clear that in all clusters, but progressively more in the average and good clusters, respondents are aware of the IFRWH research team's efforts and note that IFRWH has been explained to them. With regard to the second set of questions, concerning the practice of IFRWH, a large number (in excess of 60%) indicate that it is easy to apply IFRWH, but a considerably lower number (just more than 50%) indicate that it is easy to duplicate IFRWH. The respondents are, however, convinced that IFRWH is a superior technique to other farming methods.

Concerning the questions directed specifically to those applying IFRWH, it is clear that IFRWH has significantly improved the wellbeing of the majority of respondents. While most think that IFRWH can be applied to, and are willing to apply IFRWH in the croplands, very few actually think that it is better than ploughing. Much research effort and demonstration, therefore, has to be dedicated to this issue. Additionally, very few are willing to use cattle for ploughing. Excitingly, however, by far the majority is willing and eager to produce a surplus, work with other members of the community, and sell the produce on the market.

Table 8: Percentage of respondents who indicated “agree” and “strongly agree” to the total number of observation by household cluster and for the entire survey

Ques.		% of respondents indicating agree & strongly agree to the total number of respondents			
		Poor n=62	**Average n=82**	**Good n=73**	**Overall n=217**
	In-field rainwater harvesting research				
34	In-field rainwater harvesting research has been in ongoing in my village for three years or more	65	72	81	73
35	The in-field rainwater harvesting research team has demonstrated how the technique work	65	71	79	72
36	In-field rainwater harvesting has been explained to me	63	71	78	71
37	I have been able to talk to the in-field rainwater harvesting research team at any time	61	65	77	68
38	The demonstration was convincing and I have accepted it after one demonstration	61	66	74	67
39	The research team has involved me in and during the research process	63	61	74	66
	In-field rainwater harvesting practice				
40	I knew about in-field rainwater harvesting before the start of the research project in 2002	6	4	3	4
41	In-field rainwater harvesting in my village has taken place BEFORE the research team started their research	0	2	1	1
42	In-field rainwater harvesting has only started since the research team’s involvement	60	62	73	65
43	I understand in-field rainwater harvesting	65	73	77	72
44	In-field rainwater harvesting is easy to apply	55	66	73	65
45	In-field rainwater harvesting can be duplicated easily	44	49	55	49
46	I prefer alternative ways to farm and to produce food than to use in-field rainwater harvesting	5	18	12	12
47	The conventional way of cropping is better than in-field rainwater harvesting	3	10	10	8
48	Hydroponics is better than in-field rainwater harvesting	16	18	19	18
49	It is easy to switch to in-field rainwater harvesting	56	71	68	66
50	In-field rainwater harvesting yields fewer crops than the conventional method	8	20	5	12
51	In-field rainwater harvesting yields fewer crops than hydroponics	11	18	14	15
52	In-field rainwater harvesting yields more crops than the conventional method	56	60	62	59

53	In-field rainwater harvesting yields more crops than hydroponics	56	46	59	53
54	Tools such as spades and forks is easily available	69	65	68	67
55	Access to seed for crops is easy	27	27	30	28
	Questions asked to those applying IFRWH only				
57	In-field rainwater harvesting has improved my crop yields	60	56	67	61
58	In-field rainwater harvesting has helped me financially	35	45	52	36
59	In-field rainwater harvesting has made me more food secure	60	61	70	64
60	In-field rainwater harvesting can be applied in the croplands	52	55	62	56
61	All the people with vegetable gardens in the village apply in-field rainwater harvesting methods	0	6	0	2
62	I will apply in-field rainwater harvesting in the croplands	45	50	55	50
63	For the croplands, in-field rainwater harvesting is better than ploughing	0	6	1	3
64	I will use cattle to plough the croplands	10	1	1	4
65	I will only plant maize in the croplands	0	6	3	3
66	I will plant maize plus vegetables in the croplands	34	40	42	39
67	I will only produce for my own household	2	7	8	6
68	I will try my best to produce a surplus of crops	47	59	62	56
69	Should I have a surplus, I will sell my crops	35	46	52	45
70	I will not use any of the harvest from the croplands, but sell all of it	39	45	52	46
71	I will work with other people in my village and sell a larger volume to the market	50	59	64	58

Several open-ended questions form part of the questionnaire in which case respondents could state their perspective in an unrestricted way, or in a way not linked to the above-mentioned five-point scale, meaning or non-perception determining questions. The results of these questions are provided in Table 9.

Table 9: Responses to a variety of non-perception determining questions

	Number of Respondents		
	Poor n = 62	**Average n = 82**	**Good n = 73**
The land tenure is secure: Yes	60	77	68
The land tenure is secure: No	2	5	5
Availability of the land in the next 5 years: Yes	56	76	67
Availability of the land in the next 5 years: No	6	6	6
Ownership of land: Father	34	24	30
Ownership of land: Mother	28	58	43
Reasons for using IFRWH: Easy to Use	6	11	9
Reasons for using IFRWH: Conserves Water	16	9	16
Reasons for using IFRWH: Better Yields	15	34	27
Reasons for using IFRWH: Not Applicable	25	28	21
Reasons for not using IFRWH: Hydroponics is Better	3	7	7
Reasons for not using IFRWH: Too Much Work	9	13	10
Reasons for not using IFRWH: No Knowledge of IFRWH	11	10	5
Reasons for not using IFRWH: Not Applicable	39	52	51

Almost all the respondents indicated that land tenure is secure and that they have access to land for farming for at least the next 5 years. Ownership of the land, for those surveyed, are favouring the mothers, or females, in both the average and good clusters by some margin.

When asked to provide reasons for using IFRWH, the majority indicated better yields, followed by better water conservation, and then finally ease of use. No knowledge of IFRWH is the most dominant reason given for people who are not using IFRWH, followed by IFRWH has too much work, and then finally that hydroponics is better. This latter set of questions is only applicable to those people not applying IFRWH.

While the responses of the respondents are dealt with here in this section in quite some detail, the field researcher used the time to conduct informal interviews. The next section deals with these field-trip impressions.

4 TEST FOR STATISTICAL DIFFERENCES BETWEEN THE KEY QUESTIONS OF POOR AND GOOD GROUPS

An Analysis of Variation (ANOVA) statistical test was performed on the results of questions 34-39 from Table 8 by comparing the outcomes to the various questions for both the poor and the good groups to determine if any statistical differences exist in the uptake of IFRWH between the two groups. Questions 34-39 represent the views of the respondents concerning the performance of the research team. The results of these tests are depicted in Table 10 and reveal that, indeed, there is a statistical difference between the two groups with regard to the uptake of IFRWH. The F test statistic (109.802) is larger than an *F* critical value (4.9646), and a *p* value (0.00) that is significant at a 5 per cent level of significance, confirm the difference in the uptake of producer-push between the two groups.

Table 10: ANOVA procedure to determine differences in responses to questions 34-39 (see Table 8) between the poor and good groups

ANOVA: Single Factor						
SUMMARY						
Groups	***Count***	***Sum***	***Average***	***Variance***		
Column 1	**6**	**378**	**63**	**3.2**		
Column 2	**6**	**463**	**77.166**	**7.7666**		
ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	**602.0833**	**1**	**602.0833**	**109.802**	**0.00**	**4.9646**
Within Groups	**54.83333**	**10**	**5.4833**			
Total	**656.91666**	**11**				

The same ANOVA procedure is performed on questions 40-55 (see Table 8 and Table 11) to determine whether a statistical difference exists between the views of the respondents of the poor and good groups with regard to the practice of IFRWH. The results reveal an *F* test statistic (0.3396051) that is less than the *F* critical (4.1708), and a *p* value (0.5644) that is not statistically significant at a 5 per cent level of significance. There is, therefore, no significant statistical difference between the views of the poor group and the good group concerning the practice of IFRWH. This is confirmed by the results depicted in Figures 24-28 which illustrate homogenous responses between the two groups to most of these questions (40-55).

Table 11: ANOVA procedure to determine differences in responses to questions 40-55 (see Table 8) between the poor and good groups

ANOVA: Single Factor						
SUMMARY						
Groups	***Count***	***Sum***	***Average***	***Variance***		
Poor	**16**	**537**	**33.5625**	**678.129**		
Good	**16**	**629**	**39.3125**	**879.562**		
ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	**264.5**	**1**	**264.5**	**0.3396**	**0.5644**	**4.1708**
Within Groups	**23365.375**	**30**	**778.845**			
Total	**23629.875**	**31**				

The last difference tested between the two groups concerns the respondents' views regarding the application of IFRWH in the croplands. The ANOVA procedure (see Table 12) indicates that there is no significant statistical difference between the poor and good groups. This is shown by an *F* test statistic (0.7688) that is smaller than the *F* critical value (4.1959), and a *p* value (0.3880387) that is not statistically significant at a 5 per cent level of significance. It is encouraging that no difference exists between the poor group and the good group with regard to the respondents' views on the practice of IFRHW and the application thereof in the croplands. This represents solid common ground for future initiatives.

Table 12: ANOVA procedure to determine differences in responses to questions 57-71 (see Table 8) between the poor and good groups

ANOVA: Single Factor						
SUMMARY						
Groups	***Count***	***Sum***	***Average***	***Variance***		
Poor	**15**	**469**	**31.266667**	**514.6381**		
Good	**15**	**591**	**39.4**	**775.97143**		
ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	**496.13333**	**1**	**496.13333**	**0.7688357**	**0.3880**	**4.1959**
Within Groups	**18068.533**	**28**	**645.30476**			
Total	**18564.667**	**29**				

5 IMPORTANCE AND UPTAKE OF IFRWH: OBSERVATIONS AND ANECDOTAL EVIDENCE

The first thing that one notices about the area around Thaba Nchu is its beautiful scenery – its beautiful mountains and endless fields of green. This is evident in all the 12 villages visited during the study. Also evident is the warm spirit of the people of these villages. Despite not even having enough for themselves in some cases, they share and their generosity is unmistakable.

The second thing one notices is the love for farming that is prevalent in all villages. Farming is an integral part of these communities' social and economic fibre. Not surprising then is the widespread acceptance of IFRWH, which is now common practice among the young as well as the old. There is a general consensus that IFRWH is superior to other farming techniques and as a result of its water-saving qualities, it is viewed as the future of farming in general.

Related to IFRWH are issues of coordination and governance. Sadly, this third aspect is a cause for concern. Each village visited during the study has a tribal authority – a headman that reports to Chief Moroka in Thaba Nchu. The tribal authority represents the common interests of each village. Furthermore, in each village there is an elected IFRWH committee responsible for the co-ordination of all IFRWH activities in the villages studied. A problem arises in instances where the tribal authority and the IFRWH committees work in isolation. Since the tribal authority represents the interest of all in the village, and the IFRWH committees only represent the interest of IFRWH participants, it becomes vital that the tribal authority oversees the committees to ensure that their activities do not adversely affect the interest of the community as a whole. Unfortunately, this is not happening in all the villages studied. Unrelated social conflicts enter the debates of IFRWH committees. This is most prevalent in the village of Potlane were "social outcasts" stopped using IFRWH as a result of social conflicts, threatening their food security as a result of lower yield from either conventional methods or hydroponics.

Unless mitigated, the lack of coordinated governance could create a situation were IFRWH becomes a catalyst of social conflict and not a catalyst of food and income security as intended.

6 CONCLUSION

A survey, with 217 carefully selected respondents to reflect the profile and status of IFRWH among the various villages surrounding Thaba Nchu, was conducted during the third week of November 2007 – a summary of all responses are found in annexure C.D. This survey, which included 15% of the total official IFRWH members, also included non-members and non-farmers. The villages were divided into three clusters, namely those villages where the performance of the IFRWH committee was poor, average or good. This was done to assess the uptake and participation in IFRWH among the villagers, and was done in accordance to the McMaster research assessment impact tool.

It is determined, both through casual observation and confirmed through the survey, that there is indeed a large degree of participation and knowledge about IFRWH. Respondents view IFRWH superior to other farming options, especially in the wake of unreliable access to water, despite being linked to a regional water supply scheme. Those applying IFRWH, overwhelmingly respond that IFRWH has improved their wellbeing and improved their food security. Almost all the respondents have access to land, and land tenure and land security is not a concern when considering expansion, or to upscale towards implementing IFRWH in the croplands. This is a subject, however, for further research and action. Respondents think that IFRWH harvesting can be applied in the croplands and they are willing to do so, but the perception that ploughing is actually better prevails. They are convinced that for the food gardens, IFRWH is superior to ploughing, but this is not a view shared when considering the croplands. Furthermore, they are opposed to the idea of using cattle for ploughing.

In summary, IFRWH has made a meaningful contribution to the wellbeing of the respondents and the respondents are very satisfied with the performance of IFRWH. However, some doubt exists about the application of this technique in the croplands, and this has to be the subject of future research.

ANNEXURE C.A: QUESTIONNAIRE USED DURING SURVEY

The enumerator commenced by reading the following:

The Water Research Commission in Pretoria has been supporting research in Thaba Nchu since 1997 concerning in-field rainwater harvesting. In-field rainwater harvesting is a technique whereby one does not plough the land, but apply no-tilling methods of crop production and prepare the land in a very special way to optimise the rainwater concentration in the areas next to the roots of the crops. In this way soil moisture is retained for a longer period and the crop production is higher. Below please find a couple of photos of examples of a field prepared according to infield rainwater harvesting method.

In this study we wish to determine your views regarding a variety of perspectives concerning in-field rainwater harvesting and appreciate your time and effort. Please remember that there is no right or wrong answers. We wish to determine YOUR view. Also, this survey is anonymous. We do not ask you your name. You are free to speak your mind.

No.	General questions	Response			
1	Resident of village				
2	Gender of the farmer/household gardener	Male	Female		
3	Age of respondent	Younger than 35	36-55	56 and older	
4	I am the head of the household	Yes	No		
5	Number of people in your household (including you)	1-2	3-5	6-8	9+
6	Number of people in household older than 20	1-2	3-4	5+	
7	I am formally employed	Yes	No		
8	My highest educational level is	Gr 5 or lower	Gr 6 - Gr 10	Gr 11+	
9	Do you have a specific skill for which you got special training	Yes	No		
10	If yes, what skill and what training				
11	Monthly income for the whole household	Less than R1,000/m	R1,000-R2,000/m	R2,000/m or more	
12	Main source of energy/electricity	Wood	Paraffin & candles	Eskom/Mains	
13	How reliable is your energy source	Not reliable (the supply is insufficient for more than 15 days a month)	Reliable (there is enough for between 15 and 25 days a month)	Very reliable (thee is enough for more than 25 days a month)	
14	How much do you pay for your energy/electricity	Less than R50/m	R50-R150/m	R150/m or more	
15	What is your main water source for your garden	Irrigation: Self-abstraction	Irrigation: Municipal	Rain-fed	
16	How reliable is the water supply for your garden	Not reliable (have enough water for no more than 15 days a month)	Reliable (have enough water for between 15 and 25 days a month)	Very reliable (have enough water more than 25 days a month)	
17	Source of source of tap water for your house	Self-abstraction	Tap in street/yard	Tap in house	
18	How reliable is the tap water supply	Not reliable (have enough water for no more than 15 days a month)	Reliable (have enough water for between 15 and 25 days a month)	Very reliable (have enough water more than 25 days a month)	
19	Shelter type	Shack	Traditional	Brick	
20	I have a vegetable garden	Yes	No		
21	I use my vegetable garden	Yes	No		
	If you have answered yes to question 21, then please continue, otherwise go to question 34				
22	I plant the following crops in my garden				
23	The other people in my house have an interest in farming	Yes	No		
24	The children in the household participate in farming	Yes	No	No children in house	
25	The children in the house are being trained to farm	Yes	No	No children in house	
26	Who are going to take the garden over when you are sick or when you will be too old				
27	Do you have access to croplands	Yes	No		
28	Do you use your croplands currently	Yes	No		
29	Do you have permission to occupy the croplands	Yes	No		
30	Do you have a PTO (Permit to Occupy)	Yes	No		
31	Do you know of, or are you aware of, in-field rainwater harvesting	Yes	No		
32	I apply in-field rainwater harvesting technique	Yes	No		
33	Are you a member of the CB:WHIG	Yes	No		

No.	In-field rainwater harvesting research	Strongly disagree	Disagree	Neither agree nor disagree or do not know	Agree	Strongly agree
34	In-field rainwater harvesting research has been in ongoing in my village for three years or more					
35	The in-field rainwater harvesting research team has demonstrate how the technique works					
36	In-field rainwater harvesting has been explained to me					
37	I have been able to talk to the in-field rainwater harvesting research team at any time					
38	The demonstration was convincing and I have accepted it after 1 demonstration					
39	The research team has involved me in and during the research process					
No.	**In-field rainwater harvesting practice:**	**Strongly disagree**	**Disagree**	**Neither agree nor disagree or do not know**	**Agree**	**Strongly agree**
40	I knew about in-field rainwater harvesting before the start of the research project in 2002					
41	In-field rainwater harvesting in my village has taken place BEFORE the research team started their research					
42	In-field rainwater harvesting has only started since the research team's involvement					
43	I understand in-field rainwater harvesting					
44	In-field rainwater harvesting is easy to apply					
45	In-field rainwater harvesting can be duplicated easily					
46	I prefer alternative ways to farm and to produce food than to use in-field rainwater harvesting					
47	The conventional way of cropping is better than in-field rainwater harvesting					
48	Hydroponics is better than in-field rainwater harvesting					
49	It is easy to switch to in-field rainwater harvesting					
50	In-field rainwater harvesting yields fewer crops than the conventional method					
51	In-field rainwater harvesting yields fewer crops than hydroponics					
52	In-field rainwater harvesting yields more crops than the conventional method					
53	In-field rainwater harvesting yields more crops than hydroponics					
54	Tools such as spades and forks is easily available					
55	Access to seed for crops is easy					

	If your answer to question 32 was yes, then please continue with the questionnaire, otherwise jump to question 72					
56	Please provide us with the reasons why you are applying in-field rainwater harvesting					
57	In-field rainwater harvesting has improved my crop yields					
58	In-field rainwater harvesting has helped me financially					
59	In-field rainwater harvesting has made me more food secure					
60	In-field rainwater harvesting can be applied in the croplands					
61	All the people with vegetable gardens in the village apply in-field rainwater harvesting methods					
62	I will apply in-field rainwater harvesting in the croplands					
63	For the croplands, in-field rainwater harvesting is better than ploughing					
64	I will use cattle to plough the croplands					
65	I will only plant maize in the croplands					
66	I will plant maize plus vegetables in the croplands					
67	I will only produce for my own household					
68	I will try my best to produce a surplus of crops					
69	Should I have a surplus, I will sell my crops					
70	I will not use any of the harvest from the croplands, but sell all of it					
71	I will work with other people in my village and sell a larger volume to the market					
	If you have answered yes to question 32, then please go to 73					
72	Please tell us why you are not applying in-field rainwater harvesting. Please be honest. Remember, we do not know your name.					
	Ownership of land: Household gardens					
73	Could you please tell us who owns the land on which your garden is?					
74	How secure is your use of the land?					
75	Will this land be available for you to use over the next 5 years as well? Why?					
We thank you for your time and participation						

ANNEXURE C.B: NUMBER OF IFRWH MEMBERS PER VILLAGE AND VILLAGE PERFORMANCE CLASSIFICATION

Village name	IFRWH members	Performance
Springfontein	13	A
Yoxford	33	A
Tabale	12	A
Ratau	28	A
Rooifontein	19	A
Sediba 1	23	A
Sediba 2	30	A
Tiger River	26	A
Feloane	22	A
Paradys	25	A
Middledeel	17	A
Merino	54	A
Morago	44	A
Ratabane	10	A
Seroalo	38	A
Rietfontein	21	G
Tweefontein	27	G
Gladstone	67	G
Woodbrigde 1	18	G
Kommiesdrift	30	G
Motlaltla	18	G
Mokwena 1 & 2	34	G
Potsane	17	G
Kilpfontein	14	P
Balaclava	5	P
Grootdam	4	P
Woodbrigde 2	16	P
Nogas Post	17	P
Selosesha	15	P
Rakhoi	8	P
Talla	50	P
Rooibuilt	55	P
Longridge	8	P
Mariasdal	6	P
Moroto	25	P
Kgalala	25	P
Modutung	21	P
Thubisi	8	P
Spitskop	18	P
Houtnek	8	P
Bofulo	6	P

Key:

G = Good

A = Average

P = Poor

Source: Received from the ARC at Glen on 2 November 2007.

ANNEXURE C.C: DEMOGRAPHIC PROFILE OF RESPONDENTS

	Number of Respondents:			**Percentage**		
	Poor	**Average**	**Good**	**Poor (n=62)**	**Average (n=82)**	**Good (n=73)**
Gender: Male	31	25	26	50%	30%	32%
Gender: Female	31	57	47	50%	70%	57%
Age: Below 35	12	13	6	19%	16%	7%
Age: Between 36-55	27	34	30	44%	41%	37%
Age: 56 and above	23	35	37	37%	43%	45%
Head of Household: Yes	46	54	52	74%	66%	63%
Head of Household: No	16	28	21	26%	34%	26%
Household size: 1-2	5	11	14	8%	13%	17%
Household size: 3-5	40	49	42	65%	60%	51%
Household size: 6-8	13	17	15	21%	21%	18%
Household size: 9 and above	4	5	2	6%	6%	2%
Number of people older than 20: 1-2	37	52	45	60%	63%	55%
Number of people older than 20: 3-4	20	27	24	32%	33%	29%
Number of people older than 20: 5 and above	5	3	4	8%	4%	5%
Formally Employed: Yes	11	15	22	18%	18%	30%
Formally Employed: No	51	67	51	82%	82%	70%
Education: Grade 5 or less	25	30	26	40%	37%	36%
Education: Grade 6-10	26	38	36	42%	46%	49%
Education: Grade 11 +	11	14	11	18%	17%	15%
Skill: Yes	6	8	10	10%	10%	14%
Skill: No	56	74	63	90%	90%	86%
Household Income: < R1000 per month	51	65	63	82%	79%	86%
Household Income: R1000-R2000 per month	11	14	8	18%	17%	11%
Household Income: > R2000 per month	0	3	2	0%	4%	3%
Main source of energy/electricity: Wood	8	11	5	13%	13%	7%

Main source of energy/electricity: Paraffin	7	5	9	11%	6%	12%
Main source of energy/electricity: Eskom	47	66	59	76%	80%	81%
Reliability of the electricity: Not Reliable	16	25	24	26%	30%	33%
Reliability of the electricity: Reliable	31	38	38	50%	46%	52%
Reliability of the electricity: Very Reliable	0	4	0	0%	5%	0%
Reliability of the electricity: Not applicable	15	15	11	24%	18%	15%
Expenditure on Electricity: < R50 per month	33	47	34	53%	57%	47%
Expenditure on Electricity: R50-R150 per month	13	20	28	21%	24%	38%
Expenditure on Electricity: > R150 per month	1	0	0	2%	0%	0%
Expenditure on Electricity: Not Applicable	15	15	11	24%	18%	15%
Main water source for garden: Irrigation: Self-abstraction	13	8	2	21%	10%	3%
Main water source for garden: Irrigation: Municipal	15	13	28	24%	16%	38%
Main water source for garden :Irrigation: Rain-fed	29	50	39	47%	61%	53%
Main water source for garden: Not Applicable	5	11	4	8%	13%	5%
Reliability of the water supply for garden: Not reliable	44	60	49	71%	73%	67%
Reliability of the water supply for garden: Reliable	11	11	20	18%	13%	27%
Reliability of the water supply for garden: Very Reliable	2	0	0	3%	0%	0%
Reliability of the water supply for garden: Not Applicable	5	11	4	8%	13%	5%
Source of tap water in household: Self-abstraction	5	2	8	8%	2%	11%
Source of tap water in household: Tap in street	46	65	20	74%	79%	27%
Source of tap water in household: Tap in Yard	11	15	45	18%	18%	62%

Reliability of the tap water supply: Not reliable	50	70	46	81%	85%	63%
Reliability of the tap water supply: Reliable	12	10	26	19%	12%	36%
Reliability of the tap water supply: Very Reliable	0	2	1	0%	2%	1%
Shelter type: Shack	3	3	4	5%	4%	5%
Shelter type: Traditional	25	27	22	40%	33%	30%
Shelter type: Brick	34	52	47	55%	63%	64%
Vegetable garden: Yes	55	73	67	89%	89%	92%
Vegetable garden: No	7	9	6	11%	11%	8%
Use Vegetable garden: Yes	55	66	70	89%	80%	96%
Use Vegetable garden: No	7	16	3	11%	20%	4%
Plants in vegetable garden: Vegetables	53	70	64	85%	85%	88%
Plants in vegetable garden: Maize	1	0	2	2%	0%	3%
Plants in vegetable garden: Not applicable	8	12	7	13%	15%	10%
Interest in Farming: Yes	44	56	44	71%	68%	60%
Interest in Farming: No	10	14	22	16%	17%	30%
Interest in Farming: Not Applicable	8	12	7	13%	15%	10%
Children in the household participate in farming: Yes	38	49	35	61%	60%	48%
Children in the household participate in farming: No	14	16	26	23%	20%	36%
Children in the household participate in farming: No Children	2	5	4	3%	6%	5%
Children in the household participate in farming : Not Applicable	8	12	8	13%	15%	11%
Children in the house are being trained to farm: Yes	38	46	34	61%	56%	47%
Children in the house are being trained to farm: No	14	19	27	23%	23%	37%
Children in the house are being trained to farm: No Children	2	5	5	3%	6%	7%
Children in the house are being trained to farm: Not Applicable	8	12	7	13%	15%	10%
Caretaker of garden in case of	12	2	9	19%	2%	12%

sickness: Wife						
Caretaker of garden in case of sickness: Husband	5	8	5	8%	10%	7%
Caretaker of garden in case of sickness: Children	25	37	27	40%	45%	37%
Caretaker of garden in case of sickness: Parents	4	5	4	6%	6%	5%
Caretaker of garden in case of sickness: None	6	11	13	10%	13%	18%
Caretaker of garden in case of sickness: Neighbours	2	6	7	3%	7%	10%
Caretaker of garden in case of sickness: Not Applicable	8	13	8	13%	16%	11%
Access to croplands: Yes	28	47	43	45%	57%	59%
Access to croplands: No	26	22	23	42%	27%	32%
Access to croplands: Not Applicable	8	13	7	13%	16%	10%
Use of croplands currently: Yes	0	4	11	0%	5%	15%
Use of croplands currently: No	54	64	55	87%	78%	75%
Use of croplands currently: Not Applicable	8	14	7	13%	17%	10%
Permission to occupy the croplands: Yes	30	46	47	48%	56%	64%
Permission to occupy the croplands: No	24	23	19	39%	28%	26%
Permission to occupy the croplands: Not Applicable	8	13	7	13%	16%	10%
PTO (Permit to Occupy): Yes	52	68	65	84%	83%	89%
PTO (Permit to Occupy): No	2	1	1	3%	1%	1%
PTO (Permit to Occupy): Not Applicable	8	13	7	13%	16%	10%
Awareness of in-field rainwater harvesting: Yes	38	56	57	61%	68%	78%
Awareness of in-field rainwater harvesting: No	16	13	9	26%	16%	12%
Awareness of in-field rainwater harvesting: Not Applicable	8	13	7	13%	16%	10%
Apply in-field rainwater harvesting technique: Yes	36	53	50	58%	65%	68%
Apply in-field rainwater harvesting technique: No	18	16	16	29%	20%	22%

Apply in-field rainwater harvesting technique: Not Applicable	8	13	7	13%	16%	10%
Member of the CB:WHIG: Yes	36	49	49	58%	60%	67%
Member of the CB:WHIG: No	18	19	16	29%	23%	22%
Member of the CB:WHIG: Not Applicable	8	14	8	13%	17%	11%

ANNEXURE C.D: SUMMARY OF ALL RESPONSES

	Question 34: In-field rainwater harvesting research has been in ongoing in my village for three years or more			**Question 35:** The in-field rainwater harvesting research team has demonstrate how the technique work			**Question 36:** In-field rainwater harvesting has been explained to me		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	1	5	0	2	6	3	0	4	4
Agree	39	54	59	38	52	55	39	54	53
Neither	20	19	11	20	18	11	21	17	9
Disagree	1	4	3	2	6	4	2	7	7
Strongly disagree	0	0	0	0	0	0	0	0	0
Total	**61**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**
	Question 37: I have been able to talk to the in-field rainwater harvesting research team at any time			**Question 38:** The demonstration was convincing and I have accepted it after 1 demonstration			**Question 39:** The research team has involved me in and during the research process		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	0	5	5	0	6	4	0	5	1
Agree	38	48	51	38	48	50	39	45	53
Neither	21	16	9	21	16	9	21	16	9
Disagree	3	13	8	3	12	10	2	16	10
Strongly disagree	0	0	0	0	0	0	0	0	0
Total	**62**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**
	Question 40: I knew about in-field rainwater harvesting before the start of the research project in 2002			**Question 41:** In-field rainwater harvesting in my village has taken place BEFORE the research team started their research			**Question 42:** In-field rainwater harvesting has only started since the research team's involvement		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	0	0	0	0	0	0	0	3	3
Agree	4	3	2	0	2	1	37	48	50
Neither	23	28	17	23	31	17	23	29	17
Disagree	28	42	51	35	43	55	2	1	3
Strongly disagree	7	9	3	4	6	0	0	1	0
Total	**62**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**

	Question 43: I understand in-field rainwater harvesting			**Question 44:** In-field rainwater harvesting is easy to apply			**Question 45:** In-field rainwater harvesting can be duplicated easily		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	6	11	10	7	10	15	0	1	5
Agree	34	49	46	27	44	38	27	39	35
Neither	22	20	12	22	21	13	22	21	14
Disagree	0	2	5	6	7	7	8	19	19
Strongly disagree	0	0	0	0	0	0	5	2	0
Total	**62**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**
	Question 46: I prefer alternative ways to farm and to produce food than to use in-field rainwater harvesting			**Question 47:** The conventional way of cropping is better than in-field rainwater harvesting			**Question 48:** Hydroponics is better than in-field rainwater harvesting		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	0	0	0	0	0	0	0	1	1
Agree	3	15	9	2	8	7	10	14	13
Neither	20	19	13	20	20	14	21	27	15
Disagree	36	44	49	37	51	50	26	33	40
Strongly disagree	3	4	2	3	3	2	5	7	4
Total	**62**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**
	Question 49: It is easy to switch to in-field rainwater harvesting			**Question 50:** In-field rainwater harvesting yields less crops than the conventional method			**Question 51:** In-field rainwater harvesting yields less crops than hydroponics		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	4	10	10	0	1	2	0	0	0
Agree	31	48	40	5	15	2	7	15	10
Neither	22	19	15	21	21	20	23	30	20
Disagree	5	4	8	34	42	49	28	34	43
Strongly disagree	0	1	0	2	3	0	4	3	0
Total	**62**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**

	Question 52: In-field rainwater harvesting yields more crops than the conventional method			**Question 53:** In-field rainwater harvesting yields more crops than hydroponics			**Question 54:** Tools such as spades and forks is easily available		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	0	3	0	2	6	1	4	10	0
Agree	35	46	45	33	32	42	39	43	50
Neither	20	20	18	22	26	15	9	9	7
Disagree	7	12	10	5	18	15	9	18	16
Strongly disagree	0	1	0	0	0	0	1	2	0
Total	**62**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**

	Question 55: Access to seed for crops is easy		
	Poor	**Average**	**Good**
Strongly agree	0	0	0
Agree	17	22	22
Neither	8	8	7
Disagree	35	51	44
Strongly disagree	2	1	0
Total	**62**	**82**	**73**

	Question 57: In-field rainwater harvesting has improved my crop yields			**Question 58:** In-field rainwater harvesting has helped me financially			**Question 59:** In-field rainwater harvesting has made me more food secure		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	0	6	1	0	4	1	0	5	1
Agree	37	40	48	3	33	37	37	45	50
Neither	0	1	0	1	7	4	0	0	0
Disagree	0	5	2	0	8	9	0	2	0
Strongly disagree	0	0	0	2	0	0	0	0	0
Not applicable	25	30	22	1	30	22	25	30	22
Total	**62**	**82**	**73**	**7**	**82**	**73**	**62**	**82**	**73**

	Question 60: In-field rainwater harvesting can be applied in the croplands			**Question 61:** All the people with vegetable gardens in the village apply in-field rainwater harvesting methods			**Question 62:** I will apply in-field rainwater harvesting in the croplands		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	9	14	10	0	0	0	7	11	9
Agree	23	31	35	0	5	0	21	30	31
Neither	0	1	0	0	1	0	0	1	0
Disagree	5	6	6	36	44	51	9	9	11
Strongly disagree	0	0	0	1	2	0	0	1	0
Not applicable	25	30	22	25	30	22	25	30	22
Total	**62**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**
	Question 63: For the croplands, in-field rainwater harvesting is better than ploughing			**Question 64:** I will use cattle to plough the croplands			**Question 65:** I will only plant maize in the croplands		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	0	0	1	0	0	0	0	2	0
Agree	0	5	0	6	1	1	0	3	2
Neither	0	1	0	2	7	2	0	2	1
Disagree	37	44	50	29	44	48	37	45	48
Strongly disagree	0	2	0	0	0	0	0	0	0
Not applicable	25	30	22	25	30	22	25	30	22
Total	**62**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**

	Question 66: I will plant maize plus vegetables in the croplands			**Question 67:** I will only produce for my own household			**Question 68:** I will try my best to produce a surplus of crops		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	0	1	0	0	0	0	0	2	0
Agree	21	32	31	1	6	6	29	46	45
Neither	0	1	1	0	1	0	1	0	0
Disagree	16	18	19	36	44	45	7	4	6
Strongly disagree	0	0	0	0	1	0	0	0	0
Not applicable	25	30	22	25	30	22	25	30	22
Total	**62**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**
	Question 69: Should I have a surplus, I will sell my crops			**Question 70:** I will not use any of the harvest from the croplands, but sell all of it			**Question 71:** I will work with other people in my village and sell a larger volume to the market		
	Poor	**Average**	**Good**	**Poor**	**Average**	**Good**	**Poor**	**Average**	**Good**
Strongly agree	0	3	0	0	2	0	7	12	7
Agree	22	35	38	24	35	38	24	36	40
Neither	0	0	0	3	2	1	0	0	0
Disagree	15	14	13	10	13	12	6	4	4
Strongly disagree	0	0	0	0	0	0	0	0	0
Not applicable	25	30	22	25	30	22	25	30	22
Total	**62**	**82**	**73**	**62**	**82**	**73**	**62**	**82**	**73**

ANNEXURE D: SECOND SURVEY RESULTS

1 BACKGROUND

Following the outcome of the first survey conducted using the McMaster tool, see Annexure C, a second survey was conducted in the same villages using a semi-structured questionnaire to solicit answers to specific questions. These questions arose from the results of the first survey and pertain to the clarification and understanding of matters with specific reference to the interaction between the crop and cattle farmers, among the crop farmers to form a co-operative or to farm in a co-operative way, and the crop farmers' wiliness and ability to access the croplands.

The questionnaire used, see Annexure D.A, was constructed in an iterative way between the researchers, the WRC staff and Dr Cobus Botha of the ARC at Glen.

The survey was conducted by Mr Xolani Sibande of the research team with the assistance of Ms Kelebogile Modise, the Chairperson of the local organising IFRWH committee.

2 SURVEY PLAN

The survey was conducted from the 21-24 February 2008. The selection of the villages surveyed was exactly the same as that of the first survey – see Annexure C.B.

Three villages were selected from the good cluster: 1) Gladstone, 2) Rietfontein and 3) Potsane. Five villages were selected from the average cluster: 1) Springfontein, 2) Yorksford, 3) Feloane, 4) Merino and 5) Morago, and four villages were selected from the poor cluster: 1) Nogas Post, 2) Kgalala, 3) Talla and 4) Thubisi.

As stated above, while it was anticipated in the proposal (see Annexure A) that the second survey will follow the same format as the first, the research team in conjunction and after consultation with the WRC decided to change the research format. The McMaster tool used during the first survey has revealed significant results, but also questions. It was, therefore, decided to use a semi-structured questionnaire (see Annexure D.A) instead to solicit answers to specific questions using focus group discussions.

Of the 20 targeted focus groups, 13, or 65 per cent, were reached (see Figure 34 below). A deliberate attempt was made to differentiate between gender and age among the focus groups and such differentiation was achieved. The composition of the interviewed groups varied from mixed in terms of gender and age, to homogenous groups that were either men or women of the same age.

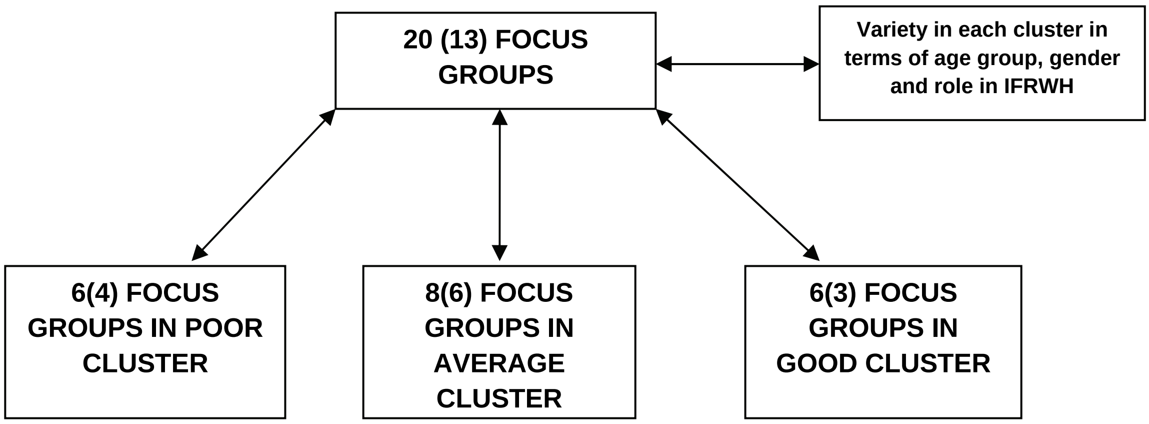


Figure 34: Illustration of the structure of the survey
***Figures in parenthesis are actual and without are targeted.**

3 CASUAL OBSERVATIONS FROM INTERVIEWS CONDUCTED: GOOD CLUSTER

3.1 Gladstone

Here we met a group of elderly women. These elderly women are at the heart of IFRWH and the IFRWH in Gladstone. According to what we gathered from these elderly women, Gladstone has an effective leadership mechanism. The activities of IFRWH are coordinated through the IFRWH committee and decisions are taken in consultation with the headman who represents the broader community.

The participants consider the move to the croplands as a significant challenge. They consider such a move as one that will have to be a community initiative and that it cannot happen in isolation from the broader community. This relationship between the broader community and IFRWH committee is vital since, if properly managed, it eliminates tensions in the community and opens the channels for the community as a whole to benefit from IFRWH.

A further challenge is their inability to formalise a co-operative, to which end they admitted that they need help. The creation of markets is also a challenge for them – however, they already barter with one another on occasion.

3.2 Rietfontein

Upon arrival we visited the headman – who is also a member of IFRWH. This became one of the more fruitful conversations of the trip as we engaged with him on leadership issues. During the interview he described the leadership structure and it is depicted in Figure 35.

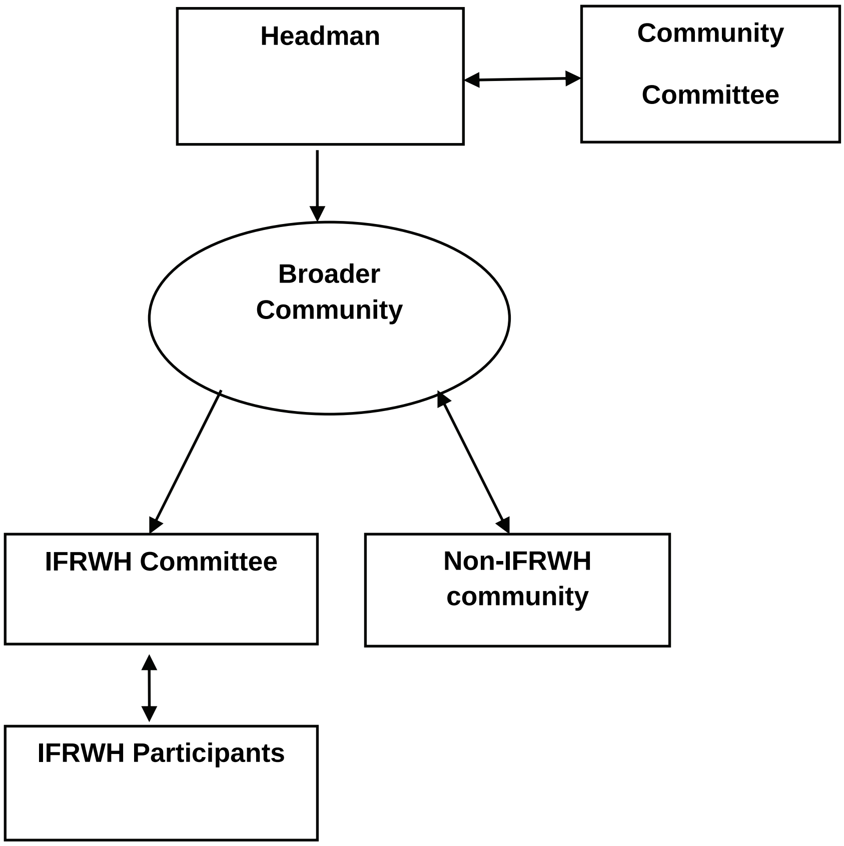


Figure 35: IFRWH Leadership structure

Brief Description: When a problem arises the headman writes a letter to the Community Committee and the matter is debated. Once decision is made a "Pitso" – community meeting – is called and after consultation with the community a decision is taken.

This structure holds for most of the villages in one form or another. As we engaged the headman further on how he saw this structure coordinating the community in a manner that allowed his community to work towards and at the croplands, the headman mentioned the following:

1. As part of community and as an IFRWH participant himself, he was in principle for moving to the croplands.
2. The structure could be amended to include a set of rules specifically for the croplands – and this would be administered within the structure. He saw himself as an integral part of that process.
3. He saw a lack of resources – farming implements, etc. – as an obstacle towards moving to the croplands.
4. The biggest challenge of all was keeping the community interested and motivated through incentives. He mentioned that initiatives in the past failed because people in the community are short-sighted and only cooperate when there is the promise of quick gratification – leadership structures, procedures are null and void if this is not addressed.

The group discussion revealed a communal spirit as they shared their views and sentiments on moving to the croplands. This community seemed more connected that the other communities visited.

What were surprising were how both male and female (young and elderly) shared similar view points on IFRWH in general and moving IFRWH to the croplands.

The group was dynamic in terms of its composition (men and women of all ages) and the responses given. The level of awareness about the importance of farming in reducing poverty and in creating employment opportunities (creating a common focus for the community), is high. Discussions with a cattle farmer revealed that he and the IFRWH participants have an understanding and that he would be willing to assist in whatever manner possible. The IFRWH participants expressed no concerns about the cattle farmer – this is also true in most other villages visited. On the possibility of using rangeland IFRWH he answered that in principle he was interested in trying it, but was sceptical about its potential for success.

3.3 Potsane

The women, mostly middle-aged, are a lively bunch – as experienced during the first survey as well. They are always positive towards life and farming.

On the prospect of moving IFRHW to the croplands they were cautiously optimistic. Their greatest concern rests on the security of their harvest in the croplands. This concern is driven by a lack of support from the community – one of the ladies called it jealousy. At a communal level, Potsane is torn by conflicts among residents and this is aggravated by the fact that the headman has lost control due to old age. This is clearly a problem many villages share and it is not clear what drives this conflict between the IFRWH team and the headman.

Another interesting issue raised was that the ladies did not think animals (cattle) pose a serious threat or is a concern for taking IFRWH into the croplands should they have fencing. They did mention that it has always been communal practice to fine the owner of the animals responsible should there be damaged to the crops. For example, if an animal was responsible for ruining someone's crops, the owner of the animal would pay R20 per "paw" mark on the plot. In the event that the owner could not afford to pay the fine, the animal would then be sold to cover the fine and the balance paid to the owner. When asked if they did not think that this was too strict, they said that this has always been common practice in their community.

4 CASUAL OBSERVATIONS FROM INTERVIEWS CONDUCTED: AVERAGE CLUSTER

4.1 Springfontein

Our experience in Springfontein was similar to that of Nogas Post. In both villages the groups comprises woman and both villages are small in terms of number (general population and IFRWH participants). At a communal level, both villages are torn by a lack of leadership and a lack of cooperation – which is driven by internal conflicts.

The women in both villages try their level best to organise themselves in a constructive manner. However, the challenge of day-to-day living (and by extension the possibility of moving to the croplands) is difficult. In both villages there is a weak presence of leadership by the headman – in Springfontein the women did not even know where the headman was and did not have positive sentiments about him. In Nogas Post we found the headman in a tavern (obviously intoxicated), also the sentiments about him were not very positive.

In both villages, however, there is resolute hope in these women to soldier on regardless of whatever challenges that they are facing at present and perhaps with time and assistance, they may realise some of their aspirations in farming.

4.2 Yorksford

We arrived in Yorksford just as the community was about to finish their “Pitso” (community gathering), which dealt with the lack of performance by their headman. It seems the community were seeking ways to replace him.

As we entered the hall we found about 24 people of all ages and gender. Upon our request they divided into two groups, but without any influence from our side, they separated into a group of males and a group of females. Sharp differences existed between the two groups and the male group dominated and subverted the female group.

Interestingly, however, when asked about the issue of having adequate knowledge to move to the croplands, the young males said they did not have adequate knowledge while the elderly (who have previously worked in the croplands during the days of Agri Co.) said they had more that enough knowledge. It turns out that the young men do not have the necessary respect for the elderly men. They feel that the knowledge that elderly have is outdated – this lead to a break-down in communication and the vital flow of information between the generations.

4.3 Feloane

The group interviewed comprised of women of all ages and elderly men. Feloane proved similar to Springfontein, Nogas Post and Kgalala in that the village is small in number and IFRWH is mostly led by women and there is a lack of youth participation.

The headman of Feloane mentioned that the most critical reason why the community of Feloane cannot move to the croplands was “income vulnerability”. He is of the opinion that for the time a person might have to work on the croplands preparing it without benefiting from it, this will mean that such a person will not be able to feed his family.

4.4 Merino

Merino turned out to be the surprise package. Within the first few minutes of the interview, the group revealed that they had previously gone to the croplands – making the questionnaire null and void. By croplands they meant a piece of land in the croplands that the community farmed collectively.

In all villages visited during the second survey there is mention of the fact that in the past the villages used to work in the croplands. However, Merino is the only village where evidence of this is still clearly visible. As one walks around the village there are old tractors, ploughs and other farming utilities lying in the yards of the residents.

The impetus to move to the croplands came from the example one gentlemen – Mr Mosidipi provided. Mr Mosipidi has managed to use a tractor to construct IFRWH basins on his own accord. He has a large area on the edge of the village were he has successfully planted and harvested various crops.

Seeing his initiative, the community asked him to help them move to the croplands. This collectively managed communal area they obtained with the help of the headman. The community exhibited the necessary levels of motivation and cooperation needed to make the transition into the croplands. They managed well until the initiative failed on account of a lack of fencing. They still, however, have the energy and the desire to move to the croplands as a community. To further understand, we asked about the pre-conditions to this occurrence, to which they replied:

1. First, the strong presence of the headman was essential – he even went as far as lending the community his own tractor.
2. The example of Mr Mosipidi enabled the community to take on and mitigate the risk inherent in the process.
3. The leadership and technical knowledge of Mr Mosipidi was important as the community followed his instruction.
4. Communal organisation and cooperation in the community is advanced as the links between generations still existed – shown by the variety (young and old) in attendance.
5. Their initial farming plan was simple. Plant maize and sunflower as these do not need much water. They organised themselves into groups of five and these groups were allocated sub-plots which they alone were responsible for – reducing the free-rider effect.
6. The whole community, not just IFRWH participants, were involved in this process.

Furthermore, their opinion on rangeland rainwater harvesting was asked for. The community revealed a surprising result:

> Nobody actually herd their cattle any longer. The cattle are simply released to the “croplands” to graze and kraaled in the evenings.

The community did not agree that IFRWH could be used to plants crops such as Lucerne since these required that the crops are cut and let to grow again.

4.5 Morago

In Morago it become apparent from the first minute that levels of motivation and IFRWH are low, as not even a single individual attended the interview at the set time – except for the IFRWH committee chairperson. She informed us that motivation runs low. We resorted to going to each house and actually collecting the members individually.

The group was entirely made up of middle-aged women. It was difficult to understand the true sentiments of this group. The responses to the questions asked and the mood in the interview reveals that the group is motivated to move forward with IFRWH. However, the fact that they did not see it as important to attend the interview as arranged, paints a different picture.

Morago is similar to Springfontein in that it is small in numbers and there is a lack of participation in farming from the fathers and the youth of the community – making sustainability of moving forward with IFRWH difficult.

5 CASUAL OBSERVATIONS FROM INTERVIEWS CONDUCTED: POOR CLUSTER

5.1 Nogas Post

See Springfontein, 4.1.

5.2 Kgalala

The group interviewed in Kgalala comprised mostly elderly men and women. They indicated concerns with the future of farming in their community since the younger generation does not show any interest in faming. Their response to the prospect of moving IFRWH to the croplands was that of polite resignation. The group did not fully engage in the questions asked making it difficult to grasp the reasons why they opt for not wanting to move into the croplands.

5.3 Talla

Talla is unique in that IFRWH is almost entirely led by the youth – mostly young males – when compared to other surveyed villages. The expectation is then that with the impetus of youth IFRWH practice in the village would be at an advanced level (comparably), however this is not so. The interview revealed that there is deep frustration amongst the group. This is firstly driven by a clear lack of leadership and support from the general community and especially the elders.

The second source of frustration comes from an apparent lack of coordination of various government programmes that are ongoing in the community. There is serious confusion about what the government programmes are suppose to achieve and there is a lack of continuity in terms of the individuals that run these programmes – this is a sentiment shared by all surveyed villages. The group communicated that those individuals from different government departments come to their community and promise them assistance in some form or other. Poverty creates an economic and social vulnerability within communities, and when these promised assistance do not materialise it is a big set back as it dampens the already strained social capital that allows them to move forward towards a better life.

5.4 Thubisi

Here we met a mixed group (of all ages and gender). From the first question it was clear that this group had not considered the possibility of moving to the croplands. One of the participants in the group even said that we should rather concentrate on the IFRWH in the gardens and not talk about IFRWH in the croplands.

According to this group the allocated croplands are located at quite a distance from them – an hour's walk. They, therefore, do not see moving to the croplands as a viable option. When asked on the opinions of the headman on this issue, the group showed a lack of faith in their leader and did not produce a clear answer. Furthermore, it seems the youth of Thubisi only see farming as a second alternative to earning a livelihood – second to finding employment elsewhere. An elderly gentleman mentioned that this – and a lack of clear leadership from the headman – has been a source of failure for past initiatives which he led. There is a serious lack of commitment and motivation within the community – especially the youth. As in Yorksford, the information link between these two generations (between the elderly and the young) is severely damaged because of differences in outlook towards life – further contributing to the current state of affairs.

6 DETAILED PERSPECTIVES BY QUESTION

Given the trip impression provided in Sections 3, 4 and 5, what are the detailed responses to the various questions raised? The answer to this question is provided in Table 13.

Table 13: Breakdown of the responses by cluster and by question following the qualitative assessment

Questions	Good cluster	Average cluster	Poor cluster
1. What does In-Field Rainwater Harvesting (**IFRWH**) mean to you?	IFRWH is a way of improving our lives.	IFRWH promotes a better standard of living through better yields.	It has improved our lives by providing our food security.
1.1 What is its benefit – its significance – to you?	Certainty of harvest and an opportunity of earning income through selling the produce. It has also helped to solve communal conflicts by creating a common focus. It also makes farming easier.	Since IFRWH we have the opportunity to provide food for ourselves through better yields and water conservation of IFRWH.	It makes farming easier and provides better yields.
1.2 What impact has it had in your life?	It improved our lives by affording us an opportunity to address our own poverty.	IFRWH has been a positive force in that it provides an opportunity to learn and work together as a community.	It is now possible to both eat and sell some of the harvest as a result of IFRWH.
1.3 What is your future expectation with regards to **IFRWH**?	To improve IFRHW so as to improve our own lives.	We wish to move forward and further improve IFRHW.	To further benefit from IFRWH.
2 Why have you not moved towards applying **IFRWH** in the croplands?	Lack of motivation to move to the croplands and also lack farming implements such as tractors.	Moving to the croplands poses too much of a risk since there is no certainty of returns. There is also a lack in the required resources to move to the croplands.	Croplands are too far away to walk to daily. Also lack motivation to move to the croplands and a lack of resources.
2.1 Do you have the desire to apply **IFRWH** in the croplands?	With help (in terms of resources), yes.	With help (in terms of resources), yes.	They are willing to go to the croplands – with help.

2.2 What are the obstacles involved?	Lack of farming implements, such as tractors, and theft in the croplands as a result of a lack of fencing. Also conflicts among community members can prevent success in the croplands.	Lack of fencing and tractors are a serious challenge.	Forming communal cooperation – organisation. Obtaining fencing and other farming implements. Lack of water is also a serious issue.
2.3 What are the benefits involved?	The opportunity to produce a larger harvest and profit from that.	Further able to explore better yields from IFRHW and the opportunity to earn an income.	Larger harvest and the opportunity to sell and earn from this.
2.4 Do you understand what the challenges and the benefits involved mean?	Not fully. Have not practiced IFRWH yet there so do not understand or know the full picture.	No. Since they are unable to unlock the opportunities and move forward and prosper in the croplands.	Not clear. They grasp some of the challenges in isolation but not holistically.
2.5 Do you believe that with time and assistance you can overcome these obstacles?	Yes. Willing to learn and move forward given the opportunity.	Yes. The critical point is consistent support in terms of skills and resources.	Yes. Willing to learn and move forward given the opportunity. However some see moving as not a viable option due to the constraints mentioned above and below.
3 What strategies would you employ to ensure that a harvest is realised in the croplands?	Use weed control, crop management, and technical support from ARC to prosper from the croplands.	Use a tractor to plough the land, fertilizers, and pesticides.	They would control weed, irrigate and use tractors to plough the land.
3.1 Would you use a tractor to plough your fields? Why? Why not?	Yes. A tractor is more efficient than using draught animals, and it reduces the work load.	Yes. A tractor is more efficient than draught animals and it reduces the work load.	Yes. A tractor is more efficient than draught animals and it reduces the work load.
3.2 Would you use a tractor only for conventional tilling?	No. From the knowledge gained from Glen, it is possible to construct IFRWH basins.	No. From the knowledge gained from Glen, it is possible to construct IFRWH basins, which reduces the manual work.	No. From the knowledge gained from Glen, it is possible to construct IFRWH basins.
3.3 Would you use a tractor to	With help from ARC on how to	Yes. As explained in 3.2.	Yes. It would reduce the amount of

construct the IFRWH basins? Why? Why not?	construct basins, yes. Saves time and reduces the workload using manual labour.		manual labour involved in the process.
3.4 Would you use cattle to construct the IFRWH basins? Why? Why not?	No. Cattle are not readily available and it involves too much work and old-fashioned.	No. No cattle available to construct basins. And cattle are too much work and old-fashioned.	No. Cattle are not available and it is too much work and old-fashioned.
3.5 Will a demonstration plot of the construction of the IFRWH basins in the croplands help?	Yes. As done with IFRWH and then we can carry on from there.	Yes. Demonstrations would be most helpful.	Yes. Demonstrations would be most helpful.
3.5.1 What type of demonstrations?	Demonstrations on constructing basins and taking measurements in the croplands.	Demonstrations on constructing basins, taking measurements in the croplands.	Demonstrations would be most helpful.
3.5.2 Where do you want the demonstrations done?	At the croplands.	At the croplands.	At the croplands.
3.6 If yes in 3.5, what sort of help or skills training do you think you need?	Skills as mentioned in 3.5.1. On how to construct basins and manage crops in the croplands.	Skills as mentioned in 3.5.1. On how to construct basins and manage crops in the croplands.	Skills as mentioned in 3.5.1. On how to construct basins and manage crops in the croplands.
3.7 How would you manage the extra work load presented by the croplands in addition to your normal day-to-day work?	Sacrifice time as they do in gardens. Also use time management to cope with the work load in the croplands.	Generally the sentiment is that the work load in the croplands is too much because of old age or a lack of adequate numbers in the community.	Sacrifice personal time and even involve families in process.
3.8 Do you believe that you have adequate knowledge about crops and farming in general to farm in the croplands? If not, what knowledge do you think you still need?	No. Need further knowledge on how to farm in the croplands. As mentioned above – construction of basins, taking measurements and crop management in general. Not clear on the type of skills needed.	They do not, categorically, have enough knowledge to farm in the croplands. They are also not clear on the type of skills needed.	No. Need further knowledge on how to farm in the croplands. As mentioned above – construction of basins, taking measurements and crop management in general; but they are not clear on the type of skills needed.
3.9 Are there sufficient tractors	No – no tractors are available.	No – no tractors are available.	No – no tractors are available.

available to plough the croplands should you use them?			
3.10 Would you be able to afford the tractors and other farming implements?	Not at this time. Not even collectively as a community/group.	Not at this time. Not even collectively as a community/group.	Not at this time. Not even collectively as a community/group.
3.11 What could you use in addition to the tractors to operate the field?	Other farming tools such as spades to control weeds, etc.	Other farming tools such as spades to control weeds, etc.	Other farming tools such as spades to control weeds, etc.
4 Do you believe that your harvest would be secure in the croplands?	Generally no. Some contest that they know their community and would be able to deal with theft; while some contest that their own communities are a threat to their harvest.	No. Theft is a serious issue because of a lack of fencing.	The harvest would be safe only if the croplands were fenced.
4.1 Do you have access to the croplands?	Yes. The croplands were allocated with the “stand cards”.	Yes. The croplands were allocated with the “stand cards”.	Not everyone has access to the croplands. Allocation of communal land is an issue that is being discussed currently.
4.2 Why are you not using the croplands currently?	Lack of fencing and the fact that the croplands are dilapidated.	Croplands are being used as grazing land, which increases the fear of harvest theft because a lack of fencing. Difficult to commute to the croplands because of inadequate roads.	Access is a problem as mentioned in 4.1 above. Lack of fencing and other farming implements.
4.3 Is your allocated portion of the cropland for your own use only?	Yes. However it is possible to work in groups if agreement is reached.	Yes. However it is possible to work in groups if agreement is reached.	In cases where access is clear, yes. However it is possible to work in groups if agreement is reached.
4.4 What are the challenges involve in ensuring harvest security?	Finding adequate fencing. The establishment of some form of	Finding adequate fencing to protect against theft and animals. Forming	Finding adequate fencing to protect against theft and animals. Forming

	community policing structure such as a community policing forum that involves cooperation with SAPS were mentioned.	some form of community policing structure to ensure harvest security.	some form of community policing structure to ensure harvest security.
4.5 What steps can be taken to ensure harvest security?	See 4.4.	See 4.4.	See 4.4.
4.6 What roles can the **IFRWH** committee play in ensuring harvest security?	IFRWH committee must lead in terms of organising the people around this process – including communicating with the headman.	IFRWH committee must the lead in terms of organising the people around this process – including communicating with the headman.	IFRWH committee must lead in terms of organising the people around this process – including communicating with the head man.
4.7 What role can cattle farmers play in ensuring harvest security?	With fencing cattle farmers would not be an issue. However they can assist in the process by helping with the work and securing the croplands.	Cattle farmers can ensure that their herds are clear of the croplands – however this would not be an issue with adequate fencing.	Cattle farmers can assist by keeping their herds away from the croplands.
4.8 What roles can the community and the headman play in ensuring harvest security?	Headman must assist in protecting the croplands and solving conflicts when they arrive.	The headman can assist in obtaining buy-in from the community to assist in protecting the croplands.	The community and the headman must be directly involved in the process of moving to the croplands and assist in protecting the croplands.
5 Do you think co-operatives can be beneficial in realising better yields in the croplands?	Yes. It would help promote food security and create self-employment opportunities.	Not clear. Depends on how the community participates in the co-op and how the co-op would be run.	Not clear. Depends on how the community participates in the co-op and how the co-op would be run.
5.1 What is a co-operative?	No coherent definition or understanding. Some mention of collective buying and selling.	No coherent definition or understanding. Some mention of collective buying and selling.	No coherent definition or understanding. Some mention of collective buying and selling.
5.2 Why have you not formed a co-operative yet?	A lack of knowledge on how to form a co-op has prevented them from forming a co-op.	A lack of knowledge on how to form a co-op and a lack of communication in the villages.	Do not possess adequate knowledge to form a co-op.

5.3 Do you know how to form a co-operative?	No. As mentioned in 5.2.	No. As mentioned in 5.2.	No. As mentioned in 5.2.
5.4 How would the co-operative be operated for the benefit of all?	The key is to involve all so as to benefit all.	Not clear. No clear definition on what a co-op is and how it would operate.	No specifics on how to operate co-op for the benefit of all. However involvement of all is mentioned.
5.5 Would you participate in a co-operative that collectively buys seed and consumables?	Yes	Yes	Yes
5.6 Would you participate in a co-operative that collectively buys and use instruments such as ploughs and tractors?	Yes	Yes	Yes
6 How would you ensure that a surplus is realised from the crops produced in the croplands?	Use a tractor to plough, fencing to ensure security and apply weed control.	Use a tractor to plough, apply fencing to ensure security and to use weed control.	Use a tractor to plough, fencing to ensure security and apply weed control.
6.1 Where would you sell your surplus production?	Sell to markets in Bloemfontein and Thaba Nchu.	There is uncertainty and concern on the availability of markets. There is some mention on markets in Thaba Nchu and Bloemfontein.	Sell to markets in Bloemfontein and Thaba Nchu and even sell to their own community members.
6.2 What mode of transport would you use to deliver your produce to the market (when needed)?	Transport is a serious issue that they have yet to think about properly and solve it.	Not certain on transport. The government should provide some form of transportation.	Would arrange transport collectively. Use horses, buses or even hire transport.
6.3 In the case of co-operatives what mechanisms would be put in place to ensure that the surplus/losses are distributed fairly?	Agree before hand (through a constitution) on how surplus and losses are to be distributed fairly.	No clear answer.	No clear answer.
6.4 What kind of help would be needed to achieve this surplus?	To ensure a surplus they control weeds, find means of irrigation and	Help with farming implements, fertilizers, etc.	Help with farming implements, fertilizers, etc.

	manage multi-cropping.		
7 What kind of crops would you produce in the croplands?	Sunflower, maize and vegetables.	Sunflower, maize and vegetables.	Sunflower, water melons, beans, etc.
7.1 Do you have a plan to achieve different types of crops?	No. Need assistance on how to manage multi-cropping.	Yes. Believe that they posses enough knowledge to manage multi-cropping. However no specifics on plan.	Do not have enough knowledge on how to manage multi-cropping, need help from government.
7.2 What challenges are involved in different types of crops?	Knowledge when, and what to plant at what time. What crops to plant on which soil type.	Knowledge on appropriate times to plant different crops and appropriate soil types for different crops.	Not clear on what kind of help, however they do mention that this can be provided by ARC Glen.
7.3 Do you believe that you have enough knowledge and skill to manage multiple crops at the same time?	No. Need more knowledge on how to manage multi-cropping.	See 7.1.	See 7.1.
8 What skills are needed to move to and surplus from the croplands?	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and demonstrations.	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and demonstrations.	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and demonstrations.
8.1 Do you believe that you posses adequate skills to achieve this?	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and demonstrations.	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and demonstrations.	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and demonstrations.
8.2 What are your needs in terms of skills?	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and

	demonstrations.	demonstrations.	demonstrations.
8.3 Where do you think can you obtain the skills?	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and demonstrations.	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and demonstrations.	Knowledge and skills are interchangeable in seSotho. Refer to questions about knowledge and demonstrations.
9 Do you believe that the knowledge obtained from the Glen researchers is adequate in enabling you to move to the croplands?	No. The knowledge from the ARC is adequate for gardens and not for the croplands.	No. The knowledge obtained from the ARC is adequate for gardens, but not for the croplands.	Not adequate knowledge need more help – demonstrations in the croplands.
9.1 What more could have been done?	Demonstrations in the croplands would be most beneficial.	Need more knowledge on aspects such as determining soil quality and taking the appropriate measurement when farming in the croplands. Further demonstrations at the croplands are needed.	Demonstrations in the croplands would be most beneficial.
10 If you were to move to the croplands tomorrow, what are the most important necessities would you need?	A tractor, fencing and other farming implements and technical support.	A tractor, fencing and other farming implements.	A tractor, fencing and other farming implements.
10.1 How can the headman assist in facilitating this process?	Headman can assist in facilitating the process through communication with the different stakeholders.	Headman can assist in facilitating the process through communication with the different stakeholders.	No clear role is mentioned for the headman.
10.2 What role should government (Dept. of Agric.) play?	The DTA must take interest in the process and provide the necessary support.	The Department of Agriculture must provide the necessary resources and expertise.	The DTA must take interest in the process and provide the necessary support.

Section 2: Questions for the Headman	**Good cluster**	**Average cluster**	**Poor cluster**
1 Do you believe that applying **IFRWH** in the cropland would benefit your village?	Yes – they would be able to produce more in the croplands and even sell.	Yes. The community would benefit from working in a larger space and the possibility of earning an income.	Yes, the community would benefit through improved food security. Also the gardens are too small and moving to the croplands would solve this.
2 What do you foresee as the main challenges to this?	A lack of motivation from the community and an inability to work collectively.	Fencing is the biggest challenge and motivating the community to pursue this.	Main challenges are fencing and organisation.
3 What role do you see yourself playing in this?	Being a bridge between the community and government since he is part of IFRWH committee by directly being involved in farming on the croplands.	To provide leadership were necessary and coordinate efforts between the community and other stakeholders.	The role of a coordinator and messenger between the community and the government.
4 How can you assist in the facilitation and functioning of an **IFRWH** system in the croplands?	Provide the organisational and leadership structures necessary for the process to succeed, however this can only work if the community cooperates.	Contributing knowledge on organisation and farming in general.	By having oversight over the process and being a mediator when there are conflicts.

Section 3: Questions for the cattle farmers	**Good cluster**	**Average cluster**	**Poor cluster**
1 Do you know what **IFRWH** is?	Yes but not fully.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
2 Do you think that it can be applied in the croplands?	Yes they can with adequate space, tractors and fencing.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
3 How do you think will IFRWH in the croplands affect you?	Willing to help in any way possible.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
4 In what way do you believe that this could be affected by the grazing of your cattle?	If the croplands are properly fenced, there should be no effect.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
5 Would you be interested in playing a role in the application of **IFRWH** in the croplands by, for example, keeping the cattle out of the croplands?	Yes. Move cattle to different fields, away from croplands.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
6 Are you willing to work with the IFRWH leaders of the village to develop the croplands as well?	Yes willing to participate.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
7 How do you respond to some of the comments made by the crop farmers (interviewer mentions what crop farmers have said about cattle farmers)?	Generally no conflicts between two groups. Part of the same community.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.

8 Would you be willing to manually remove the plant residuals from the croplands to feed the cattle if the cattle are not allowed to enter the croplands (not even in winter because it will damage the IFRWH basins)?	Not sure. Depends on the work that is involved in the process.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
9 Is a fence necessary to protect the croplands?	Yes.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
10 Will your own herding system, without fencing in the croplands, be sufficient to protect the croplands?	No. Fencing is also necessary to protect the croplands.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
11 Would you use IFRWH for your cattle – Rangeland Rainwater Harvesting?	Not sure but willing to try. However crops such as Lucerne would be difficult to cultivate.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
a Would you benefit from using rainwater harvesting for your cattle?	Not sure but think they would benefit.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
b Would you participate in using rainwater harvesting for your cattle?	Not sure, yet willing to try.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.
c Would you use rainwater harvesting for crops such as Lucerne, etc?	Lucerne requires that it is cut and allowed to grow again, rainwater harvesting may not be best for this.	Due to time constraints no interviews were conducted in this category.	Due to time constraints no interviews were conducted in this category.

ANNEXURE D.A: QUESTIONNAIRE USED DURING SECOND SURVEY

IMPROVING THE IMPACT OF IN-FIELD RAIN WATER HARVESTING SECOND QUESTIONAIRE

In the second week of November 2007 a survey (survey 1) was conducted in 12 villages surrounding Thaba Nchu. The focus of that survey was to measure the social and economic impact of the In-Field Rainwater Harvesting (IFRWH) research and implementation over the past 15 years. The respondents assisted the research team to understand the impact of IFRWH much better. From the research conducted it was clear that such impact is generally very positive and that the people are generally very supportive of the concept, and many are practising it in their gardens.

To guide the future research and development efforts of the research team, the Water Research Commission (who is funding the IFRWH research and development), and the work of the IFRWH-team in Bloemfontein, towards expanding and improving the impact of IFRWH we need to learn and understand what can and should be done to do so. This is therefore the purpose of this second survey. The question is therefore: How to improve the impact of IFRWH?

To answer this question we request your inputs concerning some key aspects. This survey applies what is called a semi-structured questionnaire whereby we ask various questions, but you determine the outcome of the discussion. We apply the same questionnaire, but will meet with various focus groups such as the cattle farmers, the youth, the IFRWH leaders, the traditional leaders, and those who apply IFRWH.

Please discuss the following questions:

Section 1: Questions for In-Field Rainwater Harvesting Participants

1. What does In-Field Rainwater Harvesting (**IFRWH**) mean to you?
   - 1.1. What is its benefit – its significance – to you?
   - 1.2. What impact has it had in your life?
   - 1.3. What is your future expectation with regards to **IFRWH**?

2. Why have you not moved towards applying **IFRWH** in the croplands?
   - 2.1. Do you have the desire to apply **IFRWH** in the croplands?
   - 2.2. What are the obstacles involved?
   - 2.3. What are the benefits involved?
   - 2.4. Do you understand what the challenges and the benefits involved mean?
   - 2.5. Do you believe that with time and assistance you can overcome these obstacles?

3. What strategies would you employ to ensure that a harvest is realised in the croplands?
   - 3.1. Would you use a tractor to plough your fields? Why? Why not?
   - 3.2. Would you use a tractor only for conventional tilling?
   - 3.3. Would you use a tractor to construct the IFRWH basins? Why? Why not?
   - 3.4. Would you use cattle to construct the IFRWH basins? Why? Why not?
   - 3.5. Will a demonstration plot of the construction of the IFRWH basins in the croplands help?
     - 3.5.1. What type of demonstrations?
     - 3.5.2. Where do you want the demonstrations done?

3.6. If yes in 3.5, what sort of help or skills training do you think you need?
3.7. How would you manage the extra work load presented by the croplands in addition to your normal day-to-day work?
3.8. Do you believe that you have adequate knowledge about crops and farming in general to farm in the croplands? If not, what knowledge do you think you still need?
3.9. Are there sufficient tractors available to plough the croplands should you use them?
3.10. Would you be able to afford the tractors and other farming implements?
3.11. What could you use in addition to the tractors to operate the field?

4. Do you believe that your harvest would be secure in the croplands?
4.1. Do you have access to the croplands?
4.2. Why are you not using the croplands currently?
4.3. Is your allocated portion of the cropland for your own use only?
4.4. What are the challenges involve in ensuring harvest security?
4.5. What steps can be taken to ensure harvest security?
4.6. What roles can the **IFRWH** committee play in ensuring harvest security?
4.7. What role can cattle farmers play in ensuring harvest security?
4.8. What roles can the community and the headman play in ensuring harvest security?

5. Do you think co-operatives can be beneficial in realising better yields in the croplands?
5.1. What is a co-operative?
5.2. Why have you not formed a co-operative yet?
5.3. Do you know how to form a co-operative?
5.4. How would the co-operative be operated for the benefit of all?
5.5. Would you participate in a co-operative that collectively buys seed and consumables?
5.6. Would you participate in a co-operative that collectively buys and use instruments such as ploughs and tractors?

6. How would you ensure that a surplus is realised from the crops produced in the croplands?
6.1. Where would you sell your surplus production?
6.2. What mode of transport would you use to deliver your produce to the market (when needed)?
6.3. In the case of co-operatives what mechanisms would be put in place to ensure that the surplus/losses are distributed fairly?
6.4. What kind of help would be needed to achieve this surplus?

7. What kind of crops would you produce in the croplands?
7.1. Do you have a plan to achieve different types of crops?
7.2. What challenges are involved in different types of crops?
7.3. Do you believe that you have enough knowledge and skill to manage multiple crops at the same time?

8. What skills are needed to move to and surplus from the croplands?
8.1. Do you believe that you posses adequate skills to achieve this?
8.2. What are your needs in terms of skills?
8.3. Where do you think can you obtain the skills?

9. Do you believe that the knowledge obtained from the Glen researchers is adequate in enabling you to move to the croplands?

9.1. What more could have been done?

10. If you were to move to the croplands tomorrow, what are the most important necessities would you need?
    10.1. How can the headman assist in facilitating this process?
    10.2. What role should government (Dept. of Agric.) play?

Section 2: Questions for the Headman

1. Do you believe that applying **IFRWH** in the cropland would benefit your village?
2. What do you foresee as the main challenges to this?
3. What role do you see yourself playing in this?
4. How can you assist in the facilitation and functioning of an **IFRWH** system in the croplands?

Section 3: Questions for the Cattle Farmers

1. Do you know what **IFRWH** is?
2. Do you think that it can be applied in the croplands?
3. How do you think will IFRWH in the croplands affect you?
4. In what way do you believe that this could be affected by the grazing of your cattle?
5. Would you be interested in playing a role in the application of **IFRWH** in the croplands by, for example, keeping the cattle out of the croplands?
6. Are you willing to work with the IFRWH leaders of the village to develop the croplands as well?
7. How do you respond to some of the comments made by the crop farmers (interviewer mentions what crop farmers have said about cattle farmers)?
8. Would you be willing to manually remove the plant residuals from the croplands to feed the cattle if the cattle are not allowed to enter the croplands (not even in winter because it will damage the IFRWH basins)?
9. Is a fence necessary to protect the croplands?
10. Will your own herding system, without fencing in the croplands, be sufficient to protect the croplands?
11. Would you use IFRWH for your cattle – Rangeland Rainwater Harvesting?
    a. Would you benefit from using rainwater harvesting for your cattle?
    b. Would you participate in using rainwater harvesting for your cattle?
    c. Would you use rainwater harvesting for crops such as Lucerne, etc?

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