NN08201, 2730.

STATEMENTS

1. The preference for large and specialised irrigation systems by African governments and donors alike, is arguably the most serious error of economic judgement with respect to irrigation…large systems are generally incompatible with most African smallholder farming systems. These large systems fit the operational styles of Africa's top down, over-centralized public sector organizations. *(Rukuni, 1997: 35).*

2. After thirty years of irrigation settlement schemes in Rhodesia (now Zimbabwe) little understanding of the co-efficients involved in the development of the schemes would appear to exist, *(Reynolds, 1969: 299)*

3. Management in smallholder irrigation schemes in Zimbabwe is conceptualized as something to do with a series of problems, without a clear central idea of what management is, and how it may be different from administration, governance or policy formulation. This observation presents a strong case for problematising the concept of management in smallholder irrigation schemes in Zimbabwe, focusing on how it is defined and what aspects are involved. *(this thesis)*

4. There should be no attempt to have a fastidious definition of management –management should be understood as relating to day-to-day actions/activities undertaken by a variety of actors in relation to water delivery/distribution, field irrigation and crop production and disposal. *(this thesis)*

5. Three operational realities that are critical to irrigation management include water distribution, field irrigation and crop production and disposal. *(this thesis)*

6. Two virtual realities that militate against implementation of strategic (operational) action in irrigation management are ideology and institutionalisation. *(this thesis)*

7. The relationship between farmers and the state appears to be an eternal game where each attempts to master the intricacies of the other, and use the practical knowledge gained to their own advantage. But the playing field of this game is not level. The prominence of state structures dominated by government officials raises the political question of how the state relates to farmers. *(Manzungu and van der Zaag, 1996)*

8. The use of the word 'managers' in public-run irrigation schemes is misleading. By the same token state-managed irrigation schemes is a misnomer because we imply that in such schemes farmers do not have any management functions. These labels tell us very little about the dynamics of irrigation management, certainly not at the operational level. *(this thesis)*

9. The challenge in operational irrigation management is to identify the relevant management domains and use them to understand and craft better management practices. Management domains refer to the fact that some actors are more active than others and have more influence in what happens in some aspects of the scheme. It bears close resemblance to contingency management *(this thesis)*

10. Contingency management emphasizes that the beginning of management wisdom is the awareness that there is no one optimum management system. *(this thesis)*

Proposition related to the thesis "Strategies of Smallholder Irrigation Management in Zimbabwe". Emmanuel Manzungu. Wageningen, Oktober 1999.

Strategies of Smallholder Irrigation Management in Zimbabwe

Promotor: L.F. Vincent, Professor of Irrigation and Water Engineering, Wageningen University

Emmanuel Manzungu

Strategies of Smallholder Irrigation Management in Zimbabwe

Proefschrift
ter verkrijging van de graad van doctor
op gezag van de rector magnificus
van Wageningen Universiteit,
dr. C.M. Karssen,
in het openbaar te verdedigen
op woensdag 15 december 1999
des namiddags te 16.00 uur in de Aula

ISBN 90-5808-145-1

Address for correspondence:
1606 Marapa Road
New Houghton Park
Harare, Zimbabwe

© Emmanuel Manzungu, Harare 1999-09-22 All rights reserved. No part of this book may be reproduced in any form or by electronic or mechanical means, including information storage and retrieval systems, without prior permission in writing from the holder of the copyright except by a reviewer who may quote brief passages in a review.

BIBLIOTHEEK
LANDBOUWUNIVERSITEIT
WAGENINGEN

ABSTRACT

Strategies of smallholder irrigation management in Zimbabwe

The smallholder irrigation sub-sector in Zimbabwe, according to literature sources, is under threat due to what are called management problems. Poor water management and low crop yields have been cited, as has also been poor financial and economic viability, resulting in heavy government subsidies. Schemes run by farmers are said to be better managed than those under government management. This study sought to understand the implied management problem in both government and farmer-managed smallholder irrigation schemes in Zimbabwe. The study had its focus operational irrigation management, dealing with what irrigation management actually was, what it involved and did not involve, and how it was executed in practice. This was investigated in relation to water delivery/distribution, field irrigation and crop production and disposal as three distinguishable operational 'levels' in irrigation management.

The socio-technical approach to irrigation was chosen as the general theoretical framework of the study since it is able to handle both social and technical aspects. A number of concepts were used namely practice, coping strategies, institutionalisation and ideology. Empirical evidence was mainly gathered with respect to Mutambara, Chibuwe and Fuve Panganai irrigation schemes. The study was conducted between 1994 and 1996 and included at least two wet and dry seasons.

The empirical material demonstrated that water distribution was affected by the water source, the technology, social relations and commoditization of certain crops, which however, combined and recombined differently in each scheme it was concluded formal water allocation should not be emphasized ahead of how actually water is distributed in practice. Farmers were found to be at the very centre of field irrigation as shown by farmers' ability to cope with the demands of timing of irrigation, the amount of water to be applied and the actual application of water in the fields. Apart from the biophysical conditions of the fields, farmer's face challenges in the social realm, particularly socio-economic factors such as lack of draught power and related financial resources to adequately prepare lands for irrigation. There was also a discussion of the causes of the discrepancy between farmers and government officials in relation to operational aspects of irrigation management. These included institutionalization highlighting that certain practices were largely a result of routines having been established and ideology referring to the fact that interventions tend to be based on ideas about what ought to be done ideally, and not on practical realities on the ground.

The major conclusions of the study were that the state tended to administer rather than manage irrigation schemes. In contrast farmers in all the schemes easily engaged with operational aspects of irrigation management. Farmers, however, had their shortcomings particularly, in relation to factoring extra-local factors. The findings caution against hasty conclusion that farmer management was superior to government management without understanding the coefficients of the actual management in place. It is suggested that irrigation management should be seen as composed of management domains where some actors are more active in one area than others for a variety of reasons. This observation justifies a contingency approach to management originating from organizational theory which can be summarized thus: the beginning of management wisdom is the awareness that there is no one optimum management system.

CONTENTS

FIGURES

TABLES

BOXES

ABBREVIATIONS AND ACRONOYMS

Agritex	Department of Agricultural, Technical and Extension Services
ADB	African Development Bank
AFC	Agricultural Finance Corporation
ARDA	Agricultural, Rural and Development Authority
DANIDA	Danish Development Agency
DDF	District Development Fund
DERUDE	Department of Rural Development
DR&SS	Department of Research and Specialist Services
DWR	Department of Water Resources
EEC	European Economic Commission
FAO	Food and Agriculture Organisation
GOZ	Government of Zimbabwe
IFAD	International Fund for Agriculture Development
IMC	Irrigation Management Committee
MRRWD	Ministry of Rural Resources and Water Development
NAZ	National Archives of Zimbabwe
NGO	Non-Governmental Organisation
ODA	Overseas Development Administration
ROZ	Republic of Zimbabwe
ZESA	Zimbabwe Electricity Supply Authority
ZIMWESI	Zimbabwe Programme on Women Studies, Sociology, Extension and Irrigation
ZINWA	Zimbabwe National Water Authority

PREFACE

A Ph.D. PhD thesis is a hybrid of good ideas, motivation and hard work (of course financial means bring these ingredients to a healthy mix). There is no researcher who can claim to have, in sufficient quantity all the time, all of these. Many people, in their individual capacities and on behalf of the organizations they represent, contribute greatly to a Ph.D. endeavour. Such was the case with this thesis.

This study was conducted under the auspices of the Zimbabwe Programme on Women Studies, Extension, Sociology and Irrigation (ZIMWESI), an inter-university exchange programme on teaching and research between the University of Zimbabwe, Zimbabwe and Wageningen University, the Netherlands. The programme was funded by the Netherlands Organization for International Co-operation in Higher Education (NUFFIC), The Hague. I am grateful to these organizations for making the study a success.

Within the two universities, a number of people made immense contribution in a variety of ways. My securing the Ph.D. fellowship was due to members of both universities, who, in spite of my lack of formal training in irrigation engineering as was the requirement, put their confidence in me. On the Wageningen side, Professors Norman Long, Niels Röling, Lucas Horst, Dr Pieter van der Zaag (the project co-ordinator) and Ms Joke Muylwijk were prepared to gamble and gave me a chance. On the University of Zimbabwe side, Mr Godfrey Mudimu, Dr Adedayo Ogunmokun and Dr Victor Muzvidziwa did the same. I am extremely grateful to all of them. I hope I have not betrayed their trust. Some of these people continued to play an important role in my research.

Professor Lucas Horst did a tremendous job as my stand-in supervisor. He laid a firm foundation for the research. Professor Linden Vincent quite ably built upon where Lucas Horst left. She helped me sort out the direction of the research. Dr Ogunmokun was closely associated with my work and appreciated my efforts although he did not always agree with me. Pieter van der Zaag's influence endured throughout the study. I remember him for one thing in particular. Often times when the temptation to cut corners was strong, and I was inclined to settle for less (in the spirit of "hey what's the heck?" he reminded me not to compromise my full potential. I shall keep this in my future endeavours. His family was also supportive. His life partner Malou Bijlsma and their two children kept an open door policy to my visits to their home.

During formulation of the research a number of people offered invaluable assistance. The now Dr Peter Mollinga and Dr Geert Diemer were helpful resource persons in the conception of the research proposal in the Netherlands. Dr Paul Hebinck helped with concretization of research ideas in Zimbabwe.

The research period was a stimulating experience. My colleagues, Alex Bolding, Mavis Chidzonga, Dumisani Magadlela, Jeff Mutimba and Carin Vijfhuizen, all in one way or another, contributed to the success of the research. I must also mention with appreciation students I worked with at various stages of the research. These include Itayi Chidewu, Thomas Natsa, the late Garikayi Mataranyika, Innocent Nyakudya and Jeskia Chigerwe. Mannias Abraham and Tawanda Chakauya were two faithful data scribes. Sincere gratitude is due to government personnel and farmers in the various irrigation schemes I worked in. They made me feel welcome and considerably lessened the field research gloom that sometimes visits a lonely researcher with vengeance. The now Dr Phibion Nyamudeza of Save Valley Experiment Station, together with his wife Mercy, not only made accommodation available, but their friendship as well.

Last but not least I want to acknowledge the invaluable support of my wife Felistas, my son Isaac Mufaro and daughter Ruvimbo Deborah for trying and partially succeeding to keep me some distance from "those books"! To them I dedicate this book.

Emmanuel Manzungu
September 1999

1 INTRODUCTION

The smallholder irrigation sub-sector in Zimbabwe (see Figure 1.1) is considered mainly to be of socio-political significance since its economic contribution, valued at below 1% of total national agricultural output, is small (Manzungu and Van der Zaag, 1996: 1). Recent figures estimate that about 10,000 ha of irrigated land in some 300 formal[1] smallholder irrigation schemes support about 20,000 households (IFAD, 1997). The total number of people directly and indirectly benefiting is estimated to be tenfold that number (Figtree Consultants, 1998) which translates to 200,000 people in total, a small but significant proportion of the country 's 12 million people. The schemes range in size from 2 to 600 ha with 40 ha being the average. Landholding per plotholder is between 0.1 and 1.5 ha. According to literature sources (see section 1.1), the future of smallholder irrigation is under threat due to what are called management problems. The same sources also claim that government-managed schemes are not well managed compared to those under farmer management. Farmer-managed schemes are said to outperform government-managed schemes in terms of water utilization and agricultural production (Makadho, 1994; Rukuni, 1996). This study sought to understand the implied management problem in both government and farmer-managed smallholder irrigation schemes in Zimbabwe.

This introductory chapter presents an outline of the study. It begins by presenting, in section 1.1, a brief overview of what are considered to be management problems in the schemes. Section 1.2 presents the focus of the research, which can be summarized as an examination of the practice of management at various operational levels in different smallholder irrigation schemes. The question is, what aspects are involved in management, how are these influenced by the actors in the schemes, and by the wider physical, technological and social environments?

To search for some insights into the concept of irrigation management, section 1.3 discusses the concept as discussed in international irrigation management literature. This discussion focuses mainly on those studies where there was an attempt to conceptualize irrigation management. Section 1.4 is dedicated to theoretical issues. The section begins by briefly discussing the weaknesses of the 'portmanteau' conception of irrigation management, a sort of 'container' definition characterized by a wide range of topics and themes supported by few accompanying concepts. The discussion then turns to the socio-technical approach/ perspective, which is seen as a more operational perspective. Aspects that are covered in the discussion include a definition of what socio-technical means. The ground rules of applying a socio-technical perspective in the irrigation context and some concepts that can be used to operationalize the approach are also discussed. The research methodology is discussed in section 1.5. This is followed by an outline of the structure of the thesis in section 1.6.

1.1 AN OVERVIEW OF MANAGEMENT-RELATED PROBLEMS IN SMALL-HOLDER IRRIGATION IN ZIMBABWE

A number of evaluation studies have suggested that smallholder irrigation schemes in Zimbabwe have poor performance[2] and are not sustainable. These studies have identified three

[1] 'Formal' refers to schemes initiated and constructed by government, which are either farmer or government-managed. There are also a few schemes that were initiated by farmers and were taken over by government, as is the case of Mutambara, one of the study schemes.

[2] P.S. Rao (1993) notes that performance in irrigated agriculture is a very complex subject. Common indicators of performance are concerned with water delivery system, agricultural production and financial and economic benefits. Performance indicators usually take a quantitative dimension.

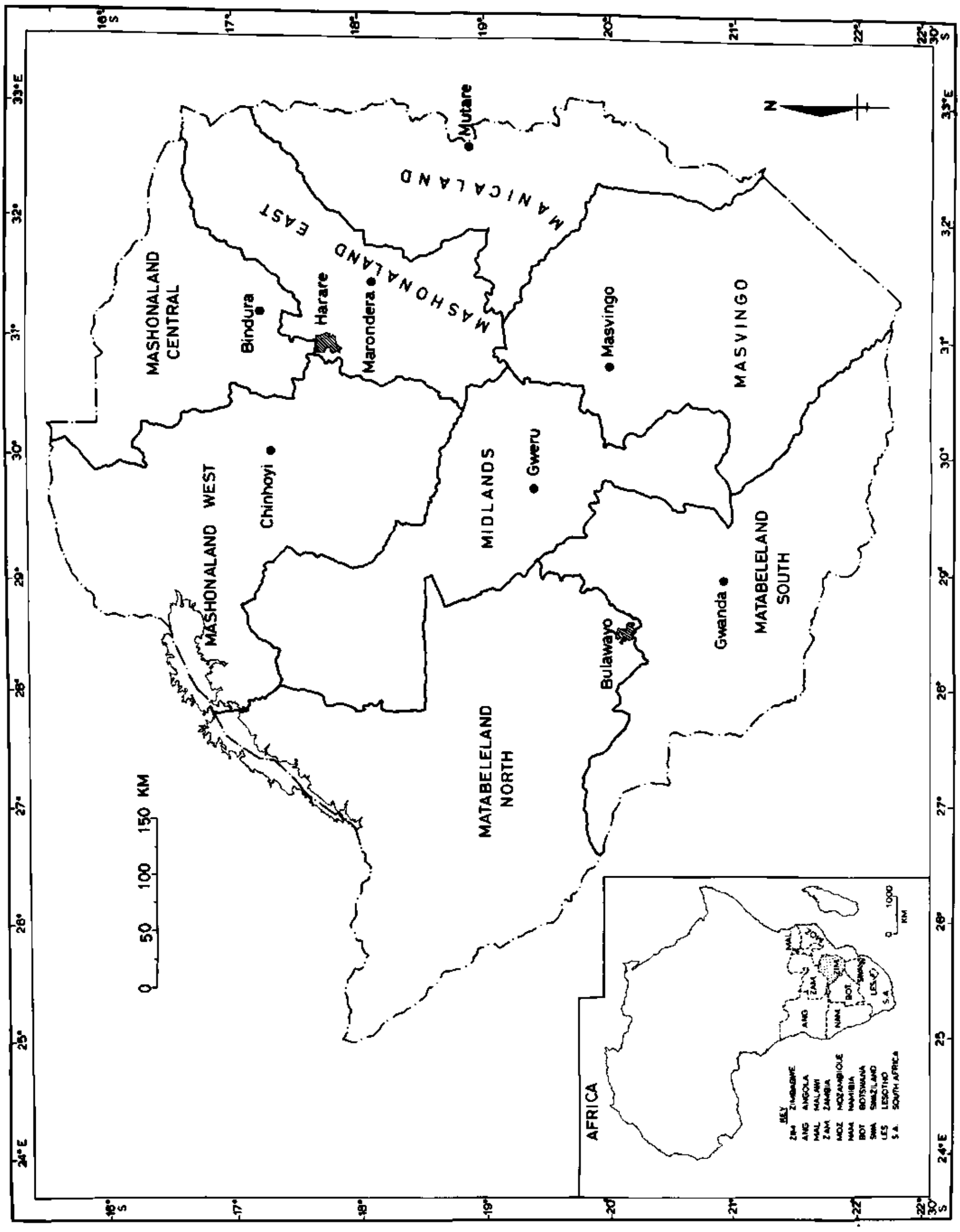


Figure 1.1 Zimbabwe: Location, administrative provinces and major urban centres

problem areas. Water utilization, in terms of its timeliness and adequacy to the field edge, is said to be poor, as is water application in the field (Pearce and Armstrong, 1990; Donkor, 1991; Makadho, 1993, 1994). Crop yields have been reported to be low and way below those achieved in the commercial farming sector (IFAD, 1997). Peacock (1995) contends that the poor agricultural performance has translated itself into poor financial and economic viability, thereby necessitating heavy government subsidies, up to 75% in some cases[3]. There is another interesting dimension to the irrigation management debate: there is a growing consensus in literature that farmer-managed schemes are better managed and perform better than those that are government-managed (see for example Makadho, 1994, Rukuni et al, 1996). The basis of the comparisons is, however, open to question since:

a. the comparisons hardly take into account other relevant details such water reliability of the schemes, design characteristics and physical state of the irrigation infrastructure;
b. farmer-managed schemes currently constitute a small proportion (less than 1%) of the total command area and tend to be of much smaller size and sometimes involve a few people the majority of whom may be related (see Matsika, 1996) and
c. farmer-managed schemes in general tend to be managerially less complex as they are less capitalised, because of their reliance on simple technology such as gravity-fed irrigation systems, compared to expensive and high skills-demanding, large pump-operated schemes under government management.

The claim that farmer-managed irrigation schemes are better managed and perform better is, however, quite significant and warrants close investigation. This is because the majority of the schemes were developed by and are still run by government. A pertinent question is: is farmer management the solution to the implied poor management of smallholder irrigation schemes in Zimbabwe? This question can be considered of secondary importance as there has been no documentation, and by inference, a clear understanding of how government officials and farmers actually manage schemes under their jurisdiction. This is why this study sought to make a comparison of management practices in both government- and farmer-managed schemes.

1.2 FOCUS OF THE RESEARCH

1.2.1 The Concept of Management in Zimbabwe

It is the contention of this study that there has been little to no systematic discussion of management in smallholder irrigation in Zimbabwe, both at a conceptual and practical level. The bulk of recent studies has focused on the production of quantitative performance data. While such data do provide some insights into the performance of smallholder irrigation schemes, they nevertheless fall short when it comes to providing insights into operational aspects of irrigation management. The IFAD (1997) report is a case in point. The report claims that sub-optimal performance in smallholder irrigation schemes in Zimbabwe is due to:

a. poor sustainability, a result of inappropriate scheme management and inadequate quantity and quality of investment;
b. low productivity as a result of poor farmer practice, insufficient water availability and low cropping intensities and
c. poor market access, a consequence of lack of market information and knowledge as well as

[3] This contrasts Rukuni's (1993, 1996) assertion that the sub-sector is by and large financially and economically viable. The problem according to him was the inappropriate conventional budgeting technique, which ignores the sub-sector 's unique history. Meinzen-Dick et al (1996), on the other hand, emphasize that agro-economic performance of smallholder irrigation schemes depends on number of factors such as plot size, level of education of plotholders, access to markets and management structure.

inadequate communication infrastructure.

The report gives four characteristics that are said to denote inappropriate scheme management. First, in most public schemes, a relatively small proportion of recurrent costs is recovered from farmers. Second, there are numerous examples of relatively large schemes in which scheme managers report to government institutions rather than to farmers. This situation is seen as giving rise to lack of transparency, distrust and poor co-operation between managers and the irrigators. Third, in most public schemes, and in some farmer-managed schemes, there is no workable mechanism to cope with poor performance of individual farmers. In this regard small schemes (+/- 20 ha command) are considered to be successful due to the existence of strong internal discipline and well-respected means of dealing with non-performers. Fourth, there is no plan or strategy for eventual farmer-management or turnover/handover of schemes to farmers. According to the report, management is conceived as:

- about cost recovery
- involving users and government officials as the main actors
- about enforcement of discipline which is said to be related to the size of the scheme
- about governance and the creation of rules to be enforced
- about enforcing policy, or dealing with problems resulting from a lack of policy.

Management is therefore conceptualized as something to deal with a series of problems, without a clear central idea of what management is, and how it may be different from administration, governance or policy formulation. For example, there is no clear focus on how irrigation schemes operate. This observation presents a strong a case for problematizing the concept of management in smallholder irrigation schemes in Zimbabwe, focusing on how it is defined and what aspects it incorporates.

In the following paragraphs it will be shown that the poor conceptualization of irrigation management is not confined to Zimbabwe. Section 1.3 discusses how attempts at conceptualizing management at the international level has been heavily influenced by business management thinking. Section 1.4 discusses another problem in conceptualization irrigation management -too often a 'container' type definition of management is offered where everything, which is not technical, is construed as management.

This study started from the premise that both these viewpoints of management do not shed light on the actual management practices in irrigation systems. For the purpose of this study management is delineated in terms of operation, and is loosely defined as day- to-day operational activities undertaken by different actors in relation to water distribution, field water application, and crop management. In this study water distribution, field water application and crop management constituted the three operational levels, as easily recognizable management activities, around which the subject of irrigation management was constructed. This applied to state's and farmers' practices respectively. Consequently the empirical material is arranged in that order. In unravelling the practices of the management practices of these two groups of actors, both technical and social aspects are covered in line with the study's socio-technical approach (see section 1.4).

1.2.2 The Research Question

The lack of focus on operational aspects of irrigation management in Zimbabwe (see above) is regrettable since the 'proof of the pudding' of effective management is at the operational level. Administrative, governance and policy formulation (or social aspects in general) as well as agronomic and engineering insights (technical aspects in general) are only useful when they contribute to an understanding of management at different operational levels.

What is critical is to understand how the different issues converge at the operational level. Such an attempt should not make any pre-judgements about which issues, social or technical, are more relevant. This is in line with a socio-technical approach elaborated below.

In the light of the above comments the main research question of the study was formulated as follows:

> What are the existing management practices in different smallholder irrigation schemes in Zimbabwe, why are they different and how can the observed management practices be understood in terms of the strategies of the different actors in response to the immediate and wider physical, technological and social environments?

In more specific terms the study aimed at finding answers to the basis of management operations in the different schemes, the extent to which the operations reflected users' interests, the extent to which the state influenced operations in the schemes and the underlying causes of the actions and strategies of the different actors. To answer this question a survey of the international irrigation management literature is undertaken below with a view to establish some ideas that might guide the research (see below).

1.3 THE CONCEPT OF IRRIGATION MANAGEMENT: THE INTERNATIONAL SCENE

Management became an important subject in literature from the 1970s as a response to the disappointing performance of irrigation systems constructed in the 1950s and 1960s (Lenton, 1988: 5; Mollinga, 1998: 11). However, it was not well conceptualized in the initial stages (it is also argued here that the situation, while it has improved, remains unsatisfactory). In a survey of literature irrigation water management between 1970 and 1985, Jurriens and de Jong (1989) found the literature to be diverse, characterised by different views on what irrigation management was, and what constituted its essential elements. There was reference to a wide variety of subjects and issues, including organizational forms and structures, farmers' participation, water users' associations, water distribution on main systems and at the tertiary unit level and water pricing. Unfortunately all these issues were not systematically expressed or discussed (Jurriens and de Jong, 1989: 7-8).

The situation has somewhat improved since then. This was helped in no small measure by the setting up in 1984 of the International Irrigation Management Institute (IIMI) in Sri Lanka. IIMI 's mission was 'to strengthen national efforts to improve and sustain performance of irrigation systems in developing countries, through the development and dissemination of management innovations' (Lenton, 1988). By management innovations was meant a range of ideas, practices, devices and approaches that could be used to improve irrigation management including 'upstream' policies to facilitate good management and 'downstream' technologies needed to make irrigation systems more manageable *(ibid.)*. This has had an enduring influence on some of the major conceptions of irrigation management as discussed below.

While IIMI and others helped to focus on irrigation management, they also shifted the debate into developing concepts and indicators to determine performance of irrigation systems, as well as to irrigation management reform. Through a search for scientific and measurable indicators, performance criteria have become a major focus of interest within international research institutes interested in management reform like IIMI and IFPRI.

1.3.1 Performance-based irrigation management approaches

Roberto Lenton, a Director General of IIMI, submitted that irrigation management included human, agricultural and economic aspects, and was broader than irrigation water management which relates to arrangements for delivering water to fields at prescribed places, amounts and times. Irrigation management was defined thus:

> Irrigation management is the process in which institutions or individuals set objectives for irrigation systems; establish appropriate conditions, and identify, mobilise, and use resources, so as to attain these objectives; while ensuring that these activities are performed without causing adverse effects. (Lenton, 1988: 11).

The above definition of management, according to Lenton, was based on the management model of Professor A.A. Kampfraath of Department of Management Studies of Wageningen Agricultural University. Box 1.1 shows what were considered to be some key aspects of this irrigation management model.

Box 1.1 Some Aspects of Irrigation Management

MAIN CONCERNS OF IRRIGATION MANAGEMENT
1. Setting objectives
2. Establishing conditions and acquiring resources to meet objectives
3. Controlling processes to meet objectives
4. Arranging all the above to suit the external context
5. Renewing the system to enhance its capacities
6. Performance monitoring

MAJOR FACTORS DETERMINING EFFECTIVENESS AND EFFICIENCY OF IRRIGATION MANAGEMENT
1. Irrigation policies
2. System installation
   Institutions
   Governance
3. Management of water
   Management of land
   Management of crops
   Management of institutions
   Management of finance
   Management of facilities
   Management information
4. Contextual factors
5. Improvement of physical facilities
   Institutional reform

Source: After Lenton (1988)

The irrigation management framework shown in Box 1.1, in its original or modified form, has been very influential in the international debate on irrigation management. Approaches that draw from this framework include Small and Svendsen (1992), Nijman (1993), Rao (1993) and Murray-Rust and Snellen (1993). With regard to Zimbabwe the work of Makadho (1993, 1994, and 1996) and Rukuni *et. al* (1996) also borrow from this approach.

These approaches are somewhat limited with regards to broadening our understanding of the operational realities of irrigation systems, or how irrigation systems work in practice (which is a critical in undertaking any informed intervention in irrigation management). First, these approaches are about irrigation experts talking about how they can objectively 'measure' the performance of irrigation systems. This instrumentalist perspective, emphasizing inputs and outputs of irrigation, be it water utilization or crop production, does not answer the 'how' part of irrigation management referring to the underlying causes of some the observed phenomena (if at all meaningful observations are made in the first place). There has also been the assumption that it is the 'management' or 'managers', usually referring to state officials, who manage irrigation. Farmers are not accorded a management role. In fact management of water, land and crops etc are regarded merely as factors determining irrigation management and not the real 'management' issues (see Box 1.1).

It is argued here that confining irrigation management to objective setting, planning and administration (see main concerns of irrigation management in Box 1.1) or focusing on inputs and outputs of irrigation systems, and not on strategic actions and activities involving water and land utilization and crop management (for example effects of commoditization on water distribution), is tantamount to missing the essentials of irrigation management. This is because irrigation management is taken out of the realm of the field. Fortunately there are a number of studies that have begun to advocate for a return to the 'field' when discussing irrigation management (see below).

1.3.2 'Back to the field' in irrigation management

It has already been hinted that irrigation management needs to be taken back (from the abstractions of business concepts of management) to the irrigated field. For this to happen there is a need to understand the reality of irrigation management which is related to how irrigation itself is defined and conceptualized. The question may be asked: what constitutes irrigation 'reality'? The answer may be a long list: canals, pumps, crops, engines, engineers, politicians, agronomists, financiers, head-enders, tail-enders etc. A more suitable question is what are the essential elements of irrigation i.e. if irrigation were to be stripped to its bare essentials, what would we find?

Ubels (1990: 1) and Minae and Ubels (1993) argue that irrigation has too often been depicted as physical-technical phenomenon preoccupied with how the physical resources of water and land are physically arranged and used in a technical design. This depiction of irrigation reality leaves out the human dimension, or in more general terms, the social dimension, as will be discussed below.[4]

Irrigation has also been associated with agricultural intensification. For example irrigation has been defined as a special case of intensive agriculture in which technology intervenes to provide control for soil-moisture regime in the crop root zone (Rydzewski, 1987: 1). This definition, which depicts irrigation as synonymous with agricultural intensification, is quite pervasive in Zimbabwe. There has also been a narrowing of the debate as a consequence of disciplinary specialisations e.g. irrigation agronomy. For example, irrigation management is often reduced to a definition of when to irrigate and how much water to apply (Hillel, 1988) based on certain crops being grown. Chapter 7 of this book discusses both these aspects.

Much criticism has been levelled at the above depictions of irrigation reality, especially because of their neglect of social issues. Keller argues that the importance of physical aspects should not be overstated:

[4] Participatory design has been seen as an answer. Ubels and Horst (1993) represent a collection of how this can be done in Africa. In Zimbabwe it is reported that this has yet to develop (IFAD, 1997).

> ..... the traditional irrigation system does not irrigate -it is merely[5] a network of channels feeding prepared fields. Human enterprise does the irrigating. Furthermore, the control and allocation of the water to the fields also requires continuous and direct human action. In other words irrigation involves people and their tools (Keller, 1986; 334).

Chambers makes the same point:

> Canal irrigation systems are too easily thought of as delimited by the physical domain of the capture, distribution and application of water, and by the bio-economic domain of growth and disposal of crops. But the human domain so dominates in operating the system that to limit analysis to the physical and bio-economic domains is not just misleading. It is, in a practical sense unscientific (Chambers, 1988: 182).

From this perspective Small and Svendsen's (1992) definition represents an improvement. They define irrigation as human intervention to modify the spatial or temporal distribution of water occurring in natural channels, depressions, drainage ways or aquifers and to manipulate all or part of this water for the production of agricultural crops (Small and Svendsen, 1992: 285).

Keller and Chambers represent just two examples of advocates of a return to practical realities of irrigation management (see section 1.4.3 for other examples). Both emphasize that irrigation includes social and technical aspects. They also caution against uninformed intervention in irrigation management. This is well argued in Seckler's (1985) 'laissez-faire' philosophy, which argues that unless there are good grounds for believing that intervention will result in some improvements of the situation, irrigation systems should be left alone.

1.3.3 Conclusion

To conclude this section two points need to be restated. First the concept of irrigation management has been framed within a business management setting. It was argued while this was not entirely undesirable, there was a need to take irrigation management back to the field where it belongs. This was enough justification for an operational perspective to irrigation management. A definition was offered, as well as the three operational levels around which a study on irrigation management could be constructed. It was observed that the return to the field in irrigation management was already underway, as witnessed by a number of studies emphasizing understanding operational realities of irrigation management. These studies hinted at the fact that irrigation systems are inherently socio-technical systems in that both social and technical aspects are included. This will be further discussed in section 1.4. This reality of irrigation systems will inform the concepts that can be applied in the study of irrigation management. After that there is an examination of the aspects of irrigation management or management elements that the study investigated.

5 This may be overstating the fact. As I shall show in future chapters in the book the physical infrastructure materially influences what happens in a scheme.

1.4 SOME THEORETICAL REFLECTIONS

1.4.1 A Preamble

So far emphasis has been placed on the need to understand operational aspects of irrigation management, which essentially is about engaging with the reality and not abstractions of irrigation management. In this case reality refers to the 'quality appertaining to phenomena that is recognized as having a being independent of people's volition' (Berger and Luckmann, 1966: 13).[6] To arrive at this reality involves finding out the structures and mechanisms, which generate events that take, place (Outhwaite, 1983: 321-322).

Reality has three fundamental aspects namely, *the real*, *the actual* and *the empirical domains* (Outhwaite, 1983: 322). An impression of the reality of any phenomenon is through the *empirical domain* where observations are made of the events taking place. Observations of what is happening lead to an understanding of the *actual domain* referring to the actual events/occurrences. From the documentation of the actual domain can be established the processes at play that generate the *real* domain. Applied to the subject under discussion, the reality of irrigation management can be seen as the *actuality* of the interactions of human action (the multiplicity of human interactions point to the fact that irrigation has multiple realities) *vis-à-vis* the different operations in the scheme relating to the acquisition of water, how it is shared between farmers, its application in the field and the relationships with the crops that are grown.

An appropriate theoretical framework is therefore needed to study such issues. The next section goes into some detail about how a socio-technical approach, incorporating both technical or social aspects, can shed light on the dynamics and complexities of smallholder irrigation management at the operational level. This is prefaced by a look into how management has been used as 'container' in irrigation literature.

1.4.2 Looking into the irrigation management portmanteau

As already said the 1970s marked a turning point in the way irrigation was viewed in that irrigation management became an issue. Before then the physical focus of irrigation and civil engineering professions, emphasizing technical criteria in the design (and/ or redesign) of irrigation schemes, was dominant (Diemer and Slabbers, 1990: 8). Because of the interest in management aspects, social aspects of irrigation came to the fore. A number of approaches placing differing emphases can be discerned. A selection of these is presented below.

The *organizational approach,* emphasizing organizational/institutional arrangements, was one attempt at addressing the question of irrigation management and its reform. Examples include Bottrall (1981), Sagardoy *et. al* (1982), Hunt and Hunt (1976) and Freeman and Lowdermilk (1985). Bureaucratic studies, dealing with public agencies in irrigation, can also be placed here. By and large these critiqued irrigation agencies in relation to how they carried out their functions. Irrigation bureaucracies were reported to have many weaknesses in the way they conducted their business (Wade and Chambers, 1980; Chambers, 1988), and were sometimes corrupt (Wade, 1982). Other studies chose to be proactive and concentrated on bureaucratic reform (e.g. Uphoff, 1991; Siy and Korten, 1988).

The *social force approach* attempted to shed light on the underlying social dynamics in

[6] But reality is a social construction (Berger and Lackmann, 1966) in that it is more subjective than it is objective. That is to say, any depiction of reality is to some extent 'made' by the observer. To acknowledge this cardinal fact is to admit that even 'scientifically validated' studies are to some extent a construction of certain phenomenon or phenomena. The simple yet significant deduction emanating from this observation is that constructions of some reality lie at the core of all scientific enquiry. Any enquiry, whether stated or not, starts from certain presuppositions about the reality under investigation.

irrigation and how both politics and technology shaped organization of management. Eggink and Ubels (1984: 151) saw the social force approach as incorporating two aspects: a) irrigation water as an important means of agricultural production and b) irrigation schemes as places of interaction involving local peasant communities and the national capitalist economy. Pradhan (1996) makes similar references regarding the importance of the social aspects of irrigation.[7]

In recent years the irrigation debate has shifted to other foci. Performance studies, as already said, take an instrumentalist perspective to irrigation by way of emphasizing inputs and outputs and have dominated the irrigation management research agenda in the 1980s (Gowing *et. al*, 1996). Irrigation management transfer, cost recovery and water markets have received attention as external forces of financial reform impacted on irrigation management debate (see Mollinga, 1998 for more details). Table 1.1 presents an overview of the different foci.

Table 1.1: Major irrigation issues in the literature and assistance development programmes

Period	Topic	Focus
1970-1980s	1. On farm development	What farmers should do to optimally use the opportunities provided by the irrigation system
	2. Promotion of farmers' participation	Emphasis on the interface between agency and farmers, as well as incorporation of specific water user needs and views in design and management
	3. Strengthening of irrigation agencies	Alleviation of weaknesses of the organizational and human resource aspects of agencies so as to make them more efficient
Late 1980s-mid 1990s	Irrigation management transfer	Shedding responsibility and authority over (parts of) irrigation systems to farmers
Mid 1990s	Institutional reform	Restructuring existing organizations
Late 1990s	Policy reform	Efforts towards a wider and long term view of public and private responsibilities vis-à-vis natural resource management of which irrigation is a part

Source: Adapted from de Graaf and Van den Toorn (1995)

In spite of these attempts the problem of how to meaningfully take people into account in irrigation, particularly the users, remained unresolved (Vincent, 1994). In some cases involving people in irrigation became a mere moralistic platitude and a campaign tool to raise awareness of people 's involvement in irrigation. While this may be useful in some cases, it does not help to understand how irrigation management is actually carried out in practice.

[7] Pradhan (1996: 10-14) identified three approaches. The first was the *technical/engineering* approach (equivalent to the technocratic approach) while the second, the *social constructivist approach* (which he also called the social construction of technology) sought to 'understand the relations between people, technology and physical and social processes involved in the use of technology'. This was based on the premise that a) material objects, such as technology and physical artifacts, were socially constructed and were outcomes of social shaping and b) technologies were made by people and the ultimate shape was determined by the objectives and interests of the different actors who make choices within their own social context. Also under the second approach were the actor-oriented and interface approaches which espoused the view that in irrigation schemes are found knowledgeable and capable actors who pursue their own interests. In the interactions power was an important dimension. Pradhan complained that the social constructivist approach prevented a balanced analysis of technical and physical processes because of its bias towards social issues. To restore the necessary balance, he proposed an *integrated approach.*

The above situation has been appropriately captured by Wade and Seckler:

> ... management is treated as a large portmanteau term into which are put most things that are somehow different from technical factors. Technical refers to the physical design and its translation into physical objects on the ground. Management refers to just about everything else, except perhaps for (a) water charges,.. (b) farmers' participation.. (Wade and Seckler, 1990: 14).

Irrigation management, it can be seen, fits into many compartments (not just the two as the literal meaning of portmanteau implies). Below is an attempt to streamline the definition of management in the context of the proposed a socio-technical perspective to irrigation.

1.4.3 A socio-technical perspective to irrigation

This section aims to show how a socio-technical perspective to irrigation can be used to understand irrigation management practices. This involves a) defining what socio-technical means with respect to irrigation b) establishing some ground rules about how it can be used to good effect and c) identifying concepts that can be used to operationalize it.

Definition

Uphoff (1986) argues that irrigation systems are socio-technical because both human and physical aspects interact *continually* and *profoundly* (emphasis added). The physical side refers to technical aspects relating to dams, channels, control structures, soils etc while the human or social dimension refers to behavioural aspects relating to the activities and attitudes of both water users and agency personnel. Because irrigation systems brings together different people, due to large resource requirements, an effective organizational framework for co-ordination is necessary. Power and authority are therefore an integral part of irrigation management (Uphoff, 1986: 2). Pradhan (1996) makes similar observations. He sees irrigation systems, not just as physical artefacts independent of human or social actions, but as socio-technical entities since irrigation (technology) involves people, produces social change, influences social relationships and affects the socio-economic growth of individuals and communities' (Pradhan, 1996: 6-7). While these observations are essentially correct, it is not clear how one can make these observations usable in a study like this one. In other words the approach, as it is enunciated above, is inoperable.

Mollinga (1998) is one author who has provided an operational definition of the socio-technical approach. He identified three dimensions of the approach. First, irrigation technologies have social requirements for use which means that particular social conditions have to be fulfilled for the technologies to work effectively (*ibid.*: 14). Second, irrigation technologies are socially constructed which means that technology development and design are social processes in which different stakeholders interact (*ibid.*: 15). Third, irrigation technologies have social effects through impacts on people 's health and general livelihoods (ibid.15). The next paragraphs describe how a socio-technical perspective to irrigation is used in this study.

Rules of application

There are still outstanding practical issues in relation to how best to use the approach in irrigation. In other words there needs an elaboration of the methodological implications of the approach. In this regard, the general field of sociology of scientific knowledge is useful.

The first choice that has to be made is whether analysis of irrigation systems should best be done at an aggregate level or at the level of individual actors. Knorr-Certina (1981) explains that a micro-level analysis is based on the assumption that the only valid and reliable evidence is on the basis of systematic observations and analysis of everyday life or activities. These are seen as constituting the building blocks of the macro level since macro phenomena are unknown and unknowable unless they are derived from analysis of micro-social interactions. Macro-sociology, on the other hand, refers to the study of social institutions and of socio-cultural change on an aggregate level. Because of its interest on the operational aspects, this study opted for a *micro-level* analysis of irrigation situations.

The second concern is what role is played by the empirical material. That is to say, are observations enough by themselves to depict what is being studied or should the wider society be used to explain what is occurring at the local level? Proponents of a relativist agenda argue that the real world is unproblematically represented by the empirical world: we only have to record our experiences of the world and summarize them in theories. This is called empiricism. Given the fact that observations are theory-laden (Outhwaite, 1983: 323), and therefore there cannot be any neutral observations, this study opted for a realist perspective. In other words explanations of what is happening are sought from the wider society in order to understand what is happening at the scheme level.

Irrigation principally involves humans on the other one hand and non-humans or technical artefacts on the other. The question is what agency[8] should be accorded to these? In simple terms, and limiting our discussion to irrigation, the question is what role is played by infrastructure in irrigation management?

There are three views, which pose different analytical routes. The first view is that the infrastructure or technology is deterministic in that hydraulic structures determine human behaviour. The second is that the technical infrastructure is subordinate to the wills and desires of the people. The third view, which is more philosophical, extols the principle of symmetry and proposes that both human and nonhuman factors should be analyzed in the same way to avoid biases. This study chose the middle ground between the first and the second views. The agency of technical objects was considered untenable for the purpose of this study hereunder introduced.

1.4.4 Concepts

Having drawn up the rules of applying a socio-technical perspective in irrigation, this section explores what concepts can be employed. The importance of concepts in research comes from the fact that concepts are abstractions, articulated in words, that facilitate understanding of the research and are most effective when they are used to build theories that explain research results Bernard (1988: 33). A number of concepts were used in the study.

Practice

The concept of practice is becoming established in the study of irrigation (see Van der Zaag, 1992, Mollinga, 1998). Practice can be understood as referring to the visible undertakings of

[8] Giddens has put forward a convincing case of human agency (or action). It refers to two aspects of human conduct; capability and knowledge. Capability means the agent is in a position to act otherwise (this should not be equated to the ability of human beings to make decisions or choices as is posited in utilitarian social theory or game theory). Many activities depend on capability or the possibility of doing otherwise not in rational terms but as a routine of everyday behaviour. On the other hand knowledgeability refers to the fact that members of a society know a great deal about the society they are in (which should not be equated with what is known consciously). Knowledgability is displayed in the vast array of tacit modes of awareness and competence that can be called the practical consciousness as differentiated from discursive consciousness (Giddens, 1981: 163). These comments are very relevant to irrigation because people in the schemes (be they managers or farmers) do not follow blindly what they are told. Also their actions are not always reducible to some form of rationality. Applied to non-humans, the concept of agency as advocated by Latour (1987) is difficult to operationalize.

people. Mollinga (1998: 20), citing Giddens (1976), understands practices as what people do in a structured and structuring fashion. Practice can be used to empirically study irrigation management through observation (Bourdieu, 1977 in Van der Zaag (1992: 4). In this study the concept of practice was seen as providing a practical programme for investigation of the different irrigation activities, which included water distribution, field irrigation, and crop management.

Coping strategies

In irrigation people employ different strategies to meet their objectives by mobilising a number of resources (Mollinga, 1998: 20). Such actions are called coping strategies and apply to the short rather than long term (Johnson, 1992). Both farmers and government officials, particularly the 'frontline' state officials, rely on one coping strategy or another due to the difficult circumstances they encounter in their daily irrigation-related activities. In this coping both technical and social aspects are involved, since in daily activities the distinction between the two gets blurred. The different coping strategies by the variety of actors were documented in this study for the various irrigation activities.

Ideology

The activities that are undertaken in irrigation are not entirely rational. What happens in schemes has also to do with a certain way of thinking or ideology, and not necessarily on the basis of rational operational considerations. For example the application of 'science' e.g. irrigation scheduling or adoption of advanced hydraulics, are often informed not by operational considerations but by a certain ideology. In such situations operational aspects can suffer since ideology tends to be de-contextual (Taras, 1984).

It is also important to realise that ideology is not power neutral. For its propagation ideology depends on unequal power relationships. It is therefore critical that the various manifestations of power in irrigation are appreciated by looking at the various modes of domination in irrigation practices (Bourdieu, 1977). Ideology, it should be added, is more relevant for state officials than farmers.

Institutionalization

As has been mentioned above, not all the actions that occur in irrigation can be explained rationally. For example institutionalization of certain human behaviour in irrigation, referring to mundane things like getting used to certain things (habitualization), can be reason enough for certain actions to prevail. It will be shown that institutionalization occurs because it simplifies human action (Berger and Lackmann, 1966). It was observed in some irrigation management aspects in this study, particularly choice of hydraulic structures.

Management domains

The relevance of any individuals or groups in irrigation is not always determined by clarifying the roles of the different actors and the rules which should govern the interactions, as is commonly thought. Management is about negotiations. In other words irrigation management should be seen as composed of different management domains where some people are more active in one area than others due to a variety of reasons. Domains refer to areas of action where some individuals have more influence than others. These observations justify what has been called a contingency approach to management where management is seen as intimately related to the local situation.

The word domain(s) here is used in the sense of social interaction (see Van der Zaag, 1992: 212; Mollinga, 1998: 22-24) and not in the physical-technical sense as discussed by Chambers (1988), Keller (1990) and Small and Svendsen (1992). Chambers (1988) identified four domains in irrigation, namely the physical (composed of infrastructure e.g. dams, weirs etc), bio-economic (made up of biological and economic aspects), the human and water domains. Keller (1990) on the other hand identified three domains namely the watershed, the water supply and agricultural domain. Meawhile Small and Svendsen (1992) saw an irrigation system as a subsystem nested within a larger set of agro-economic and socio-economic or politico-economic systems. Appendix 1A shows the latter two depictions in a diagrammatic form.

The choice to use domains in the social rather than physical-technical sense is due to the fact that management is essentially an interactive activity that has social, physical or technical connotations[9]. The concluding chapter will identify and discuss the main management domains as an essential step towards understanding irrigation management practices. It is relevant to note that while operational levels represent the entry point into how irrigation management, management domains are about how irrigation is actually executed.

1.4.5 Some management elements

Since management can be seen as composed of a number of elements or domains any study of management should therefore isolate what these are. To isolate these domains, which are not physical or material, it is important to investigate everyday irrigation activities. These are described below. It is important to note that not all of these will be treated to the same degree in this thesis.

Irrigation operations/ activities
One way of looking at management is to consider the irrigation activities that need to be undertaken. Uphoff (1986) has proposed an activity-based description of irrigation management. He distinguishes three main types namely control structure activities, water use and organizational activities. Appendix 1B shows the activities under each type. In this study irrigation activities were documented as they applied to the situation under investigation.

Water distribution and water control
Replogle (1986) and Clemmens (1987) emphasized organizational aspects of water turns or delivery policies (variations of *on demand* and supply-oriented systems) which Nijman (1993) described as irrelevant to the situation of developing countries[10]. Water control can be understood as having three dimensions (Mollinga, 1998: 25). The first relates to different methods of technical control of water. The relationship between the irrigation technology and management has been the subject of some discussion. Basically, and at the risk of over-simplification of the issues involved, the debate has centred around the modernization and simplification schools. Modernization advocates use of modern concepts in water control (see Plusquellec, *et. al*, 1994) incorporating adjustable structures and including automatically controlled systems. In general they are useful in projects with reservoir storage with sufficient water throughout the year (Horst, 1996). Such systems require operational and maintenance staff which is highly skilled with knowledge in computers, electronics and mechanics. Simplification on the other hand entails searching for simplicity in irrigation scheduling and in irrigation water division technology which is simple to operate and is less liable to damage (*ibid.*). Simplification is seen as the natural way to proceed in rural communities given the

[9] The physical-technical domains, although useful, do help to illustrate the essence of irrigation management i.e. where, when and by whom irrigation management takes place.

[10] I am, however, of the opposite view: the elaboration of delivery policies can help concretize many issues, which normally go unattended. For example a delivery policy brings forward questions regarding how many farmers are irrigating at any one time, what is the basis of that and what alternative arrangements are available.

competencies of the people involved. Similar sentiments were expressed by Shanan (1992) and Pradhan (1996).

The second dimension of water control is concerned with organizational aspects dealing with how farmers co-operate to make irrigation system work (see for example Lowdermilk, 1990). The third aspect deals with political aspects of domination and regulation processes involved in water utilization (see Mollinga, 1998: 27-30).

Field irrigation

There has also been a focus on water use below the field channel gate. One approach has been to apply performance criteria to field irrigation. Application efficiencies are held as important. The other approach has been to examine how farmers actually use the water they receive. Examples of this approach include Scheer (1996) and Gowing *et. al* (1996). The second approach was opted for (see chapter 5).

Of rights, administration and management

Some authors have stressed the importance of property rights in management. Coward (1986), through his concept of hydraulic property, drew attention to the issue of property creation during construction and maintenance of schemes in irrigation systems, which affects subsequent use of the infrastructure. This is quite pertinent to Zimbabwe given the communal sharing of resources in smallholder irrigation systems.

The presence of many actors in the schemes raises questions regarding how the different actors relate to each other and how these relationships in turn shape management operations. The concern for how the different actors interact explains why some authors have advanced the notion of rules and roles as critical in irrigation management (see Coward, 1986; Ostrom and Gardiner, 1993). Part of this effort has been to draw the distinction between administration and management. Administration is about following predetermined schedules, criteria, instructions, guide lines etc while management is about ensuring flexibility and adaptation and learning new methods and strategies (Uphoff, 1991: 26.28). This distinction is used in chapter 8 to reiterate the importance of operational aspects of irrigation management.

1.4.6 Conclusion

Given this framework of concepts and activities to interpret management reality, investigation and analysis in this study were focused on actions related to the movement of water, and the technologies and techniques[11] controlling them. Studies were made both within the system where many people interacted and also in the farmers' fields. In keeping with the socio-technical approach, the study also examined knowledge and actions around technologies and techniques used in controlling water through the system and in the field. In this study technology referred to (irrigation) artefacts and the associated knowledge and skills for their operation (Mollinga, 1998: 13). The main focus was on artefacts, which is easily the most recognized embodiment of technology *(ibid.)*. The socio-technical approach used in this study allowed the other related aspects of technology to be assessed.

1.5 RESEARCH METHODOLOGY

It was noted earlier that the bulk of studies in Zimbabwe has resulted in limited insights into operational aspects of smallholder irrigation management (see section 1.1). The methodologies

[11] Techniques can be defined as knowledge of how to produce a good or service in a particular way.

used may have contributed to this. For example questionnaire surveys, which are frequently cited in the literature, are not really useful for getting to grips with the intricacies of smallholder irrigation management practices. In recognition of this fact the case study method, which gives an in-depth understanding of events and processes (see Hammersley, 1992) was opted for. To take account of concerns about representativeness of the sample, and the generalizability of the findings, three smallholder irrigation schemes of different characteristics were chosen (see below). One major consideration was to include both government-managed or farmer-managed schemes in the sample since the majority of the schemes currently fall under the jurisdiction of the state and are planned to be handed over to farmers in the future. To be able to analyze both technical and social aspects simultaneously, as required by a socio-technical approach, both qualitative and quantitative data were used. There is a fundamental argument to justify the use for qualitative data (often looked down in 'normal' technical irrigation discourse):

> ..... human behaviour [which is what management is all about] is principally determined by the codes of meaning which are socially negotiated and transmitted through culture, and these processes cannot be properly analysed by aping the methods of the natural sciences, nor by borrowing their constructs and categories' (Hurst, 1987: 69)

The reason is that

> .....from a strictly axiological point of view all scientific research is qualitative. [Just because there are] qualities or dimensions of phenomena for which we have agreed-upon cardinal scales of measurement and accurate instruments..... (in themselves quite arbitrary) does not mean that other dimensions.... are not susceptible to scientific analysis *(ibid.)*.

1.5.1 Choice of the study schemes

A number of steps were followed in choosing the study schemes:

1. To gain insights into the details of smallholder irrigation management, a large sample of 12 schemes like that used by Makadho (1994), was considered too large. Similarly using one irrigation project such as Donkor (1991), it was felt, would not bring the **comparative aspect**;
2. Since government intervention was an important element in smallholder irrigation management, the **type of management** was considered important. A basic requirement was that a comparison at least be made between a government-managed and farmer-managed scheme;
3. Another important variable was the **method of irrigation** i.e. whether the selected schemes were overhead or surface irrigated. Only one irrigation type was decided upon since a mixture would render comparison difficult. Surface irrigation, because of its dominance in smallholder irrigation (see chapter 2), was chosen;
4. **Size of the scheme** was also another consideration: schemes were to be of comparable size. Schemes of at least 100 ha in size were selected which, in the Zimbabwe context, is large. Large schemes, it was reasoned, would capture the organizational complexities involved;
5. The **geographical location of the schemes** was also an important factor. As the research activities of ZIMWESI project, under whose auspices the research fell, was confined to Manicaland Province, only schemes within this province were initially chosen.

On the basis of these criteria, Mutambara and Chibuwe irrigation schemes were selected. Mutambara is the largest farmer-managed scheme in the country while Chibuwe is one of the largest government-managed schemes (which has also not been extensively studied before). A third scheme, Fuve Panganai in Masvingo province was added to the sample to include a relatively new scheme. (It was constructed after 1985 when Agritex is said to have started consulting farmers in the design process). This was because there were no 'new' schemes of comparable size in Manicaland. The descriptions of these schemes are given in chapter 3. Other schemes, namely Musikavanhu, Nyanyadai and Nenhowe (see chapter 6) were included in the sample for the subject of water control.

1.5.2 Research Organization

Preliminary data gathering, for familiarization purposes, was between August and September 1993. During this period interviews were held with the head offices of government and non-governmental organizations involved in smallholder irrigation. After the selection of the sample schemes, a number of steps were followed. First were introductions to the relevant actors in the schemes such as government officials, farmer-management organizations and traditional leaders, where applicable. The next step was the actual research which was from May 1994 to December 1996 (details appear below). The research period covered a minimum of two summer and winter seasons and was punctuated by monthly seminars, two workshops and a three-month study break in the Netherlands from April to June 1995. During the research period the researcher visited all schemes at crucial times such planting and water scarcity. Three contract assistants in each of the three schemes kept track of day to day events. The study received assistance from one Zimbabwean MSc student from the Wageningen Agricultural University, the Netherlands and four final year BSc Agricultural Engineering students from the University of Zimbabwe.

1.5.3 Research Methods and Techniques

A number of research methods and techniques was used. The use of any one method/technique depended on its suitability with the subject under investigation (Box 1.2).

1.6 AN OUTLINE OF THE THESIS

The next chapter, chapter 2, provides the overall context of the study by outlining some important background issues. The chapter discusses a selection of issues that are considered to have compromised operational aspects of irrigation management in Zimbabwe. Parallels are drawn with the wider African experience where relevant. The chapter also discusses characteristics of smallholder irrigation in terms of its role in the agricultural sector and the wider physical and social environment of the schemes. Chapter 3 presents the history and contemporary characteristics of the study schemes, namely Mutambara, Chibuwe and Fuve Panganai. This sets the scene for the empirical material.

The book consists of four empirical chapters, chapters 4-7. Chapters 4-6 examine different operational levels of irrigation management as well as provide information for the exposition of management domains. In turn this builds a case for what is called in this study a contingency approach to irrigation management. The first empirical chapter (chapter 4), looks at how water distribution was carried out in practice. It documents water distribution activities over two seasons in the three study schemes, paying attention to who actually was involved at the various stages of water distribution. The chapter isolates the constituents of water of water distribution which are critical to an understanding operational aspects of irrigation management.

Box 1.2 Research methods and techniques used in the study

GENERAL INFORMATION ON SCHEMES
Question: What is the history of the schemes and what are their present characteristics?

Methods and Techniques: (i) Construction of project histories from official and unofficial sources, (ii) Socio-economic surveys, (iii) Consultation of official documents (secondary) quantitative data to support insights gathered, (iv) Key informants

WATER MANAGEMENT OPERATIONS
Question 1: How was water distribution undertaken between and within blocks, concentrating on the way water was shared between different farmers; how farmers interacted with other actors as well as how they 'meddled' with the infrastructure, rules and regulations to secure better water supply and distribution?

Methods and Techniques: (i) Situational analysis (Long, 1989) of water allocation practices in different blocks, e.g. between top and tail-end blocks as well as allocation within the different sections of schemes (ii) Participant observation (Bernard, 1988) to document interactions between farmers and other relevant actors (iii) Water measurements at different sections in blocks and fields under investigation by use of current meter (iv) Examination of pumping records from the Department of Water Resources

Question 2: How did farmers practise *field irrigation* and how did this agree/disagree with official recommendations and why?

Methods and Techniques:(i) Informal and formal interviews (ii) Participant observation of field irrigation in different fields (iii) Structured and semi-structured interviews to establish basis of observed practices (iv) Studying Agritex Irrigation Manuals

Question 3: How was water control carried out in relation to types of technical infrastructure used?

Methods and Techniques (i) Participant observation of use of infrastructure by farmers and bailiffs (ii) Structured, semi-structured and informal interviews to understand observed practices (iii) Consult relevant Agritex documents on the infrastructure.

CROP MANAGEMENT
Questions (i) How were cropping patterns decided on, including the range of crops grown, dates of planting and the yields (ii) what crop variations occurred from season to season and in situations of water scarcity

Methods and Techniques (i) Examination of Agritex and farmer crop records relating to production and disposal of crops (ii) Examination of training manuals (iii) Structured, semi-structured and informal interviews on crop selection and disposal (iv) Group discussions

These include the water source, the technology (hardware), social interactions and commoditization effects of certain crops. It is emphasized that the interaction of these, when in equilibrium, determine 'orderly' water distribution. The evidence, however, underlines that there is no mathematical relationship between these factors: specific combinations or configurations of these factors in each scheme are unique. The chapter concludes that there should be more concern for day-to-day water sharing practices and less concern for formal rules of water allocation when studying water distribution.

Chapter 5 turns to the subject of field irrigation. The chapter examines how farmers actually manage water in their fields in relation to the timing of the irrigation, quantity of water to be applied and the actual application of water in the fields. Field irrigation is shown to be shaped by supply quantity, supply quality and supply utility with local agrarian, socio-economic, and biophysical conditions shaping the utility of supply.

Both water distribution and field irrigation presuppose water control: water cannot be distributed nor fields irrigated without some measure of control. Hydraulic structures play an important role in this. Chapter 6 looks at control structures used in irrigation systems. It examines how water distribution and field irrigation are (not) facilitated by water control measures in irrigation schemes through an inventory of the type of water control devices in the schemes. The devices in place were not a result of rational choice of technology as is commonly assumed. Departmental influence was evident in the choice of the structures. This phenomenon, referred to as institutionalization, is used to explain that the choice of hydraulic structures can be due to the socialization of the design engineers. It is argued that institutionalization is not necessarily negative: what is institutionalized is the issue. One other social influence that can affect operations in irrigation is ideology. In this case ideology refers to ideas about what should be done which may not related to the operational realities. This is the argument in chapter 7 where ideologies and practices of block irrigation are documented. Scientification of agricultural production in irrigation schemes is posed as deflecting attention from operational aspects of irrigation management. The chapter also explores why an ideology that may be unpopular with farmers may continue to thrive. The unequal power relations, tilted against farmers, are the cause. It is emphasized that it is important to find out how power is constructed, or to understand the modes of domination in irrigation.

Chapter 8 firstly revisits the research question including how it was addressed theoretically and methodologically. The main findings of the study are presented, followed by a characterization of state and farmer-managed irrigation. It is concluded that while farmer management does exhibit many positive aspects, it is emphasized that the state has still a role to play. Using the evidence presented in the empirical chapters, the chapter revisits the concept of management and argues that the popular definitions of management pose a number of conceptual and practical problems. The chief reason is the lack of interest of many studies or intervention programmes to engage with the reality of irrigation management. It is argued that a contingency approach to irrigation management is the best way to get to grips with operational aspects of irrigation management since it emphasizes flexibility and takes full account of the local situation.

2 CONTEXT OF THE STUDY
An overview of smallholder irrigation in Zimbabwe[1]

> The preference for large and specialised irrigation systems by African governments and donors alike, is arguably the most serious error of economic judgement with respect to irrigation....large systems are generally incompatible with most African smallholder farming systems. These large systems fit the operational styles of Africa's top down, over-centralised public sector organizations. (Rukuni, 1997: 35).

Rukuni seems to suggest that the problem facing African irrigation is the neglect of operational aspects of irrigation in favour of theoretical developmental models, which results in irrigation systems that are not suitable to their users. This chapter provides evidence in support of these assertions in the context of Zimbabwe.

The chapter discusses a selection of issues that the author considers to have stood in the way of the much-needed focus on operational aspects of irrigation management. Where appropriate, parallels with the broader African experience are made. The chapter is divided into four sections. The first two sections, sections 2.1 and 2.2, provide information on the status and characteristics of Zimbabwe 's smallholder irrigation sub-sector respectively. Section 2.3 then looks at how inappropriate national developmental models failed to define and locate irrigation within its local environment. There is also a discussion of how planning and implementation have been at a tangent to local farmer interests. Section 2.4 discusses some prominent issues at the scheme level that are closely related to operational aspects. The question is how does a) the size of the scheme, b) the technology, c) a 'scientific' approach to irrigation, and d) participatory design affect the day to day management of the schemes. Some of these issues will be covered in greater detail in the empirical chapters.

2.1 STATUS OF SMALLHOLDER IRRIGATION IN ZIMBABWE

2.1.1 Smallholder Farming in the Agricultural Sector

The large scale commercial and smallholder-farming sectors constitute two distinct farming sectors in Zimbabwe. The large-scale commercial sector is comprised of (mostly white-owned) individual, large-scale commercial farmers and company estates. There are also parastatal estates, owned by government and managed by ARDA (there is usually a smallholder farmer component attached to the main ARDA estate). The smallholder-farming sector, on the other hand, is made up of black, indigenous, communal, resettlement and small-scale commercial farmers[2]. Details of these two sectors are contained in appendix 2.

The dual nature of the agricultural sector is a result of the country's colonial history. White settlers carved out for themselves the best agricultural land during various periods of the colonial history (1890-1980). As a result the smallholder sector is confined to the poor natural-

---

[1] Parts of this chapter were written together with Pieter van der Zaag (Manzungu, Emmanuel and Pieter van der Zaag (1996) 'Continuity and controversy in smallholder irrigation' In: Manzungu, Emmanuel and Pieter van der Zaag (eds.).

[2] Communal areas refer to the former native reserves or tribal trust lands, which were reserved for black peasant farmers. The areas are largely agriculturally poor. Resettlement areas were created after independence to cater for land hungry peasants. Small-scale commercial areas were areas where black people were allowed to undertake commercial farming. These areas are marginally better than the communal areas.

farming regions of IV and V, characterised by low rainfall (mean 400-500 mm per annum)[3]. Water availability for both rainfed and irrigated crop production is consequently poor. The soils therein are also generally poor in terms of fertility and irrigability. Unfavourable land tenure, in which government owns the land and makes it available for use under unclear usership arrangements, has not helped the situation. For example farmers do not enjoy security of tenure. Poor agricultural services and poor infrastructure have added to the problems. As a result the smallholder sector has a high poverty profile (Mehretu, 1994).

The poor environment of the smallholder sector contrasts sharply with that of the large-scale sector. The latter is endowed with both good land and water resources. Furthermore it enjoys good services such as sound physical infrastructure e.g. roads and telephones. Freehold title to land provides farmers with security against which they can secure loans.

The agricultural sector plays a crucial role in the socio-economic development of the country. Agriculture is said to:

a. contribute about 15 per cent to the gross domestic product (GDP) (which in 1997 was estimated at between Z$80 and Z$100 billion which is 10 times smaller than that of London, the capital city of Great Britain[4]),
b. account for about 40 per cent of total foreign currency earnings,
c. be the largest single employer accounting for about 25 per cent of formal labour force,
d. provide raw materials for the economy as a whole and has forward and backward linkages with industry and
e. provide a holiday and home to 70 per cent of the population (Roussos, 1988: 52; Muir, 1994: 40-41).

Major agricultural enterprises include tobacco, cotton, wheat, maize, sugar cane, livestock (mainly beef and dairy) and horticultural crops such as flowers, fruits and vegetables.

The large-scale sector accounts for most of the economic contribution attributable to the agricultural industry. However, the smallholder sector has significantly increased its market share since independence in 1980. Smallholder farmers have become the main producers of maize, the staple food crop, and cotton where they have 60-70 per cent of the market share (Herbst, 1990). They also grow cash crops such as sunflower, tobacco and 'new' crops such as paprika and baby corn. Moyo (1987), however, notes that it is the better-endowed communal areas, in terms of good soils and rainfall, which have accounted for most of the contribution. In fact most of the communal areas are net food importers and are characterised by malnutrition (Rukuni and Jayne, 1995).

After this brief sketch of the status of the smallholder-farming sub-sector in the agricultural sector the discussion turns to the irrigation sub-sector with a view to contextualise smallholder irrigation schemes.

2.1.2 Structure of the Irrigation Sub-sector

Like the agricultural sector, the irrigation sub-sector is skewed in favour of the white minority population. As can be seen from Table 2.1, formal smallholder irrigation[5] contributes less than 10 percent of the total irrigated area. This figure excludes small community or individually based informal irrigation schemes and gardens (100 m^2 to 2 ha in size) in communal and resettlement areas, estimated to occupy 5,000 to 10,000 ha (IFAD, 1994: 2, annexe 7, Table

[3] Zimbabwe is divided into five agro-ecological zones; regions I to IV. Region I is the best in terms of agricultural potential while region IV is the worst. However with irrigation the potential increases substantially.

[4] The Financial Gazette, 31 July 1997.

[5] It is important to note that smallholder irrigation popularly refers to irrigation schemes in the communal and resettlement areas.

2.4). Also excluded are large areas, estimated at over 30, 000 ha in aggregate but varying in widely each year, of irrigation in *dambos* or wetlands, including areas irrigated from shallow wells (*ibid.)*. The IFAD (1997) report provides an update of the figures. The report estimates that some 154,000 ha of land has been developed for irrigation in addition to the 20,000 ha in the informal sector. In the large-scale commercial sector 139,500 ha are under irrigation on about 1,500 farms. These farms have 5,700 dams on them.

The large-scale commercial farmers enjoy better support services such as finance, infrastructure and back up services. Consequently production there is much higher than in smallholder irrigation (IFAD, 1997). Farmers also have good access to water in government dams. As a consequence there is an annual increase of irrigated area amounting to 2,000 ha compared to 400 ha in the smallholder sector.

Table 2.1 Irrigated area in Zimbabwe according to farming sub-sectors

Farming sub-sector	Command area (ha)	% of total irrigated area
Large-scale commercial	126,000	84
Parastatal estates	13,500	9
Small-scale settler ('outgrowers')	3,600	2
Communal and resettlement	7,200	5
Total	150,300	100

Source: IFAD (1994: 2, annexe 7)

Irrigation is critical to the country, but not to the same extent as countries like Egypt and the Sudan where over 90% of the crops are irrigated. In Zimbabwe irrigation contributes about 20% to total annual agricultural production (Peacock, 1995). In the 1995/96 season, irrigation accounted for over 70 % of the marketed produce in the large-scale sector. It has also enabled diversification in agricultural production (Rukuni and Makadho, 1994). Irrigation is also vital for those crops that are fully irrigated e.g. sugar cane, wheat and to some extent, tobacco.

Given its low share of the total irrigated area, it is no surprise that smallholder irrigation's contribution to the national economy is small (Rukuni and Makadho 1994: 137). According to Harvey *et al* (1987: 143), the gross output from smallholder irrigation in the 1984/85 agricultural season was only 0.4% of the total agricultural produce. This figure still applies to today 's situation (see Peacock, 1995).

Despite its poor national economic credentials, smallholder irrigation has been regarded as important by both the colonial and post-colonial governments, mainly for socio-political reasons. First, smallholder irrigation has always had a clear political content as it embodies land and water, two of the most contentious issues in Zimbabwean history in which colonial injustice is obvious. In a country with an economy based on agriculture, land and water scarcity is crystallised in smallholder irrigation where there is little of each for so many people. In the second instance, smallholder irrigation is viewed as capable of alleviating rural poverty. Third, smallholder irrigation is seen as offering a chance to modernize peasant agriculture which may result in smallholder irrigation contributing to the growth of local industries as well as to foreign currency earnings. Fourth, irrigation is seen as facilitating intensification of agricultural production which, may result in alleviating pressure on scarce land resources.

The above conceptualizations of irrigation will be shown to have negatively affected how management has been approached in Zimbabwe (section 2.3). This will be discussed after providing characteristics of smallholder irrigation schemes in Zimbabwe in the following section.

2.2 CHARACTERISTICS OF SMALLHOLDER IRRIGATION SCHEMES IN ZIMBABWE

2.2.1 General

According to Agritex data, there were about 170 formal smallholder irrigation schemes in Zimbabwe in 1996. Most irrigation schemes are found in the dry provinces of Manicaland, Masvingo and Matebeland South provinces (Table 2.2). Surface schemes account for over 60 per cent of the total irrigated area with overhead sprinkler accounting for the rest. The increase in the area under overhead irrigation is of recent origin. At independence over 90 per cent of the area was under surface irrigation (Manzungu and Van der Zaag, 1996 chapter 2). Overhead irrigation seems to have increased because of the introduction of draghose irrigation around 1988, a direct result of an FAO assistance programme.

Table 2.2 Distribution of smallholder irrigation schemes (%) according to method of irrigation and provincial location

Province	Surface irrigated	Overhead	Total irrigated area
Manicaland	85	15	34
Masvingo	93	7	23
Midlands	74	26	13
Matebeleland South	99	1	14
Matebeleland North	100	0	3
Mashonaland East	17	83	6
Mashonaland West	12	88	5
Mashonaland Central	9	91	3
Average	61	39	-

Source: Based on 1996 Agritex official records, Head Office

The schemes range in size from 2 to 600 ha. The average size is 40 ha (Table 2.3). The majority of the schemes are small in size; over 50 % being below 100 ha in size. Only a handful are over 300 ha in size (see Table 2.4).

Table 2.3 Some size indicators of smallholder irrigation schemes in Zimbabwe

Total number of schemes	170
Total operational area (ha)	8, 000
Largest scheme (ha)	624
Smallest scheme (ha)	2
Average size (ha)	43
Median size (ha)	11-20

Source: Based on 1996 Agritex official records, Head Office

Table 2.4 Frequency of smallholder irrigation schemes according to size

Size (ha)	Number of schemes
0-5	30
6-10	42
21-50	51
51-100	14
101-200	8
201-300	3
301-400	2
401-500	4
501-600	0
> 600	1

Source: Based on 1996 Agritex official records, Head Office

2.2.2 Policy and Institutional Environment

This section looks at policy and institutional aspects, which have shaped the development of smallholder irrigation in Zimbabwe. In the context of this discussion, policy is defined as a statement of intent concerning irrigation development enunciated by the state through its various institution(s). Commentators have pointed out that the irrigation policy in Zimbabwe, before and after independence, was never adequately developed (see Roder 1965; Mupawose 1984: A-12; Magadzire 1994: 10, Chabayanzara 1994: 6, Chitsiko 1995: 13). Referring to the post-colonial era, Makadho (1994: 20) remarks that `irrigation policy is not in black and white: it is only understood'. After independence there was a heavy dependence on the 1983 Derude document (Derude, 1983), which has been the most definitive statement of irrigation policy (Meinzen-Dick, 1993b: 35). About ten years later there was a FAO-assisted draft irrigation policy document (RoZ 1994), which by December 1995, was said to be under consideration by the government. Nothing came out of this particular effort. However the document is said to have been incorporated into the Zimbabwe 's Agricultural Policy Framework 1995-2020. Box 2.1 gives characteristics of the Water and Irrigation Policy as found in this document.

The policy framework identifies a number of constraints namely;

- limited water availability for irrigation development in general and particularly for smallholder farmers in the long term due to competing water uses (this may worsen the inequitable distribution of water)
- lack of capital for development of infrastructure
- irrigation development has been left to private initiative, and the`institutional capacity to support development is insufficient particularly for the smallholder sub-sector
- low levels of water use efficiency due to over-irrigation
- lack of coincidence between land and water resources.

A recent survey of key actors in the smallholder irrigation sub-sector revealed that the policy statement was regarded as inadequate principally because of its dismissive nature of operational issues (Manzungu, 1997). For example the government document merely states that the 'specific objectives for each farming sub-sector will be elaborated at operational level.' Respondents pointed out that a) the policy framework had no supporting legislation e.g. Irrigation Management Committees since their inception in 1983 have no legal standing and b) there was no clear plan on how the objectives were to be achieved.

Box 2.1 Zimbabwe's Water and Irrigation Policy

Objectives
- Growth in the irrigated area particularly in the smallholder sector with minimal negative impacts on the environment and human health
- Equitable allocation and efficient use of scarce water resources
- Establishing a water pricing structure which is consistent with cost and social efficiency
- Establishing an effective institutional structure
- Implementing efficient drought mitigating strategies

Key Policy Strategies
- Water demand and utilisation to continue in spite of increasing demands for urban and industrial development
- Priority will be placed on farmer-managed and operated systems. Government will assist in capital development while farmers will retain responsibility for operation and maintenance of irrigation systems
- Greater emphasis will be placed on more efficient and greater equity of water use
- Institutional capacity for development will be encouraged for both public and private sectors. Better co-ordination among public agencies will be encouraged
- Effective water user associations will be encouraged and facilitated in the planning, development and evaluation of irrigation projects. Current Irrigation Management Committees will be reformed and strengthened to allow broader participation and greater responsibility in irrigation management
- All major developments will be preceded by an environmental impact assessment (EIA)
- Water allocation will take into account the imbalances in water supply between large and smallholder irrigators
- Development of major irrigation infrastructure on state land will continue to be the responsibility of the government. Government will positively encourage privater sector investment in irrigation
- Water pricing policy in future will reflect the scarcity of this valuable commodity

Source: Government of Zimbabwe: Zimbabwe's Agricultural Policy Framework 1995-2020 (n.d.)

Against this background it is interesting to examine how some of the stated policy objectives affect management. This is undertaken below. Thereafter is a discussion of the institutional environment, which is a factor in management, moreso because of the presence of many different players[6].

Some stated policy elements

Appendix 3 shows a number of issues that were put forward at different times as policy. A

[6] Apart from (future) beneficiaries and those potentially affected, those involved include officials at the local level, including the Chief, the Councillor and District level staff, DDF (District Development Fund), Department of Water Resources in the Ministry of Rural Resources and Water Development, Agritex in the Ministry of Lands and Agriculture, Ministry of Finance, National Economic Planning Committee, AFC (Agricultural finance Corporation, administering the National Farm Irrigation Fund NFIF), ARDA (Agricultural and Rural Development Authority), ZINWA (Zimbabwe National Water Authority), DR&SS (Department of Research and Specialist Services in the Ministry of Agriculture), a wide range of foreign NGOs (e.g. Lutheran World Federation, Christian Care, Coopibo, MS), and official donors and other organisations (EEC, DANIDA, ODA, DGIS, ADB, FAO, World Bank etc.).

pervasive thought has been that the development of smallholder schemes should enhance food security. Later, the main objective appeared to have been to resettle black farmers thrown off white-designated farms. As pre- and post-independent governments began to count the cost of the schemes, there was a realization that for these to be financially sustainable, irrigators had to meet maintenance and capital costs. This, however, has not been elaborated to any extent. The result has been a situation where some schemes are better financially supported (subsidized) than others.

By 1972, in addition to the food supply objective, and the relief of population pressure, there was also an interest to provide economic and employment opportunities in the rural areas. This was meant to stem the urban drift. The principle of farmer involvement was embraced albeit from the state's definition. As early as the 1940s irrigators were permitted to form their own management committees for the day-to-day operation of the schemes. However, government irrigation managers took full charge of the scheme and by so doing compromised the participation of the irrigators. By and large Irrigation Management Committees have proved to be ineffective.

After independence a similar mix of objectives was formulated. There was a more genuine emphasis on social development of the rural areas. Nevertheless, the approach to irrigation hardly changed. For example there are striking similarities between some of the objectives formulated in 1983 and the policy statement of 1972 (see Manzungu and Van der Zaag, 1996 Table 2.6)[7]. Moreover, the state remained in total control of what happened in the schemes (see below).

Policy statements were often a result of political compromise, hence the large numbers of stated objectives[8] resulting in some contradictions. Two examples of this lack of consistency are given here. For example Reynolds was suspicious about how the outcomes of the 1960 policy committee were implemented, in particular with the ambitious Middle Sabi development, which was to irrigate 100,000 acres (Reynolds 1969: 299-302). He concluded:

> As with all the existing schemes in Rhodesia [now Zimbabwe] a settlement rather than development is to be the aim. .. The failure of the earlier schemes, in .. a developmental sense, is to be perpetuated without any attempt to match the abilities and rising aspirations of Africans. (p.302)

Similarly, Hughes doubted the sincerity of the food supply objective in the 1972-policy statement by the Ministry of Internal Affairs. He saw how maximising production, and the corresponding technical and economic imperatives, had become the main guiding principle, with the resulting increase in managerial control by government and a stiff increase in water rates (Hughes 1974: 213).

The stated objective of moves towards self-management of the schemes by the irrigators was never followed through to its full consequences (Rukuni 1993a: 2). The sincerity of government to achieve this objective could also be doubted (Makadho 1994: 204). Rukuni observed that 'smallholder irrigation in communal areas has always been a problematic policy area for subsequent Zimbabwean governments' (Rukuni 1993b: 6-7; see also Rukuni 1988a: 208).

It appears there has been a lack of learning from past experiences in irrigation development in Zimbabwe. This is a weakness that seems to be institutionalised. This point was made by Reynolds (1969: 299):

---

[7] Note that Derude's policy paper was not formally adopted by government.

[8] For Mupawose, 'The ideal policy for irrigation development is obviously one that will contribute most to food production, maximise economic returns, achieve an equitable distribution of productive resources and enhance the capability of the agricultural sector to minimise the adverse effects of season droughts' (Mupawose 1984:A-12).

> After thirty years of irrigation settlement schemes in Rhodesia little understanding of the co-efficients involved in the development of the schemes would appear to exist.

Reynolds' observation supports the argument in this study. This is why there is attention paid to documenting of what actually happens in the schemes.

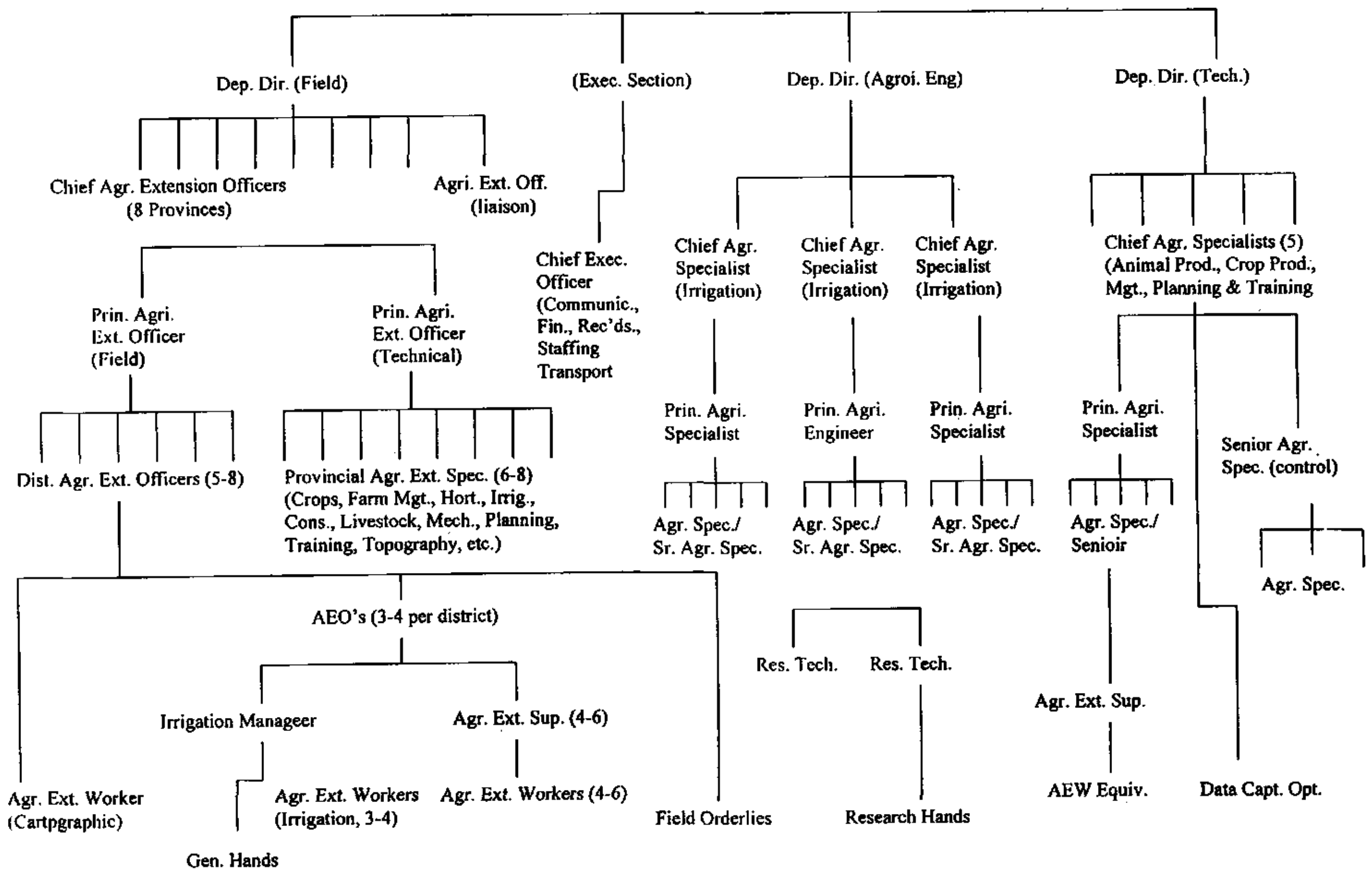
Institutional aspects

Rukuni observed that between 1932 and 1985 smallholder irrigation fell under eight different government agencies (Rukuni 1984b: 17). Appendix 4 presents an overview of the changes in the institutions. In the colonial era, smallholder irrigation, just like the rest of `African agriculture', fell under ministries and departments separate from `commercial' agriculture, with the exception of the 1964-1968 period when it fell under the Department of Conservation and Extension in the Ministry of Agriculture. These agencies included the Ministry of African Affairs, Internal Affairs Administration, the Department of Native Agriculture, the Ministry of Internal Affairs and the Department of Agricultural Development. This situation often created conflicts between the `African' and `European' agricultural sectors, and problems of co-ordination (see for a contemporary account of some problems: Alvord, n.d.: 36, 47).

The situation has not changed much with independence. By 1984 Rukuni reported that 'an important characteristic of smallholder irrigation in Zimbabwe is that management and agricultural extension are located in three different ministries' (Rukuni, 1984b: 23). Rukuni thought this posed problems of co-ordination. Makadho (1990a) added the donor factor, which he suggested, needed regulating (cf. Peacock 1995).

In terms of the number of institutions in smallholder irrigation, too many ministries are involved and are guided by poor legislation (see appendix 5). The operational level, however, has been clarified. Agritex, by and large, is responsible for planning and development of smallholder irrigation schemes. Even farmer-managed schemes receive help from Agritex in connection with design aspects. The question that may be asked is to what extent is Agritex inclined towards an appreciation of operational aspects of irrigation management by smallholders. Figure 2.1 shows Agritex's organogram, which is supposed to guide how operations proceed in the department. Extension workers, who are certificate holders, are entrusted with the management of the schemes. These have no formal training in irrigation. This situation is partly a result of the fact that the Irrigation Branch (of Agritex) staff are involved in designing schemes than managing them. For example the staff in the irrigation schemes fall under the Field Branch. The Irrigation Branch nearest to the ground are irrigation officers at the district level. These officers, however, are not involved in the day-to-day operations of the schemes. It is also important to note that government staff responsible for distributing water to farmers, commonly called water bailiffs, do not have that not official status. They are in fact general hands who are given this responsibility as a local arrangement.

Figure 2.1 Agritex 's organogram



Source: Agritex official records

2.3 NATIONAL GOALS VERSUS LOCAL NEEDS

At the end of the previous section reference was made to the fact that the state tended to impose particular ways of undertaking irrigation. This section provides further evidence in that direction. This explains why operational aspects of irrigation management have been neglected. The comments relate to African and Zimbabwean irrigation.

2.3.1 The African Experience

Irrigation and Development

There is a consensus that approaches to irrigation development in Africa, hailing from national development plans, have negatively affected the operations of irrigation projects, hence their poor performance (Underhill, 1990; Diemer and Vincent, 1992; Rukuni, 1995, 1997). A major problem has been to think of irrigation as a tool to modernize peasant agriculture, a mindset which caused indigenous irrigation systems to be regarded as inconsequential (Diemer and Vincent, 1992: 143 cf. Underhill, 1990: 14; Adams, 1992). There has, however, been research evidence to the viability of informal schemes as demonstrated by Fleuret (1985), among others. These research efforts have resulted in smallholder irrigation schemes being viewed as capable of mobilising indigenous knowledge and skills at low investment costs. They have also been seen as promoting the much-needed spirit of self-reliance and motivation, for long undermined by too much external assistance.

But the bias towards formal and against informal irrigation still remains today, at least in Zimbabwe. For example in Zimbabwe, formal irrigation schemes are heavily subsidized even though the crop yields obtained there are lower than in informal irrigation schemes which are completely farmer-financed and farmer-managed (Bolding, 1996). Moreover informal irrigators' water rights are insecure as government officials tend to favour formal irrigators *(ibid.)*.

Donors in both Anglo- and Francophone Africa were said to be equally to blame for this state of affairs on account of their close association with the modernisation drives of nation states (Diemer and Vincent, 1992). This is in marked contrast to NGOs, which promoted bottom up rather than top-down versions of development *(ibid.)*. Despite the poor performance of irrigation, Moris and Thom (1990: 13) assert that irrigation still dominates national politics in Sub-Saharan Africa on *prima facie* grounds. While it has lost some of its status as a privileged solution in Africa (Moris, 1987), irrigation is seen as a means for:

a. alleviating the impacts of drought, quite common in many parts of the continent,
b. stabilising internal food supplies and
c. saving hard currency through reduction of food imports.

These biases towards irrigation, or irrigationism as Adams (1992) calls it, are apparent in the way irrigation has been planned and implemented.

Planning and Implementation

One of the weaknesses of irrigation planning in Africa has been a failure to contextualise irrigation in terms of its local environment, specifically the physical and social aspects. A major contributing factor, perhaps, is how irrigation has been and is defined. For example there are differences in irrigable land estimates in Africa (Underhill, 1990: 2 cf. Diemer and Vincent, 1992: 143). Other forms of irrigation, other than the formal irrigation, e.g. seasonal or permanent wetlands, are usually not included in official statistics as they do not lend themselves to the common definitions of irrigation (Diemer and Vincent, 1992). Vincent (1990) identified one other problem: often there is not a sound hydrological database in Africa to guide informed interventions.

Apart from the lack of appreciation of the physical dimension, there has been even more ignorance concerning social and cultural aspects. The emphasis has been on technological models based on 'factual' quantitative data to the exclusion of socio-cultural variables. Irrigation has tended to be prised off from its wider farming system (Guijt and Thompson, 1994; Underhill, 1990: 13). Issues that are frequently missed are gender, labour constraints and cultural factors (such as religion and land tenure), among others. This was not helped by planning and implementation procedures which:

a. tended to see irrigation development as progressing from a frame of reference, based on rapid diagnosis of the situation, through pre-feasibility studies to the drawing up of a master plan;
b. emphasized big projects, because of their visibility, which Adams (1992) said fulfilled the dreams and schemes of their planners;
c. placed emphasis on the project cycle and not on processes, relying on readily quantifiable targets which often have little to do with the substantative issues of irrigation; d. produced the misplaced optimism that the implementation phase follows a predetermined plan (Underhill, 1990);
d. maintained a planning-implementation dichotomy, which is neither practically nor theoretically founded, as implementation is a co-learning process given that there are frequent changes in the ecological, human, political and economic spheres (*ibid.*).

Similar submissions have been made by Wageningen Agricultural University (1990) and Ubels and Horst (1993). The foregoing references point to shortcomings in the design process.[9]

Apart from problems relating to the design processes, Diemer and Vincent (1992), as do Adams (1992) and Ubels and Horst (1993), critique the design method itself, which in their view, has been dominated by engineering with its fixation on physical or hardware aspects. This has been blamed for contributing to the poor performance of many irrigation schemes. (Because of its focus on technical aspects and its exclusion of relevant social aspects, the approach has been labelled technocratic). Given this scenario, Rydzewski 's assertion that 'the disappointing performance of many modern irrigation projects can often be traced to their conception as exercises in applied hydraulics on a large scale, rather than a facility for providing a reliable water input to the farmer' (Rydzewski, 1987: 210-227 cited in Adams, 1992) holds water.

2.3.2 The Zimbabwean Experience

Formal smallholder irrigation in Zimbabwe started in the mid 1900s. In its 90-year history, formal smallholder irrigation has been under colonial administration for close to 70 years. The effects of these have been profound as will be outlined in chapter 3. This section demonstrates how government has attempted to influence the proceedings in smallholder irrigation, perhaps to guarantee the preferred intervention/developmental models.

Government's grip on smallholder irrigation became stronger between 1935 and 1956, culminating in attempts to implement the Land Husbandry Act (Roder 1965: 103-117)[10] Government's wish to control was premised on food security, import substitution and resettlement of displaced farmers. In order to control farmers, farmers were required to:

a. give up dryland farming and not to leave the irrigated plots;
b. produce surplus food crops for the market;
c. practise prescribed crop rotations, plant on specific dates and follow specified production packages;

[9] A distinction is sometimes made between *design process* and *design method. Design process* can be defined as all activities concerning technical and socio-economic considerations, decision-making and interactions between actors, that together lead to the realization of the physical design while *design method* refers to the tools and techniques used in the production of a physical design (Wageningen, 1990).

[10] The Land Husbandry Act was apparently only enforced in Nyachowa (Roder 1965: 184-85).

d. pay water rates as a cost recovery measure.

It was believed that close supervision of the farmers was key to increased productivity (Hunt 1958: ii)[11]. But not everyone agreed. Reynolds (1969) thought that the problem emanated from a lack of communication between management and farmers because government staff viewed irrigators 'as children' (Reynolds, 1969: 289). Reynolds observed that the farmers were sophisticated and rational in their own way although they faced unfavourable factors in the form of rigid rules (*ibid.*: preface). He came to the conclusion that farmer capability was greatly compromised by a feeling of insecurity, a result of strict regulations concerning irrigated crops, the ever-present threat of eviction (which made farmers feel like employees) and the insistence on cash crops which farmers considered too risky (Roder 1965: 172 cf. Hunt, 1974: 186). Despite these problems, irrigators managed to muster `financial, organisational and innovative dynamism' and made economic decisions that were `close to optimal within the given conditions' (Reynolds, 1969: 303, 330).

The command and control style of 'management' by the state, perhaps diverted the attention of government officials from providing reliable and adequate services to farmers. This observation holds true for today's schemes. Recent studies on water distribution (for example, Pearce and Armstrong 1990, Donkor 1991, Makadho 1994, Nyakudya 1995) confirmed the pre-independence findings of Roder and Reynolds that the irrigation service generally is unreliable (cf. Rukuni 1993a: 2). The situation was not conducive for farmers to improve their irrigation practices since irrigation can only succeed if reliable and timely supply of water is provided (Makadho, 1994: 200). Water supplies were said to be less reliable in government-managed schemes than in community-managed schemes. Respondents (all Agritex staff) to a questionnaire by Makadho (1993: 33-37) identified 'shortage of water' as the most important problem facing smallholder schemes, followed by `poor managerial ability'. Data provided in the same study, however, indicate that despite 'water shortage', Agritex schemes wasted nearly twice as much water as community schemes in the 1991 winter season (Makadho 1993: 30). It could therefore be suggested that 'poor managerial ability' resulted in 'water shortage', indicating that the central issue in smallholder irrigation is management. Despite these problems there has been no hesitation to prescribe which crops farmers should grow (see later). Below are further examples of how the state has sought to control farming in smallholder irrigation schemes.

As already stated, government started to interfere with irrigators' crops from about 1936. First, plotholders were pressed to grow food crops for sale (in order to pursue the famine relief objectives of government), followed by compulsory crop rotation of beans and wheat. Sunhemp was later included (Roder 1965: 111). During the first half of the 1960s, cotton was introduced (Reynolds 1969). From the start, irrigators appeared to have distrusted cash crops. They were at the whims of crop disease, transport and markets[12], things beyond their control. On the other

[11] By the early 1970s this view still held currency (Hughes 1974: 186). Hughes observed that 'Official attitudes seem to have been based on the assumption that since the people in the area were being "given" irrigated plots they should be only too happy to pay water rents, and submit to control by the scheme management, in exchange for the right to use these plots' (Hughes 1974: 215). Still `at the time of independence in 1980, management control was highly centralised Decisions were taken with little regard to what farmers felt' (Pazvakavambwa 1988: 1).

[12] 'One of the most important limiting factors to agricultural and industrial expansion in Southern Rhodesia at present is the non-existence or small size of market outlets.' (DNA 1960 cited in Roder 1965: 131) Cf. Alvord (n.d.: 39): 'the need for a cash market for surplus native crops [is] an essential necessity. All over the country, Natives asked with wisdom, - "What is the use of adopting better methods and producing more crops, when there is no market?"

hand food crops necessary to satisfy their own subsistence needs and which had a wide market (including their own informal market networks) were preferred. Maize was such a crop, and later also wheat, when bread had become an accepted staple (Roder 1965: 133). But continued maize cultivation often clashed with the official crop rotation, and was considered 'illegal'. As one irrigator in the early 1960s complained: government lays down what to plant, when to plant and where to plant (Roder 1965: 172).

By 1974, the situation had become excessive:

> technical and economic imperatives make it essential to ensure that plotholders should cultivate their plots in the manner approved .. The main devices used to bring about this increase in managerial control have been the introduction of lease agreements and the appointment of scheme managers. .. the "managerial bureaucracy" specifies the precise areas of which crops each plotholder will plant, final planting dates for these crops, which types of seed will be used, and what quantities of which types of fertilizer will be applied. .. Plotholders are also bound, in terms of their leases, to obey the orders of the managers in respect of such activities as weeding their plots and being present at predetermined times to take water. (Hughes 1974: 213-214)

The situation is somewhat changed today but irrigation staff still interfere with irrigators' preferences as documented by Bourdillon and Madzudzo (1994). It appears that the state has been caught in the belief that irrigation as a form of planned development should be under the strict guidance of the state. This view is not unique to the state. For example, many economists maintain that the only economical way of utilizing expensive irrigation infrastructure is through the production of 'high value' crops which 'are the most efficient users of irrigation investment (while) food crops are the least' (Jansen 1993: 42).

But high value crops are highly perishable, have stringent quality requirements, require speedy and delicate transportation to markets and have no assured market. For many smallholders farming in areas served by poor roads, poor transport network and at great distance to the market growing, high value crops remain a mere ideal. There are also socio-economic dimensions. Once planners interfere with farm decisions, problems are bound to emerge. How, for instance, can planners weigh the labour constraints of a particular household against that household's objectives, which may include food security, cash income, providing proper care and education to children, and probably a host of other objectives as well? A recent study found that the preference for 'multipurpose' crops, a strategy followed by many irrigators ever since the 1930s, may have been sound after all:

> Irrigated maize cultivation offers a compromise between the high margins of horticultural production, and production stability, and food security. (Meinzen-Dick *et al* 1993: 34)

Some authors saw irrigation succeeding provided 'the basic farm management responsibilities' are placed into their hands (cf. Nzima 1990: 382). This, it was demonstrated, was not the case.

2.4 RECURRING ISSUES IN IRRIGATION MANAGEMENT

This section examines and details scheme-based issues that have a bearing on operational aspects of irrigation management. Some of these themes are relevant in today's schemes as shown in the empirical chapters (4-7).

2.4.1 The issue of Scale

The size of the scheme as it relates to management, has been a popular topic in international irrigation literature (see Hunt, 1992). There is a view that managing a larger scheme appears to be more complicated than a smaller scheme. In Zimbabwe the debate is very much alive. Roder reflected on the ideal scale of schemes, referring to contemporary studies some of which favoured larger scale schemes which were supposed to achieve high efficiencies because of economies of scale (Roder 1969: 9). Others preferred smaller schemes because of the supposed smaller gap between irrigators and management *(ibid.)*. Small projects were thought to be compatible with the existing regional economy.' Peacock, however, referring to a recent World Bank report, maintained that small irrigation development has no distinct advantage over large-scale developments. He argued that large irrigation schemes were more likely to succeed than smaller ones, simply because `larger schemes attracted better managers, and because borrowers were more disposed to take the actions necessary to ensure that larger, more visible schemes succeed' (Peacock 1995: 48).

If this is true, and if it is also true that management becomes more complex with increase of scale, then questions should be asked as to how the technical design may make management easier. One way of easing this situation is by creating one or more intermediate management levels in a scheme, parallel to system levels (Makadho 1994, Tiffen and Harland 1990). Tiffen and Harland (1990: 54) proposed to break the 400 ha Nyanyadzi scheme into more manageable components. In their proposal, the lowest management level would be formed by 'field channel groups', each with their own intake. The second level would be formed by channel groups `federated into a block, which also has its independent water source, or intake from the main canal.' Makadho focused his discussion on the second option, block level (Makadho 1994: 190). With the channel group concept in mind, Tiffen and Harland (1990: 54) suggested that, for new schemes, each field channel should supply water to some 8 to 25 farmers, 'as Zimbabwe experience in settlement schemes has shown this to be a good size for a social unit'. The above discussion has implications on how smallholder irrigation schemes are designed and managed.

2.4.2 Technology

Management problems are often directly related to technical design elements of an irrigation scheme. There have been few attempts in Zimbabwe towards improving existing design concepts of smallholder schemes or exploring new ones[13]. The bulk of the studies concentrated on social, economic and most importantly, agricultural objectives and considerations (cf. Meinzen-Dick 1993b: 29)[14]. Below is a review of those publications, which implicitly or explicitly address technical design issues. A related point is how water could be controlled to expedite the irrigation practice. This subject, that touches on the rationale of particular technical infrastructure, is largely absent in Zimbabwe despite its having important practical implications (see chapter 6).

Roder concluded in 1965 that with the increasing number of irrigation schemes, the most favourable sites in relation to water availability and soil quality had already been occupied, making it necessary for later schemes to be equipped with night storage dams and pumps.

[13] Even the handful of technical studies on water distribution did not come up with concrete proposals for improved designs; Pearce and Armstrong concluded that whereas `in the past a design efficiency of 70% has been used. .. A field application efficiency of 55% appears to be a feasible target' (Pearce and Armstrong 1990: 18-19; cf. Watermeyer 1990).

[14] A revealing example is Derude's policy paper of 1983. Its 'format for irrigation project report' (appendix 9) contains no paragraph that gives attention to the design criteria used and design decisions made.

Furthermore poorer soils were brought under irrigation. As a result, these schemes were more complex and expensive to operate (Roder 1965: 149). At independence all smallholder schemes had open canal systems except for two schemes with sprinkler sections (Derude 1983: 2).

During the 1980s there was a consensus that smallholder schemes should be simple, robust and low cost (Derude 1983: 2, Pazvakavambwa 1987: 2, Rukuni 1988b: 17, FAO 1990: 35, cf. Rukuni 1995). It was argued that such technology would be more sustainable and would facilitate farmer participation. But by 1995, the highest Agritex officer in charge of irrigation dismissed the simple technology philosophy by arguing that new technologies would save enormous amounts of water (Chitsiko 1995: 15). He further disagreed with the widely held belief that 'sprinkler and drip systems are more difficult for the smallholder, compared to surface irrigation'. He, instead, argued that sprinkler and drip systems had 'more in-built management when compared to the latter' and were therefore easier to manage. Unfortunately, this debate has tended to hail from a technical perspective. The views of farmers and the actual practice on the ground remain unknown.

2.4.3 Science in Irrigation

The conclusion that smallholder irrigation systems have not performed well were on the basis of 'scientific' calculations of some chosen parameters. For example there have been efforts at determining the adequacy and reliability of water supply in terms of timeliness (see Makadho, 1994). However, these science-based interventions/solutions, hailing mainly from irrigation agronomy, have not addressed fully operational aspects of irrigation. Some examples are given below.

Makadho argued that winter crops received adequate water despite all the wastage and the unreliable supplies. This was because farmers and irrigation staff behaved as if evaporation in winter was as high as in summer. One factor, which made water available in winter, was that the cropped area in winter was reduced (Makadho 1993: 41; cf. Makadho 1994: 196). Makadho estimated that the area under winter irrigation could be boosted by about 50%, if the water was used more effectively (Makadho 1994: 196). It was suggested that water wastage can be addressed by proper water scheduling based on actual crop water requirements (e.g. Hoecht 1990)[15]. This would inevitably require a greater, if not complete, control over water flows by government officials. Others have argued that before addressing the issue of water wastage, the issue of highly unreliable supplies should be tackled.

This second line of reasoning was followed by Tiffen and Harland (1990). They observed that in Nyanyadzi each farmer took water for as long as needed (cf. Makadho 1994: 157, Table 6.15), turns were unpredictable, and that during water shortage this led to unacceptable long intervals and inequity. They proposed a time-based roster of irrigation turns that was fixed: each farmer would got a precise time allocation, normally proportional to the land that a farmer owns, but adjusted, if needed, for reduced flows in the lower reaches of the canal system. Depending on the amount of water in the canal, this would enable the farmer to water all or part of his land. Tiffen and Harland argued that such a system 'is more equitable than that operating in Nyanyadzi since in water-short years each farmer, whether at the top or bottom, will have time to water only part of his land' (Tiffen and Harland 1990: 48). They recognized the trade-off between reliability and ease of management on the one hand and satisfying crop water requirements on the other.

In conclusion it can be said that the way irrigation turns are arranged has implications

[15] But establishing crop water requirements is not that straightforward: these calculations, which used to be based on pan evaporation data, tended to over-estimate peak demand for wheat by as much as 30% (Butlig and Makadho n.d.: 11).

the Irrigation Committee and the Chief, became bitter opponents of the authorities.

The stance of the plotholders exasperated government officials at the national, provincial, district, and scheme level. From the office of the Secretary of Internal Affairs came the advice that all irrigators could be removed if necessary[10].

The closure of the scheme in 1974

The simmering discontent among farmers, caused by losing *their* scheme to the government, eventually led to the closure of the scheme. J.R. Peters, in a 1974 letter to the provincial commissioner, Manicaland, gave an account of the main events leading to the immediate closure of the scheme.

The suggested increased water charges from Z$2.50 per acre to Z$14.00 per acre met with disapproval from farmers. Although the officials had given a prior warning of the issue two years before, this did not help matters. A last meeting called by the district commissioner to resolve the issue was reported as 'unruly' and that there was 'obvious hostility which made it impossible to reason with them'. At that meeting the district commissioner, the irrigation manager and the agricultural officer were present while farmers were represented by the 'Acting Chief and leading irrigation personnel from the scheme'.

According to Peters, farmers opposed the proposed increases on these grounds:

a. The irrigation scheme had been built by the people and not by the Government; Under the direction of Mr. Alvord, they had dug the main canal in 1934 and opened up the area for irrigation;
b. Government had not developed the scheme by introducing an improved layout with lined canals as was the case with other irrigation schemes;
c. They did not see how the government could charge them for water which came from God, not the government;
d. During the last summer season they had received so much rain that it spoilt their crops - so why irrigate?'[11]

The view of the government was contained in the next paragraph of the same letter:

> After listening to their arguments it was obvious that the majority of those present were unable to see the real advantages of irrigation, as there was "no apparent need" for irrigation in a highveld area where drought years were the exception rather than the rule. Our own Ministry 's history of weakness on this issue and an assurance by a previous Minister in 1969 or 1970 that no increases in water rates would occur until the scheme was re-developed, are factors which are not easily forgotten and encourage opposition to new policies or changes in existing policies[12].

A three-point ultimatum was given to farmers. The three points were:

a. Acceptance of the increase in water rates to Z$14.00 per acre;
b. Modification of the scheme to allow those who wished to accept the increase the opportunity to continue irrigation farming whilst the remainder could either leave the irrigation scheme or that part of the scheme be turned into dry land farming area;
c. Conversion of the entire scheme into a dry land farming area without water, in which case

[10] Agritex, Mutare, de Bruijin, L.J. to Provincial Commissioner (Manicaland) 26 April 1972; Hunt, Noel, A. to the Provincial Commissioner (Manicaland), 4 May 1972.

[11] Agritex, Mutare, Peters to the District Commissioner, 11 Sept. 1974.

[12] *Ibid.*

the main canal would be closed and no private or individual irrigation permitted[13].

Farmers refused to budge regarding the issue of water fees. At a meeting 'with the tribal leaders at Acting Chief Mutambara 's kraal' this was conveyed to the district commissioner. The scheme was officially closed on 1 October 1974. Farmers chose point (c) and embarked on rainfed farming within the scheme boundary. Farmers are quick to point out that in that particular year, without the benefit of irrigation, they got a very good harvest better than when they used to irrigate! Even so Peters requested that the water rights of the scheme be retained as it was thought that many plotholders wanted the scheme to remain open[14].

The ill feeling towards the scheme by government officials spilled into the post-colonial era. E.P. Danby, who was the principal agricultural officer (irrigation) for Manicaland province some time between 1974 and early 1980s, commented that 'far better use could be made of any money that is contemplated to be spent on the re-development of Mutambara[15].'

3.1.2 The Period of Democracy

The scheme re-opens

The scheme remained closed until the war of liberation was over in 1980. For farmers the fruit of the struggle was immediate - they regained *their* irrigation scheme. Farmers talk about the district administrator from Chimanimani, who in August 1980[16], came and handed over the scheme to farmers. In 1993 the Chief talked about a document which was signed by the district administrator in which the hand-over of the scheme was made legal. The document could not be traced, however. This 'legal' ceremony was preceded by opening up the canal through the efforts of farmers who pooled their labour and cleaned it. To promote democracy in the scheme, it was decided at the same meeting that an Irrigation Management Committee (IMC) be elected to run the scheme.

A decade of popularly-elected committees[17]

The first IMC was elected in 1980. Subsequent committees were elected in 1982, 1984 and 1987. The main positions were the chairperson, vice chairperson, secretary, treasurer and vice-treasurer. The committee employed two water bailiffs who were directly answerable to the committee. According to Mangudya, who served as IMC member from 1982 to 1990, and was the last chairman of the popularly elected committee, the committee met weekly to review progress. He recounted other activities of the committee. It supervised the water bailiffs and worked closely with Agritex. The committee had a plan to build a dam across the Ruvaka River. It was also constructing or in the process of constructing fly-overs to prevent siltation of the canal at those points, four in all, where natural waterways crossed the main canal. There was also a plan to open a bank account for the scheme. The IMC produced a set of byelaws. The byelaws were instituted eight years after the popularly elected committees experienced 'difficulties of working with people'.

During the tenure of the four popularly elected committees there was no apparent clash with the Chief. The Chief acted as a patron of the scheme while the IMC oversaw the daily running of the scheme.

---

[13] *Ibid.*

[14] Mutare, Agritex, J.R. Peters to Provincial Commissioner, Manicaland, 18 Oct. 1974.

[15] Agritex, Mutare, Danby, 'Mutambara Irrigation Scheme'.

[16] Agritex, Mutare, Woodworth, S.G. to the Director, DEVAG, 1981.

[17] In this context, 'popularly-elected' means that all plotholders could participate in electing the office bearers.

Popularly-elected committees lose control

Popularly elected members of the IMC were composed of people from all blocks that composed the scheme. This seemed to have riled a section of the "royal family" particularly the "Chief 's sons" (who are not necessarily his sons but could be sons of the Chief 's full and half brothers).

The opportunity to take-over the scheme by the royal family seemed to have presented itself in the late 1980s. A sum of Z$50, 000 was given by ANCPD (full name could not be found) under the auspices of the Zimbabwe Council of Churches (ZCC). The money was meant for fencing, canal repairs, desilting the night storage dam, constructing a grid as well as catchment conservation. ZCC insisted on creating new institutional structures to handle the money. The nearby Mutambara Mission was thus drawn into the picture ostensibly because of its religious credentials. The Chief was incorporated as the traditional leader. The popularly elected IMC was left out. It is alleged that the Chief and his "sons" monopolised the situation to their advantage. It is also pertinent to state that the money was not used to the satisfaction of ZCC (see Manzungu, 1995).

Ever since the Chief took over the scheme disappointment with the way the scheme is run has been rife among the generality of farmers. Many farmers accused the Chief, not openly though, of bringing the scheme into chaos. Some said that development was being hindered. They referred to cases of donors being turned away simply because the Chief and his close associates were afraid to lose control of the scheme. The water bailiffs, who were appointed by the Chief, were alleged to distribute water unfairly. The low and sporadic wages, Z$150 per month sometimes more than six months in a arrears, may have had contributed to the alleged corruption.

The take-over by the Chief also brought to light socio-political problems among farmers, which had been dormant during the colonial years. Back then their concern was to get back *their* scheme from the colonial authorities. A long-standing feud between certain members of the irrigation community is the cause. The most significant name in this regard is Maunzani, historically a separate community which was lumped together by the technical design with the other three blocks: Guta, Gonzoni and Zomba. People from Maunzani felt water insecure. They wanted the government to take over the scheme so as to enforce equity in water distribution. This, however, did not materialize for reasons discussed before.

3.1.3 The Scheme Today

The physical infrastructure

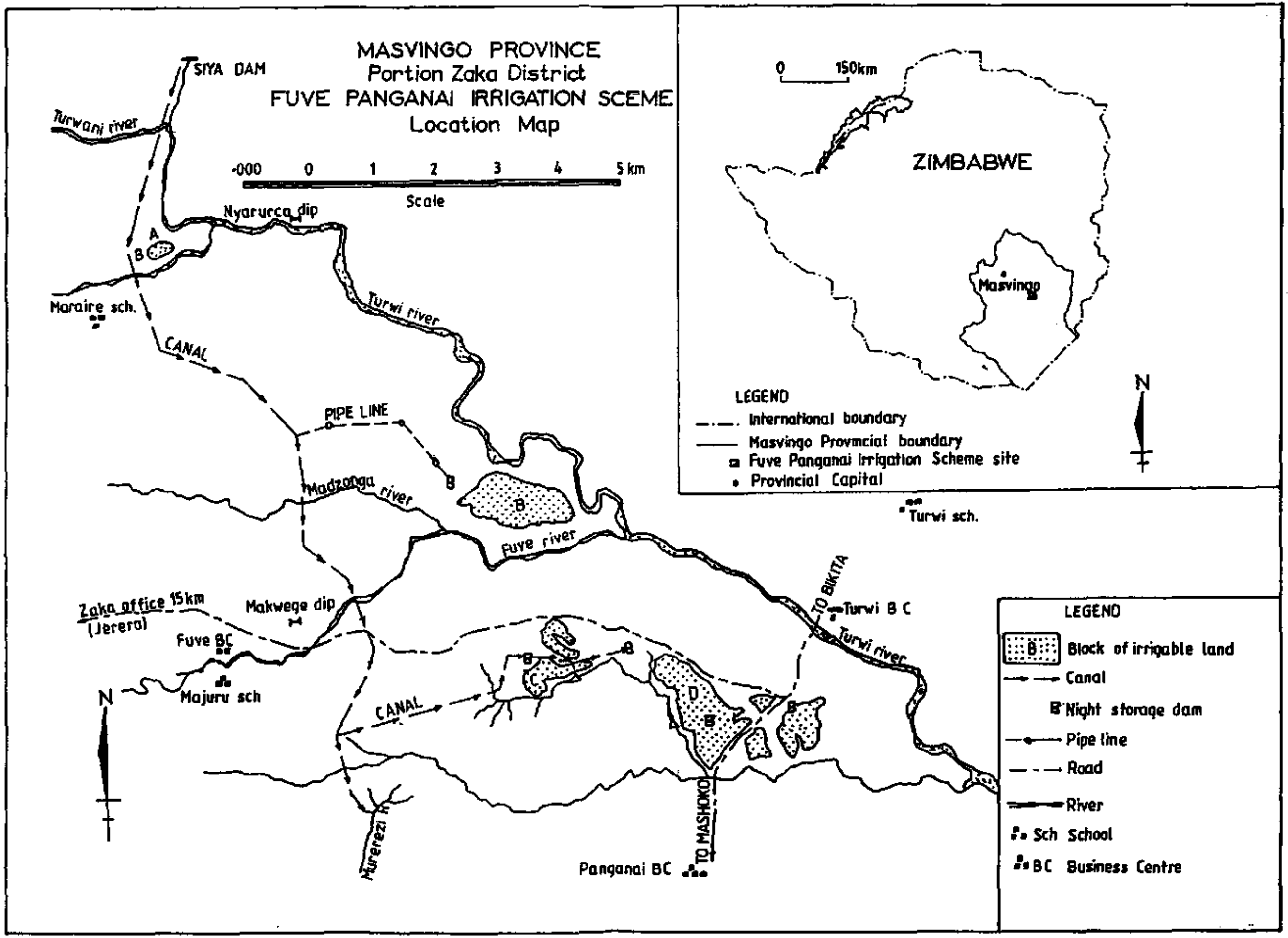
The scheme is currently divided into four blocks (see Figure 3.2). Parts of the irrigated areas are not suitable for irrigation (GOZ, 1985). These represent former grazing areas that were brought under cultivation because of the increasing population. The infrastructure is also in a poor physical state. The worst examples are the silted-up reservoirs. Sections of the canals that are lined are however, in a better shape. The scheme is said to use more than its water allocation (GOZ, 1985).

A profile of plotholders

Table 3.1 shows that close to half of the plots are registered under female names. The number of people indirectly living off the plot by way of grain gifts[18] almost equalled those directly living off it. Table 3.1 also demonstrates much employment creation, with total employees per hectare averaging 6.3. The wages were Z$200-500 per month plus food accompanied by free accommodation. The actual wages therefore are more than the minimum wage of Z$850 in the

[18] Grain gifts refer to grain that is given to other people, normally outside the scheme where there is no direct payment in cash or on kind. Grain gifts express a 'feeling for others'.

Figure 3.2 Sub-divisions of Mutambara Irrigation Scheme



agricultural sector[19].

Table 3.1 General details of Mutambara irrigation scheme

Average plot size (ha)	0.75
% of plots registered under females	41
No of people directly living off the plot	6.2
No of people directly living off per ha	8.3
No of people receiving grain gifts per plot	6.5
No of people receiving grain gift per ha	8.7
No of employees per plot	1.7
No of employees per ha	2.3
Total labour per plot	4.7
Total labour per ha	6.3
Employee wages per month (Z$)	200- 500

Source: Field surveys

The scheme has a resident extension worker who faced many challenges in the discharge of his duties. This was due to what he called negative attitudes by some farmers, particularly those belonging to the chieftainship.

3.2 CHIBUWE

Chibuwe Irrigation Scheme was started in 1940 as a settlement scheme for black Africans evicted from their land to make room for white settlers. The scheme is located on the east bank of the Save River opposite its confluence with the Turgwe River. It lies 220 km south of Mutare and falls within natural region V. It is located in Musikavanhu communal area.

Alvord, as the agriculturalist for the natives, claimed that the idea of the scheme 'started in June 1934 when at a Native Board meeting held by the Native Commissioner, Chipinga [now Chipinge], the people of Musikwantu [Musikavanhu] Reserve made a request for irrigation'[20]. It appears, however, that Alvord was the real driving force behind the scheme. He justified the scheme on the grounds that:

> The natives tilling these flood water areas lead a precarious existence and, during the past season, they experienced an almost total crop failure. Yearly they suffer from a periodical food shortage[21].

Below is a chronicle of the events relating to the development of the scheme.

3.2.1 The Development of the Infrastructure

A controversial beginning

It appears that Alvord managed enough support for the construction of scheme but not for the type of irrigation to be installed. He was in favour of a gravity scheme for which he was ready

[19] The people that are employed are mainly rainfed farmers. Quite a good number of these 'employees' were children in their early teens.

[20] NAZ, SP160/IP, Director of Native Agriculture to the Chief Native Commissioner, 30th October 1944.

[21] NAZ SP160/IP, Agriculturalist, Department of Natives to the Chief Native Commissioner,
3 February 1940.

to argue for, beg for, and when necessary, ridicule the rival pump option which was favoured by the Department of Irrigation[22].

The pumping option was preferred by the Department of Irrigation because:

a. the pumping plant could be installed in a very short time as all equipment was available in the country - as such irrigation could be ready for the next winter crop;
b. the point of abstraction of water could be varied from time to time and different areas watered in rotation and
c. in the event of the gravity scheme being undertaken in the future, the proposed plant could easily be moved to another area.

Alvord objected strongly to the pump option:

> It seems to me very extravagant and shortsighted policy to spend the sum of £700 on the temporary installation of two pumping plants to irrigate 300 to 400 acres when for an equal amount or less a water furrow can be constructed which will command 2, 000 acres. With reference to the imagined danger to the furrow by floods I am convinced that no such danger exists....[23]

Moreover the pumps were said to have high operational costs and posed an environmental problem since the steam engines depended on large amounts of timber. The alternative was to furrow irrigate a fertile area consisting of alluvium soil, 3 miles wide and 12 miles long at a cost of less than £600 since labour and materials would be sourced under the food for work programme[24].

After the scheme was opened, the 200 acres that were planned to be irrigated did not materialize 'due to the very open and porous condition of the soil it was not possible to irrigate more than 20 acres'[25]. To increase irrigated area, Alvord advocated lining the main furrow with brick and cement[26]. Meanwhile the pump option proved not so favourable. The main stream of the river, which was near the west bank, made it difficult for water to be diverted to the pumps on the east bank.[27] The Irrigation Department was forced to admit that the pumps were not functioning as expected. There was, however, a ready excuse as these had been 'installed for emergency purposes'. It was said that the pumps had a limited useful life since they were second hand and were better replaced by the gravity option. It appears, however, that the gravity option never really materialized as no gravity irrigation was ever reported in the scheme.

The next issue concerning infrastructural development had to do with the introduction of overhead spraylines in the scheme. It was decided to have a small pilot scheme capable of handling 40 to 50 acres involving 10 to 12 families.[28] Caution was needed since there were some unknowns such as:

a. the effectiveness of the method under local climatic conditions;
b. the economy of the method as opposed to flood irrigation and
c. whether the African peasant farmer could adapt to the method.

Table 3.2 summarises the development of the scheme.

---

[22] NAZ SP160/IP, Assistant Irrigation Engineer to the Director of Irrigation 1 February 1940.
[23] NAZ SP160/IP Agriculturalist, Department of Natives to the Secretary of Internal Affairs, 3 February 1940.
[24] *Ibid.*
[25] NAZ SP 160/IP Agriculturalist, Department of Natives to the Chief Native Commissioner, 2 September 1941.
[26] *Ibid.*
[27] NAZ 160/IP Director of Native Agriculture, Report on Irrigation Projects: Chipinga.
[28] Irrigation Officer, J.M. Watermeyer to the Provincial Agriculturalist, 1st November 1956.

Table 3.2 Some historical highlights of Chibuwe Irrigation Scheme

Year(s)	Event(s)
1940	Alvord starts the scheme
1950	The scheme has 42 ha under flood
1952 – 1958	The scheme grows to 355 ha
1955	Block D opened up
1958	A new block 21.4 ha in size, (now E) opened under sprinkler
1965	The new block (now E) is changed to flood
1968-1969	Block II (now B) redesigned and canals are concrete lined
1974	Electric pumps are introduced
1975	Block I (now A) is concrete lined
1975	Blocks III (now C) and IV (now D) are reduced in size because of poor soils

Source: Adapted from Sparrow (1983)[29]

Re-designing the infrastructure

A number of government officials believed that the irrigation infrastructure contributed to water problems. The canals were said to be too long and had wrong gradients. A number of measures were suggested. These included reducing earth furrows, increasing lining of canals, use of smaller size canals and implementing some form of cost recovery. The expectation was that these measures 'should produce an improved watering turnaround time throughout the whole of the 600 acre block".[30] The measures were not effective.

The district commissioner argued that the mere lining of canals was a waste of money unless a new design and layout was incorporated[31]. To this end he instructed officers of the Department of Conservation and Extension to prepare for the redesign of the whole of block II for which he requested more funding[32]. The renovation/reconstruction remained on the agenda of government officials into the 1970s. In the 1973-74 financial year a sum of Z$126,000 was requested, of which Z$26,000 was for in-field works and the rest for work to be undertaken by the Ministry of Water Development[33]. The ministry was tasked to re-design and electrify the pumping plant[34]. A provisional sum was allocated which showed the seriousness with which this option was viewed -the project attracted a good priority number 6 out of 26 approved projects[35]. The result was that the present blocks A and B were lined. This explains why these two blocks have a better water supply (see Table 3.3).

3.3.2 The Water Situation

The hydrological environment

The first recorded case of the scheme competing for water was in 1946. This was raised by Devuli Ranch in reaction to an application by the Chief Native Commissioner to abstract and divert water for use in the 'Musikavanu Reserve'[36]. The substance of the argument was that:

[29] Chibuwe irrigation scheme files, Chibuwe.
[30] *Ibid.*
[31] NAZ SP 160/IP, District Commissioner, Chipinga to the Provincial Commissioner, Manicaland, 7th May 1969.
[32] *Ibid.*
[33] NAZ SP160/IP L.J. de Bruijn to the Provincial Commissioner, Manicaland, 25th January 1973.
[34] NAZ SP160/IP, W.A. Proggart to the Provincial Commissioner, Manicaland, 9th February 1973.
[35] NAZ SP160/IP incomplete document circular minute No.10/73 file No. ACC/12/5 originating from the Ministry of Internal Affairs, 15th February 1973.
[36] NAZ SP160/IP, Devuli Ranching Company to the Water Registrar, 6 September 1946.

a. since the Ranch was acquired in 1920, many rivers making up the original Sabi River had been used for large irrigation projects; as a result the Sabi dried up in some parts in 1921;
b. there was fear that the course of the river could be altered considerably due to breaches in the river because of occasional overflooding and
c. there should be flowing water in the River for livestock survival[37].

Doubt was also expressed as to whether the Water Board, which allocated water in the country, had the requisite information to be able to make informed water allocations[38]. In the next decade the water situation in the scheme bore out the concerns of the Devuli Ranch. Despite the fact that the Sabi River was flowing better in 1956 than in 1954 and 1955, it was still essential to install sandbags on the riverbed across the direction of the flow across the river so as to make water available. This came to be popularly referred to as the sandbag weir. This apparently had been done before[39]. But the situation in 1971 was not amenable to the sandbag diversion fix. On 29 July 1971 the flow in the river ceased. Plowes, the provincial agricultural officer for Manicaland, took it upon himself to take urgent action to ensure the survival of the crops, especially those grown under contract. He also felt it was important to make an obligation to irrigators who had paid their maintenance fees in advance. He believed that 'the proper maintenance fee of discipline is closely linked with our ability to supply water as required'[40] The issue of water rights thus came into play.

Water rights

Plowes wondered whether the Sabi-Limpopo Authority, which he understood was pumping 180 cusecs at Middle Sabi, had more water rights than the downstream Chibuwe and Chisumbanje projects which had been established before. The reply from the Water Registrar office was that all the water rights of the scheme were now held by the Minister of Water Development and that the Minister had the prerogative of deciding how to allocate the water. The possibility of putting pressure on the Sabi-Limpopo Authority by teaming up with Chisumbanje, which had engaged an attorney to force the Authority to release water, was also suggested by Plowes. Although some water was going to be released from the Lesapi (now Rusape) Dam[41], Plowes wanted some points clarified;

> a. Is it correct that these rights are held by the Ministry of Water Development. I understand that T.T.L (Tribal Trust Land) rights were held by the Ministry of Internal Affairs. If this is indeed so, how did they get transferred across apparently without any notification and/or consultation at this level and
>
> b. If these rights are all held by the Minister of Water Development, is it correct that he can re-shuffle allocation regardless of original priorities, and if so, who makes the actual decisions, on what grounds, and in consultation with whom?[42]

Apart from the questions, he repeated his earlier suggestion of compulsory installation of gauging devices by all abstractors on the Sabi and its tributaries. In addition he suggested that no further abstractions were to be granted on any tributary of the Sabi unless adequate storage

[37] *Ibid.*

[38] *Ibid.*

[39] NAZ SP160/IP, Native Commissioner to the Provincial Native Commissioner, Manicaland, 13 July 1956.

[40] NAZ SP160/IP, Provincial Agricultural Officer (Manicaland) to the Provincial Commissioner, 31 July 1971.

[41] *Ibid.*

[42] *Ibid.*

works were provided[43]. Meanwhile within the scheme, there was unreliable water supply with a cycle of more than 30 days in 'Chibuwe III'. This discouraged people from joining the scheme[44]. Below is a description of some of the solutions that were attempted.

Solutions

There were attempts at re-designing parts of the scheme. This was complemented by upgrading of pumps to make water more available to the old and new sections of the scheme. For example it was observed that the two pumps that were operational in 1957 operated from 6.00 am to 1.00 pm. Thereafter only one pump could be operated from 1.00 pm to 4.00 pm because of 'lack of water coming down the Musikavanthu canal'[45]. Water shortage has remained an ever-present threat to the smooth operation of the scheme.

At times boreholes were relied on to reduce the water crisis. In 1973 'sufficient' borehole water was reported to be available for establishment of the new paw-paw crops. In addition 30 acres of wheat could be grown from the same water source. However it was found necessary to augment the irrigated area by installing a sand-abstraction plant to supply a further 2 cusecs at an estimated cost of Z$5,000[46]. The situation still needed further improvement. It was felt that 'to alleviate the current water shortage' a tubewell was to be brought into operation 'for the coming season 's winter crop'[47].

3.2.3 'New' Farming Enterprises

Government officials had a number of ideas to improve the scheme. One of these was the integration of livestock. It appears that a grazing scheme was established and since the locals wanted this, it was decided to leave the scheme alone and 'see how it works'[48].

Apart from the experiment with livestock, there were also attempts to try new crops and equally new aspects of crop production. These attempts included rice fertilizer[49], bean salinity[50] and rice salinity trials[51]. Then there was a proposal to grow paw paws for papain extraction, which was to be undertaken by one Mr. Thom of South Africa[52]. But there was anxiety about the project concerning the drying equipment and the vagaries and problems of 'getting Africans to produce and have continuity of production of any new crop'[53].

[43] *Ibid.*

[44] NAZ SP160/IP, District Commissioner, Chipinga to the Provincial Commissioner, Manicaland, 14th October 1968.

[45] NAZ SP160/IP, Assistant Circle Engineer, Division of Irrigation to the Native Commissioner, Chipinga, 28th October 1957. NAZ SP160/IP, Assistant Circle Engineer, Division of Irrigation to the Native Commissioner, Chipinga, 28th October 1957.

[46] NAZ SP160/IP, Minutes of a meeting held at the District Commissioner s' Office at Chipinga on 13 March 1973 at 11.50 am.

[47] NAZ SP160/IP B.R. Higgs to the Secretary of Internal Affairs, 27th April 1973.

[48] NAZ SP160 /IP Noel A. Hunt to the Secretary for Internal Affairs, 30 June 1970.

[49] NAZ SP160/IP Rice Trial. Chibuwe 1966-67 n.d.

[50] NAZ SP160/IP Salinity Trial Tube Well Winter 1966. Chibuwe Irrigation Scheme. n.d.

[51] NAZ SP160/IP, C.R. Patterson, Department of Conservation and Extension, 10 October 1966.

[52] NAZ SP160/IP, Senior Economist, Agricultural Marketing Authority to the Secretary of Internal Affairs, 8 August 1972.

[53] NAZ SP160/IP, Provincial Co-operative Officer, Manicaland Province to the Managing Director, Papain (Pty) Ltd. 6 January 1975.

3.2.4 'Management' Concerns

Different state officials had different interests in the scheme. For example it is reported that the Chairman of the Rural Land Board, Mr Goddard, on a tour of the scheme was "horrified" about the state of the scheme. The scheme was described as a waste of land and water because of a lack of control and management[54]. The Director of Conservation and Extension, Mr J.J. Duvenage was surprised because he had personally visited the scheme some months ago and had been quite impressed with the co-operation from plotholders with regard to water and soil management[55].

Of the environment and crop yields

It was said that there was a serious degree of sheet erosion in the scheme because of the concentration of humans and animals in a small area. The increase in human population was the result of 'friends, relatives and hangers-on' who moved from the area adjoining the scheme. As for animals (cattle and goats), this was a direct consequence of the increased human population as well the affluence of the irrigators. As a remedy, it was suggested that the unploughed area of the scheme be divided up into individual portions where 'a rigid stocking rate' would be enforced. In addition one of the four acres were to be released for stockfeed. Only the number of livestock that could feed off that plot would be allowed. The animals would be tethered on the acre or alternatively, crop wastes would be carried off the plot.

The Director of Conservation and Extension acknowledged the validity of the comments, and added that the denudation of areas surrounding areas 'has never been brought under control by Internal Affairs or the tribal Chiefs who are responsible for the use of land in these Tribal Trust Areas'[56]. The provincial conservation and extension officer (Manicaland) commented on the points raised by Mr Goddard in more detail[57].

Crop yields were said to be 'distressingly' low because of a combination of factors. The chief cause was the 'lack of a built-in efficiency factor in their (farmers) agreements'. The water charge of £5 for 4 acres was 'distressing' as this did not cover the cost of diesel. The fact that distribution, maintenance, depreciation etc were subsidised by the state was an 'extremely dangerous and untenable precedent'.

As for low yields the problem, this was because the plotholders did not follow recommendations for the traditional crops (maize, sorghum etc) which 'they claim to know all about anyway'. The situation was different for new cash crops (cotton, burley tobacco, and seed crops) where the yields were as high as anywhere in the country including the European areas. The water rates were said to be not that low considering that the 10% levy on all crops marketed officially was collected into the African Development Fund. It was also claimed that direct revenue covered 44% of annual running costs. Attempts to have the rates increased did not come through because of a reluctance to change an existing system.

Governance

The irrigators were said to have little or no representation in the Management Committee. This was considered unhealthy as the irrigators would 'undoubtedly not understand and probably resent future attempts to make the whole scheme more efficient and self supporting'. It was not

[54] NAZ SP160/IP, Director of Conservation and Extension to the Provincial Conservation and Extension Officer, Umtali, Chief of irrigation Officer and Assistant Director (Field), 21 October 1964.

[55] *ibid.*

[56] NAZ SP160/IP, Director of Conservation and Extension to the Chairman, Rural Land Board, 2 November 1964.

[57] NAZ SP160/IP, the Provincial Conservation and Extension Officer, Manicaland to the Director of Conservation and Extension, 9 November 1964.

lost on the colonial officials that they needed some degree of co-operation from locals to achieve their objectives as the 'the management of any peasant farming irrigation scheme required rigid discipline and if this is imposed by officials alone it could not in the long run be effective without a police state'[58].

The fact that the authorities had difficulties in evicting a non co-operator as long as he had paid his water rate was seen as a problem. There was a need to have power of eviction before 'a real impact can be made on the mind of an uneducated peasant type irrigator who is known to have a high leisure preference'[59]. The reply was that the main problem on the existing schemes in Tribal Trust Land was that the land belonged to the tribe. It would be a 'political dynamite' to excise the scheme from the tribal land so as to afford Government more control. The best option was to leave the position as it was, at least for the life for the present plot-holders. Once the present plotholders 'die or surrender the plots' Government could make recommendations as well as those in South Africa to take over the schemes.

As a preface to his letter, the Director of Conservation and Extension, noted that the points that were raised had concerned his department for years. The staff of his department had no say concerning allocation of land, selection of irrigators or conditions of tenancy. Moreover the common grazing areas, where traditional land customs prevailed, were not favourable for the individualization of the grazing areas. With regards to farmers' role in management, he thought that there was enough representation as Chibuwe Committee was made up of the Chairman, Secretary, and 10 members, two from each irrigation block.

The extension officer and the extension supervisors were said to act as advisers to the management committee. Besides helping to run the scheme, the committee helped increase the acreage under cash crops so that the schemes would be more viable[60]. It was also said that it was premature to judge the success or failure of the Management Committees. However, in future it was felt that the committees should tighten control over their own people and plot-holders under 'our guidance'. The committees were said to lack capacity to assume financial responsibilities.

Elaborate rules on virtually every aspect of irrigation were produced[61]. These strict rules seemed to have produced reaction from the irrigators. The agricultural officer for Chibuwe wrote to the district commissioner about 'a breakdown of reasonable damages claimed by these Africans'[62]. Apparently some five irrigators had filed a lawsuit against the officials through a leading law firm, Scanlen and Holderness. The irrigators wanted to be compensated for crops which government officials had destroyed. Later it was thought to evict the plotholders from the scheme[63]. This was contested through the same law firm[64]. The verdict is not on record.

3.2.5 The Scheme Today

The infrastructure and water availability

Today Chibuwe is an open canal irrigation scheme with five hydraulic blocks (Figure 3.3). Each of these blocks differs not only in terms of size and number of plotholders, but also in terms of water supply (Table 3.3).

---

[58] *Ibid.*

[59] *Ibid.*

[60] *Ibid.*

[61] NAZ SP160/IP Acting District Commissioner, Chipinga: Chibuwe Irrigation Scheme: General Orders.

[62] NAZ SP160/IP, Agricultural Officer, Chibuwe Irrigation Scheme to the District Commissioner, Chipinga, 26 July 1971.

[63] NAZ SP160/IP, Agricultural Officer, Chibuwe Irrigation Scheme to the District Commissioner, Chipinga, 26 July 1971.

[64] NAZ SP160/IP Scanlen and Holderness to the Provincial Commissioner, Manicaland, Umtali, 3 August 1971.

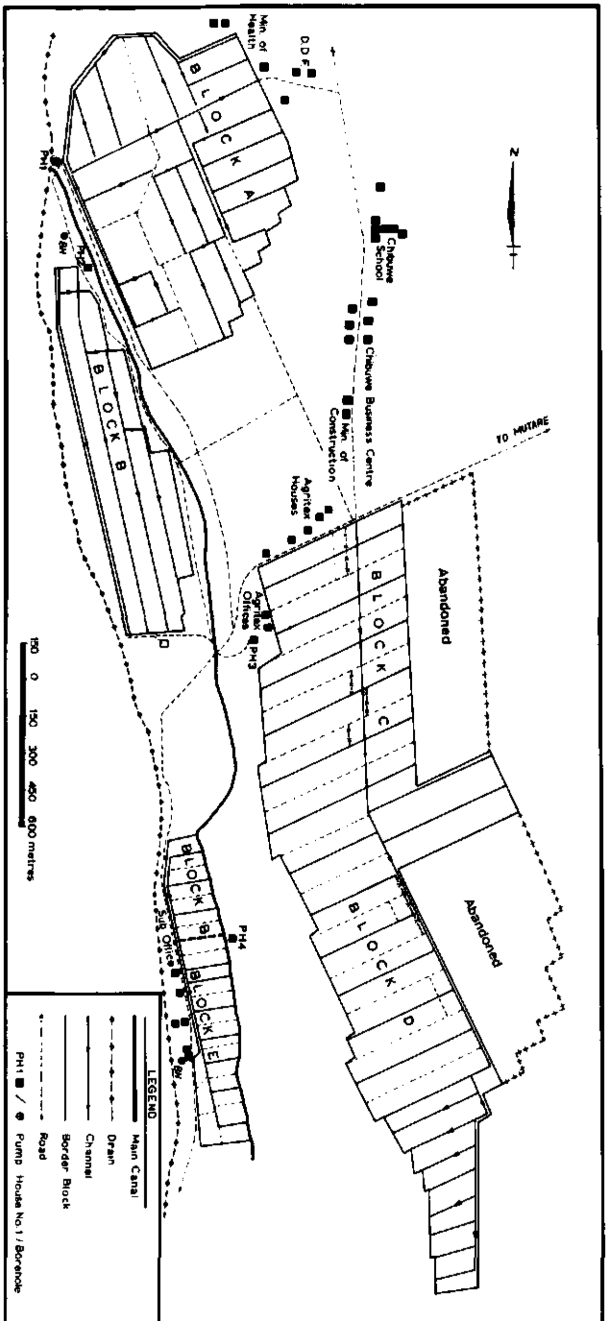


Figure 3.3 Sub-divisions of Chibuwe Irrigation Scheme

Table 3.3 General details of Chibuwe irrigation scheme

Block	Size (ha)	No of farmers	Infrastructure	Total Pump capacity (l/s)	Rank of water supply
A	90	73	Standard[65] This refers to those canal types and sizes currently used by Agritex. Lined canals, standard sluice gates	160	1
B	35	27	standard lined canals, standard sluice gates	45	2
C	75	74	standard lined canals/ earth furrows/ variable gate sizes		4
D	82	66	variable lined canals/ earth furrows/ variable gate sizes	130	5
E	21	21	variable lined canals/ earth furrows	36	3

Source: Agritex Official records, Chibuwe Irrigation Scheme and Field data
Notes: 1 = very good, 2 = good, 3 = average, 4 = poor, 5 = very poor

The differential water supply is a result of

a. the geographical position of the different blocks *vis-à-vis* the Save River from which irrigation water is sourced;
b. nature of the intakes of the various blocks and
c. the (unlined or lined) state of field canals.

Block A is the uppermost and is the only block with pumps that draw water directly from the river. The rest of the blocks are served by water that is pumped from the diversion canal. The diversion point is located about five metres downstream from the block A intake. Along the diversion canal, block B intake is the uppermost, followed by block C and D and then block E. Although block E intake is located at the lowest part of the diversion canal, it is nevertheless on the main diversion canal, and has a better water supply compared to blocks C and D that are served by a branch of the diversion canal. Block D can be considered to be at the tail-end as it is located beyond block C. It has, as a consequence, the poorest water supply. Over time the scheme was issued with water rights of 253 l/s from the Save River. However, these rights count for little as will be demonstrated in chapter 4.

All blocks are served by electric pumps. Block A is serviced by two[66] pumps with a combined capacity of 160 l/s. Block B has a one capacity pump with a capacity of 45 l/s.
Four pumps of a combined capacity of 130 l/s service blocks C and D while block E is serviced by a 36 l/s capacity pump. Judging from complaints raised publicly and privately by farmers from blocks C and D, and the acknowledgement by Agritex officials, pumps servicing blocks C and D have had more frequent and serious breakdowns compared to other blocks. The [67]unlined canals in blocks C, D and E exacerbated the water supply situation because of seepage of water into the sandy earth canals. Blocks A and D represent the most contrasting cases of differential water supply. Irrigation interval in block A is about 7 days while in block D it can go up to beyond 21 days. In worst cases in block D there is no water at all. Overall the scheme is water insecure. During the research period the scheme completely ran short of water in summer 1995 and winter 1996.

[65] This refers to those canal types and sizes currently used by Agritex

[66] Three pumps, one meant to act as a stand-bye, were installed. However the stand-by one has been sent for repairs. The pump operator reckoned it was in 1994 about one and half years since it was sent for repairs.

[67] A sum of Z$1, 000, 000 under the Public Sector Investment Programme (PSIP) was earmarked for rehabilitation of the unlined canals in blocks C, D and E. Work started in block C.

Crops
In summer maize and cotton are the main crops. However cotton accounts for 10 per cent of the irrigated area because of its high labour requirements. In winter wheat, beans and vegetables are grown. By the far the biggest portion in winter is for beans. This is the main cash crop. In recent times, as in 1996, farmers have started to diversify mainly because the market for beans is no longer assured. Some farmers grew paprika under contract. There has also been an attempt to grow contract tomatoes.

Other details
Table 3.4 provided some other details about blocks A and D the scheme.

Table 3.4 Details of blocks A and D in Chibuwe

Average age of farmers (years)	A 46.3 D 48.4
Range of plot size (ha)	0.1-1
No. of families living off one plot	A 2.6 D 1.7
No. of people living off one plot	A 15.4 D 15.2
% of plots under female registration	A 17 D 26
% of farmers who give grain gifts	A 56.5 D 42.1
% of farmers who hire labour	A 43.5 D 36.8
Monthly payment (Z$) Monthly payment (Z$)	A 80-200 D 80-145

Source: Field surveys data

Government staff complement in the scheme
There is one irrigation supervisor and three extension workers resident at the scheme. The irrigation supervisor is responsible for the overall administration of the scheme while extension workers undertake extension and other duties. Every block has its water bailiff. Each pumping station is manned by a pump operator who is an employee of the Department of Water Resources. Over the years the maintenance gang has been reduced to 9 from an original of 27 responsible because of staff cutbacks.

3.3 FUVE PANGANAI

Fuve Panganai Irrigation Scheme (Figure 3.4) is located in Zaka District[68]. It is 20 km from Zaka where the district administrator and district Agritex offices are located. Nine kilometres south of Zaka is Jerera Growth point where the Grain Marketing Board depot and the rural district council offices are located. The different blocks were developed in stages (see Table 3.5). The scheme is gravity-fed and is surface irrigated. As can be seen from Table 3.5, the scheme has low pressure buried technology. It is the only formal smallholder scheme in the country with this kind of technology (see details below).

[68] Wards were created after independence. A ward is made up of 100 villages.

Figure 3.4 Sub-divisions of Fuve Panganai irrigation

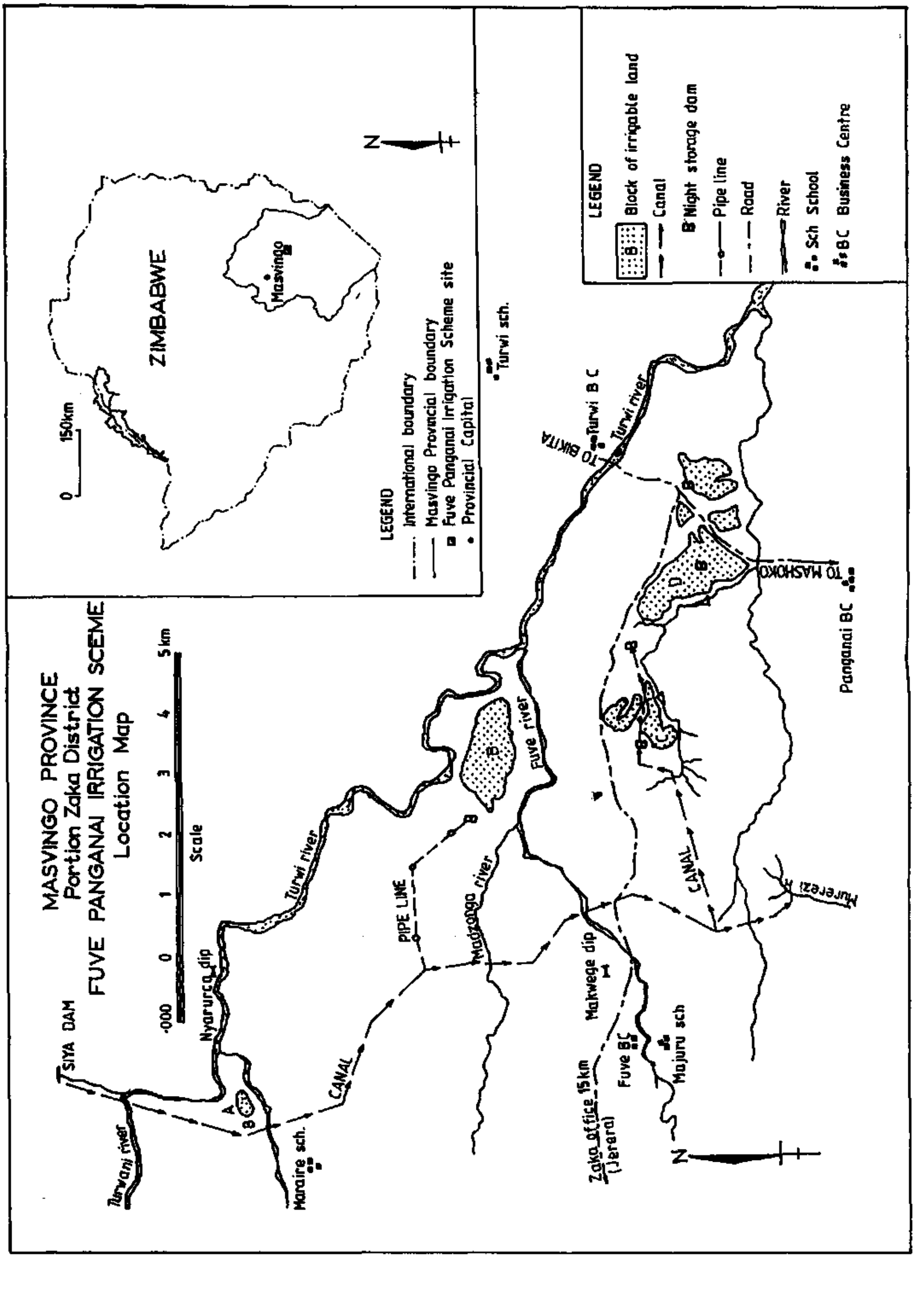


Table 3.5 Block characteristics of Fuve Panganai Irrigation Scheme

Block	Size (ha)	Method of water Delivery to field edge	Irrigation system	Year commissioned
A	10	closed pipe	open canal	Summer 1989
B	70	closed pipe	Low pressure buried pipe	Summer 1990
C	50	open canal	Low pressure buried pipe	Summer 1990
D	140	open canal	Low pressure pipe	Summer 1994

Source: Field notes and feasibility reports

3.3.1 The Beginning of the Scheme

The scheme came into being as a way of compensating people for land taken up by the Turgwe[69] Canal, which passes entirely through Zaka communal lands. The Canal was constructed in the 1970s to channel water from Siya Dam to augment water supply to the expanding sugar estates in the south-east Lowveld (ROZ, 1986a). As compensation, part of the water was reserved for 'small scale irrigation schemes' in the area under Fuve and Panganai headmen (*ibid.*). A total of 3, 125,000 m^3 per annum at a peak flow of 200 l/s was reserved.

First attempts to set up a smallholder irrigation scheme were indicated by preliminary soil studies in the 1970s and early 1980s. But it was only in the mid to late 1980s that the project materialised when KWF of Germany provided the necessary finance. Dorsch Consult of Germany and Halcrow of Zimbabwe were appointed the consulting engineering firms. These eventually put in place the first smallholder irrigation scheme in Zimbabwe with a low-pressure buried pipe technology. At first the Department of Rural Development (Derude) was the government-executing agency. Agritex took over after 1985 in line with its revised national mandate.

The irrigation 'gift' was, however, not appreciated by all as reported in the *Fuve Panganai B, C and D*[70] *Combined Physical and Socio-economic Report* of July 1986. It is reported that people of Zaka were predominantly Shona. However some families of Shangaan origin settled in the area in the last thirty years. These families were moved by the colonial government twice. First it was to make way for the sugar estates in the lowveld region in southeast part of the country. They came and settled around Zaka administrative centre. They were moved from there to make room for the construction of administrative offices. Most of the displaced persons settled in the present block B.

When the scheme was proposed these people were very much against the idea. They saw this as yet another ploy by the state to dispossess them of their land. Their main argument was that they had invested in the land by stumping and clearing the land which "they found a forest". They refused to co-operate in the initial stages of the socio-economic surveys. Sixteen families, who each had close to 10 ha under rainfed cultivation, were the most vociferous. Politicians were recruited to persuade them. Notable among the contingent of politicians was the Minister of Lands, Agriculture and Rural Resettlement and Vice President of the country. The resisted socio-economic surveys were then undertaken.

Not everyone was against the idea though. A lot of enthusiasts[71] of Shona origin, whose

[69] This name is derived from the nearby river which is on maps is cited as Turgwi, Turwi or Tokwe. However local people call it Tugwi.

[70] Block A is not included as it used different technology of surface irrigation.

[71] The enthusiasm could have come from the fact that these people were gaining land rather than a sign of embracing irrigated agriculture as such.

land and homes were outside the scheme area, came in large numbers once interviewes for potential irrigators were announced. Unfortunately the socio-economic survey results of 57 sample farmers done in June/July 1986, were not dissaggregated according to ethnicity, which perhaps could have produced interesting ethnicity-based dimension.
The main findings were that:

- family size varied from 2 to 25, with an average of 9.3
- labour available for working the family farm was 3.67 units, based on the number of adults[72] (excluding old or infirm), plus a quarter of a unit for each child aged between 9 and 18
- average dryland arable holding per household was 2.75 ha
- only 7 per cent of the respondents had any experience in irrigation, (although 66.7 per cent were reported to be cultivating gardens)
- the previous year 18 farmers sold livestock with an average value of Z$485.17
- the majority (88 per cent) of households either earned money from non-farming activities e.g remittances from relations relatives in towns
- during the severe drought of 1983, 80 per cent of the farmers received food aid
- main crops grown (with % of arable crops in parenthesis) were maize (52.9), groundnuts (13.6), rapoko (10.5) and fallow (12.7)
- minor crops included cotton, sorghum, sunflower, oriental tobacco, bambara nuts and
- crops sold included maize, groundnuts and rapoko.

It was added that most of the rapoko was mostly used for beer brewing, which was sold locally and was an important source of income to many of the households. It was, however, not clear from the feasibility reports how most of the information obtained through the socio-economic survey was used in the design.

3.3.2 The Planned Reality

A combined physical and socio-economic report (cited earlier) was produced in 1986 for blocks B, C and D since they 'were considered to be very similar in their physical and social characteristics'. Engineering reports for blocks B, C and D were also produced.

After an inventory of the soil and water resources, a technical design was planned taking into account crop water requirements (setting out design flows), physical infrastructure (to facilitate water distribution), and cropping programmes (to realise the benefits of irrigation) as well as the financial and economic analysis (to justify the project).

Cropwater requirements and irrigation schedules

Climatic data from Zaka Meteorological Station were used to determine monthly and annual evaporation (ETo) 'using the Penman method described in the FAO paper No. 24' (ROZ, 1986a). Cropwater requirements for the proposed crops - cotton, beans, maize (grain and green) and groundnuts - were calculated. After translation of crop water requirements to volumetric water requirement, the annual water available for blocks B, C and D was given as 2, 992 x 10^3 m^3. On the basis of one hectare of land requiring 9, 396 m^3 of water per annum (if the mean monthly rainfall was used) and 14, 215 m^3 (if the reliable rainfall was considered), it was estimated that total irrigable area was 318 and 210 ha respectively. The combined peak design flow was given as 190 l/s.

In block B, 70 ha on gentle to moderate slopes (0.5 to 3 per cent) were identified for irrigation. The block had basically a redddish clay loam as well as a sandy soil, with the latter accounting for about 75 per cent. Out of the eleven soil types identified in block C, eight were found to be suitable for irrigation. The hectarage suitable for irrigation was 50 ha on moderate

[72] One adult represented a labour unit.

to steep slopes (4 to 8 per cent). The slope was considered to be one of the most important factors in the choice of the irrigation technology (see below). The available water holding capacity (AWHC) of the eight irrigable soils varied but "for design purposes" an average AWHC of 12 per cent was used.

An example was given for a green maize crop representing summer and beans for winter. The maximum irrigation interval was 9.8 days for green maize and 7.5 days for beans. It was added that 'during the early stages of growth when the rooting depth is still shallow, more frequent irrigations are necessary, with the depth of water reduced accordingly'.

Irrigation infrastructure in blocks B and C

General: The irrigation infrastructure in blocks B, C and D is basically the same. As such the description of blocks B and C is not much different from block D. In block B two irrigation systems were initially suggested. An open canal system was to serve the portion of land (67 per cent) with a gentle 0.5 per cent slope. The remaining 33 per cent with steeper slopes (2.5 to 3 per cent) was to be served by a closed pipe system (ROZ, 1986b). This was refused by KWF the financier, on the grounds that having two systems of irrigation on the same project was undesirable[73]. Another design had to be made[74]. The whole of block B was subsequently put under the closed pipe system as in block C. The closed pipe system was considered superior to open canals because:

- The cost of medium and small diameter PVC pipe compared very well with the cost of constructing an Agritex "250" section canal
- Seepage and evaporation losses were eliminated
- There were no stilling boxes or similar places where stagnant water would collect and become breeding grounds for mosquitoes and snails
- With only hydrants protruding above the ground, it was possible to undertake land levelling and other mechanical cultivations after the infrastructure had been installed
- The system could be installed very quickly, for example once the trenches had been excavated the pipe network and hydrants could be installed and operated within three weeks
- Very little land was lost at the headlands of each plot as the crops could be planted right up to or even over the pipeline
- The farmer had complete control over the water supply to his plot and since water was available "on demand" he could irrigate whenever he wished without being tied to a strict rotation
- The underground pipes formed a closed system which significantly reduced conveyance losses.

Each block was served by a night storage dam. Night storage reservoirs were meant to;

- store the night flow,
- serve as a buffer between the fluctuating field demand and the constant inflow supply and
- serve as settling pond to reduce the possibility of silt entering the pipe distribution system.

From the reservoirs water was designed to be carried out of the reservoir through 400-mm outlet pipes. Just below the storage dams were installed junction boxes from which pipes serving different sections of blocks fanned out. On these pipes were installed Kent water meters for measuring water.

Within the fields, hydrants were spaced at 30-m interval along the pipe. Plots were arranged in a herring bone pattern with furrows sloping away from the hydrant line on both

[73] Portch cited in ROZ (1987).

[74] This point raises two important issues. Firstly the choice of technology was not according to technical arguments underlining the fact that (irrigation) technology is socially constructed. In the second instance the Agritex-donor interface is highlighted. The issue is how much Agritex is allowed to influence the course of events, particularly technical ones in a donor-funded project.

sides. Each 1 ha plot was planned to be served by three or four hydrants to which a length of flexible plastic hose pipe would be attached to direct water to the furrows. The flow from each pipe 'would be divided into two or three furrows'. Irrigation was planned on the basis of 8 hours per day using a discharge of 2 l/s per hydrant.

Block B: Water to block B is supplied by means of a 228 m long 250 mm diameter asbestos pipe. A gravity pipeline was chosen on the basis that it has the advantage of reducing conveyance losses. It was also said to be less expensive than an open canal system. A silt trap meant to prevent sediment being drawn into the pipeline was mentioned. Water was to be measured using a volumetric Kent water meters placed in the pipeline. Control of water supply by the responsible authority, the Regional Water Authority, was by a 500 x 500 VG type Neyrpic gate[75] 'which could easily be operated'. A 5,300-m^3 reservoir sufficient to store a 100 l/s flow over 14.7 hour period replaced the two original planned reservoirs. Kent water meters were installed the reservoir so as to quantify the amount of water used.

Block C: Water to block C is conveyed from the main canal by a concrete lined open canal which also supplies water to block D. The canal was designed to carry 250 l/s of which 50 l/s was reserved for block C. Regulation of flow to the block by RWA was designed to be by a Neyrpic VGSL 400 x 400 slide gate mounted on a headwall of the inlet box from the canal. This, however, was not completed, which has some implications on water distribution (see chapter 4). A Parshall flume 500-mm throat width was installed 10 m from the offtake point. A rating table (of the Parshall flume) was provided.

Table 3.6 Infrastructure in blocks B and C in Fuve Panganai

	Block B	Block C
Method of delivery of water	228 m long 250 mm asbestos closed pipe	open canal which also supplies water to block D
Offtake structure	500x500 VG Neyrpic slide gate	Neyrpic VGSL 400 x 400 slide gate
Measurement device at the offtake	Kent water meter	Parshall flume 500 mm throat width
Capacity of night reservoir	5, 300 m^3	2, 700 m^3
Design supply of reservoir	100 l/s in 14.7h	50 l/s in 15h
Basis of pipe specifications	1 l/s per ha	1 l/s per ha
Irrigation period	8 h per day	8 h per day
Design capacity of pipes	3 l/s per ha	3 l/s per ha
Nominal hydrant discharge	2 l/s	2 l/s
Average number of operational hydrants per ha	1.5	1.5
Cost of developing 1 ha (water supply and infield works)	Z$8, 860.50	Z$6, 785.08

Source: Feasibility reports

The open canal delivery canal leads to a night storage reservoir that has a storage capacity of 2,700-m3 equivalent to a flow of 50 l/s of water over a 15-h period. Table 3.6 summarises the main infrastructural details for blocks B and C.

[75] This type of gates are supposed to let out modular flow i.e. let out the same flow irrespective of upstream and downstream flow fluctuations.

Proposed crops

According to the feasibility report recommended cropping programmes were based on field crops with a guaranteed market either through the Grain Marketing Board or Cotton Marketing Board because of the fairly large area involved and the limited marketing outlets. Table 3.7 shows the details in a tabular form. It is noteworthy to state that, because of market de-regulation, these crops no longer enjoy a secure market. This however, does not seem to be appreciated as discussed in chapters 4, 7 and 8.

Table 3.7 Proportion and duration of proposed crops in Fuve Panganai

Crop	Duration	Proportion of plot(%)
Groundnuts	mid Nov- Feb	30
Cotton	mid Oct. - Apr.	40
Dry maize	mid Oct -Feb.	20
Green maize	Aug –mid Nov.	20
Wheat	May –Sept.	30
Beans	Feb – mid Jul	30

Source: Adapted from Figure 1 in the ROZ (1989)

3.3.3 Translating Plans into Reality

Farmer selection

In July 1990 the district Agritex officer organised a one-day workshop to deliberate on plot size, selection criteria for farmers and settlement procedures. The workshop was held at Fuve Rural Service Centre, 5 km west of the scheme. A total of 70 participants attended. These participants came from Ward Development Committees[76] and Village Development Committees, village heads (also known as kraalheads), party[77] leaders from Masimbaevanhu Ward in which blocks B, C and D fall, Headman Maraire and Chief Nhema of Zaka District, Agritex and Ministry of Local Government officials.

From the workshop the following were agreed upon:

- because farmers were going to be full time irrigators, the plot size was to be 1 ha instead of 0.2 ha;
- selection criteria, in order of priority, were;
  - those people displaced by construction of the irrigation scheme
  - master farmers[78]
  - people with no formal employment and those with no other form of sustenance
  - people with not more than six head of cattle
  - people dependent on farming only
  - people from other villages and
  - people in formal employment.

The allocates were required to transfer their homesteads to near the scheme. The homesteads of such people could be exchanged or sold. People who were affected, but were not interested in irrigation, were given the option of exchanging land provided the selection committee was a witness.

[76] A ward is made up of a number of villages. However, 'village' in this case does not refer to the traditional villages headed by what are called kraalheads. The villages actually group together a number of traditional villages.

[77] This refers to the ruling party, Zimbabwe African National Union (Patriotic Front) abbreviated Zanu (PF).

[78] Master farmers refer to farmers who undertake a special training course at the end of which they are examined. If successful, farmers are given a certificate. The course has two levels: the ordinary and advanced level.

The starting point was for all kraalheads to produce a list of people under their jurisdiction. From these lists were drawn interviewees. Displaced farmers were not interviewed as their access to land was automatic. For the interviewees to be successful they had to prove that they had some training in farming such as a possession of a master farmer certificate and enough resources to start irrigated farming. Agritex was given the responsibility of interviewing potential irrigators. Names of successful farmers were then submitted to a committee which comprised Zaka District Council, district administrator 's office, Agritex and the area councillor. The same committee was responsible for plot allocation. The actual job was given to the area councillor and Agritex. In the end each irrigator in blocks B, C and D was given one hectare for full time irrigators. In block A, where farmers were allowed some dryland cultivation, each farmer got 0.1 ha.

Current crops

The scheme operates under block irrigation (see chapter 7). In summer each farmer grows one half of his 1 ha plot to cotton and the other to groundnuts. Maize and wheat are grown in winter in similar proportions.

Bye-laws

Agritex felt a need to have a mechanism of control in the schemes. This took the form of bye-laws which were formulated allegedly by block A, B and C Irrigation Management Committees in 1992. Copies of bye-laws were made and copies were sent to the rural district council, district administrator and the various IMCs of the different blocks.

Apart from bye-laws Agritex instituted other rules. One significant one dealt with the type and number of domestic animals allowed in the irrigation scheme. Goats and donkeys were not allowed at all. A maximum of four cattle were allowed consisting of two oxen and two cows.

The political arrangements, stating to who actually had what authority to do what and how, was left unsaid. Another notable omission was the lack of explanation of how the different local actors e.g. district council as the legal custodian of land, traditional leaders such as kraalheads and headmen, the Irrigation Management Committee, as an institution representing irrigators and Agritex were to relate to each other.

General information about blocks B and C

Table 3.8 presents contemporary general information about blocks B and C. The table shows that irrigated plots sustain a large number of people than anticipated.

3.4 CONCLUSIONS

This chapter has offered some insights into factors that have shaped and continue to shape management practices in smallholder irrigation schemes in Zimbabwe, as will be illustrated in the empirical chapters. It was shown that the present schemes have been affected by different development paradigms (including donor influence) as discussed in chapter 2. In this regard Chibuwe is the most illustrative since it has been under government control for over half a century. Some space was devoted to the history as current arrangements regarding the water supply to the field edge, infield works and administrative set-up owe their origin to what happened many years ago. This underlines the fact that it is necessary to go into history if a full understanding of irrigation management is to be obtained. This line of argument shall be followed in the subsequent chapters. It was also clear that in the schemes both social and technical aspects were closely intertwined, which vindicates a socio-technical perspective to irrigation (see chapter 1).

Table 3.8 General information of Fuve Panganai irrigation scheme

Average age of farmers (years)	B 51.0
	C 42.2
No. of families living off the plot	B 1.2
	C 1.0
No. of people living off the plot	B 7.6
	C 6.9
% of plots under female registration	B 0
	C 0
% of farmers who give grain gifts	B approx. 100
	C approx. 100
% of farmers who hire labour	B approx. 100
	C approx. 100
Monthly payment (Z$)	80-145

Source: Field survey data

4 THE DYNAMICS OF WATER DISTRIBUTION

This chapter seeks to provide a documentation and explanation of how water, on a daily basis, was shared between farmers in the three study schemes namely, Mutambara, Chibuwe and Fuve Panganai. This is based on information gathered between 1994-1996 covering a total of six crop seasons. The argument is that both documentation and explanations are critical to an understanding of operational aspects of irrigation management.

Water distribution, it needs to be said, enjoys a high profile in international literature. There are as many reports dealing with cases of inequitable water distribution among farmers as there are also reported cases of poor water delivery by irrigation agencies. Despite its wide coverage, there are gaps in the way water distribution has been studied (Diemer and Huibers, 1996: 3). Diemer and Huibers believe this to be the case chiefly because of the low interest *vis-a-vis* documenting how water is actually distributed in practice. This chapter aims to fill this gap in the Zimbabwean context by firstly identifying what constitutes water distribution. Here constituents, rather than factors, are emphasized, on the basis that it is more important first to understand the nature or composition of water distribution rather than just what affects water distribution. The chapter also attempts to shed light on the inter-relationships between the constituents. In line with the socio-technical perspective, social and technical aspects that were relevant to water distribution were explored since 'the control and allocation of the water to the fields... requires continuos and direct human action.... (and) involves people and their tools (Keller, 1986: 334).

On the basis of the empirical material the chapter makes two main conclusions. The first relates to what constitutes water distribution. Water distribution was constituted by the water source (the hydrological environment), the irrigation technology, socio-political relations (with access to water and land as the critical elements) and commoditisation of certain crops. These four constituents were found not to operate in isolation but in conjunction with each other. Thus for 'orderly' water distribution to take place, the 'equilibrium point', between the various constituents, needed to be established. This, however, cannot be determined *a priori* since the exact configurations of the relationships cannot be reduced to a mathematical relationship. The second major conclusion is about how an understanding of the constituents of water distribution can be obtained. This relates to the methodology. The identification of the constituents of water distribution and their interactions was through a documentation of the coping strategies of the relevant actors (a quantitative methodology would not have yielded the same insights). This was on the premise that it is more critical to focus on how water is actually distributed rather than dwell on formalized rules of water distribution. The approach taken in this chapter demands a reconceptualization of water distribution. This is undertaken in section 4.1 as a prelude to a presentation of the empirical material.

4.1 CONCEPTUALIZING WATER DISTRIBUTION

Water distribution remains an ill-defined term despite its frequent usage (Nijman, 1993: 42-43). Where definitions are offered, e.g. Bos and Nugteren (1990) 's *movement of water through the tertiary and quaternary canals or pipe conduits to the field inlet,* these are inadequate to give an idea of the real operational issues involved. Decrying this state of affairs, Nijman proposed the concept of allocation-regulation[1] as a way of striking a balance between technical and

[1] Nijman rejects the Cornell-based allocation-distribution paradigm on the basis that this omits the issue of flow regulation.

managerial aspects of water distribution. In this concept allocation refers to the decisions about how much water is allocated, where and when, while (flow) regulation involves decisions on timing, frequency and size of gate settings along canals to get water to the offtakes (Nijman, 1993: 40). The concept, however, does not address the fundamental question of the *hows* and *whys* of water distribution i.e. how water is actually distributed and why that is so. Besides the concept places too much weight on the 'management' (usually staff of an irrigation agency) and plays down the contribution of ground staff, such as water bailiff. This runs contrary to recent insights where actual water distribution has been documented to be carried out by ground staff rather than by middle to high-ranking officials (see van der Zaag, 1992 chapter 4). This point shall be expanded in the concluding chapter on the lines that it is not helpful to assign labels to 'management' without looking at who actually is involved in the actual operations of water distribution (see chapter 8).

There is no attempt in this chapter to come up with a strict definition of water distribution. What is pleaded for is a recognition that both social and technical aspects are involved in water distribution. In this respect the concept of water distribution suggested by Van Halsema and Wester (1994) is helpful. They see water distribution as including people (farmers, state officials, politicians etc) on the one side, and hydrologic and technical (infrastructural) dimensions on the other. People interact over how water is distributed as individuals and groups. These social arrangements about sharing water and irrigation facilities have material (physical) and non-material dimensions. The material dimension relates to physical artefacts such as irrigation artefacts and the water flowing in the system. Because measurements, figures and drawings can be ascribed to these, these have attracted the attention of many technical people to the neglect of other important issues. It will be shown that the non-material dimension, relating to human interactions, is just as important, and in some cases, even more. In any case there is no clear-cut division between technical and social aspects of water distribution. Specifically the focus in this chapter was on:

a. the interactions between the various actors, particularly the irrigation agency, operating staff and water users over water distribution and
b. how the interactions were shaped by hydrologic and irrigation technology aspects and
c. crop choice.

In this discussion water distribution refers to activities of water movement from the water source and how water is shared within the scheme between the different farmers. How water was applied in the field is the subject of the next chapter.

A study informed by such a concept of water distribution cannot be operationalized sufficiently by a quantitative methodology. This justifies a descriptive analysis of water distribution, complemented by quantitative data that is adopted here. To operationalise the study it was decided to look at how the prevailing delivery schedule[2] (formal or informal) came into being as well as how it was (re)constructed by different actors. A water delivery schedule includes the rate of flow or discharge that is made available to the farm turnout, the irrigation frequency or number of irrigation turns available over a certain period, and the irrigation delivery duration or the length of the irrigation turn (Replogle, 1986; Clemmens, 1987).

[2] Basically the method of water delivery can either be *on demand* or *supply-oriented*. In *on demand* systems farmers take water whenever they want it. This applies in those situations where water is generally not limiting. Where water is limiting the practice is for the irrigation agency to allocate water to farmers; this system is known as *supply-oriented*. In between these two extremes are other combinations (see Clemmens, 1987).

4.2 WATER DISTRIBUTION IN CHIBUWE: THE DOMAIN OF THE WATER BAILIFF DOMAIN

Block A was chosen as the sample as it was the largest block in the scheme, had the best infrastructure, and the most secure water supply (see chapter 3). Block D was used for comparison as it had the poorest water supply as well as the worst physical infrastructure. In the description water distribution the water bailiff takes prominence on the basis that he was the most active in water distribution.

4.2.1 Irrigation Organization

The water bailiff in block A was a local of the area whose home was about 3 km away from the block. He assumed the post of water bailiff in December 1993. At one time he worked as a government-employed contract worker in the scheme. It is in this capacity that he participated in the construction of the present canals in the block. After only about six months on the job, on 13 June 1994, the water bailiff showed that he was quite conversant with how water distribution was organized in the block. This was evident from his explanations about irrigation organization in "his"' block.

The water bailiff distributed water to 90 ha of land demarcated into 88 plots farmed by over 70 farmers (Figure 4.1). As can be seen from Figure 4.1, a short main canal branched into three canals codenamed (by the researcher) northern canal for the most northern, central for the one in between and the third as the southern. Irrigation was organized according to what were locally known as "blocks"[3], which in reality were irrigation groups which totalled 11. Figure 4.2 shows the location of the various irrigation groups within the block.

The irrigation groups derived their identity from the names of farmers who took the first irrigation turn e.g. if farmer Taruziva took the first turn then that "block" was known as Taruziva 's "block" or group. Table 4.1 shows the details of the various groups. All the irrigation groups, with their respective members, the plot number and plot size area, were written in a book which the water bailiff kept at his home. He did not need to carry the book as he knew the information by heart.

In each group there was an established order in which farmers took turns to irrigate. Usually at any one time 11 farmers would irrigate, one from each group. The number of irrigation groups was reduced to eight or any other appropriate number depending on circumstances. Irrigation was mostly undertaken from Monday to Saturday. Sunday was used to catch up on any delays. On Tuesdays and Saturdays irrigation was organized differently. These were the "garden days" set apart by the IMC to enable farmers to irrigate their vegetables since these required shorter irrigation intervals.On these days normal irrigation duties only started after 12 noon by which time gardeners were supposed to have finished irrigating. In most cases irrigation started during the day from 6.00 am to 4. 30 pm in summer and 6.30 - 7 am to 4.00 - 4.30 pm in winter. Irrigation could also start at 5.30 am which was dependent on the water bailiff. Even night irrigation was so arranged[4].

[3] Blocks in this sense refers to sections or parts of the hydraulic unit, in this case block A. The blocks represented different groups according to which farmers irrigated. Neither the water bailiff nor farmers knew how the groups originated.

[4] Unless the water in the Save River is low such that pumping may jeopardize irrigation in blocks B, C, D and E. Such incidents are dealt with during the weekly Monday morning meetings where all water bailiffs, the extension workers, the supervisor, the foreman of the maintenance gang and the Irrigation Management Committee are represented. By that time, however, the water bailiff is forced to have acted in one way or another.

Figure 4.1 Map of block A block in Chibuwe

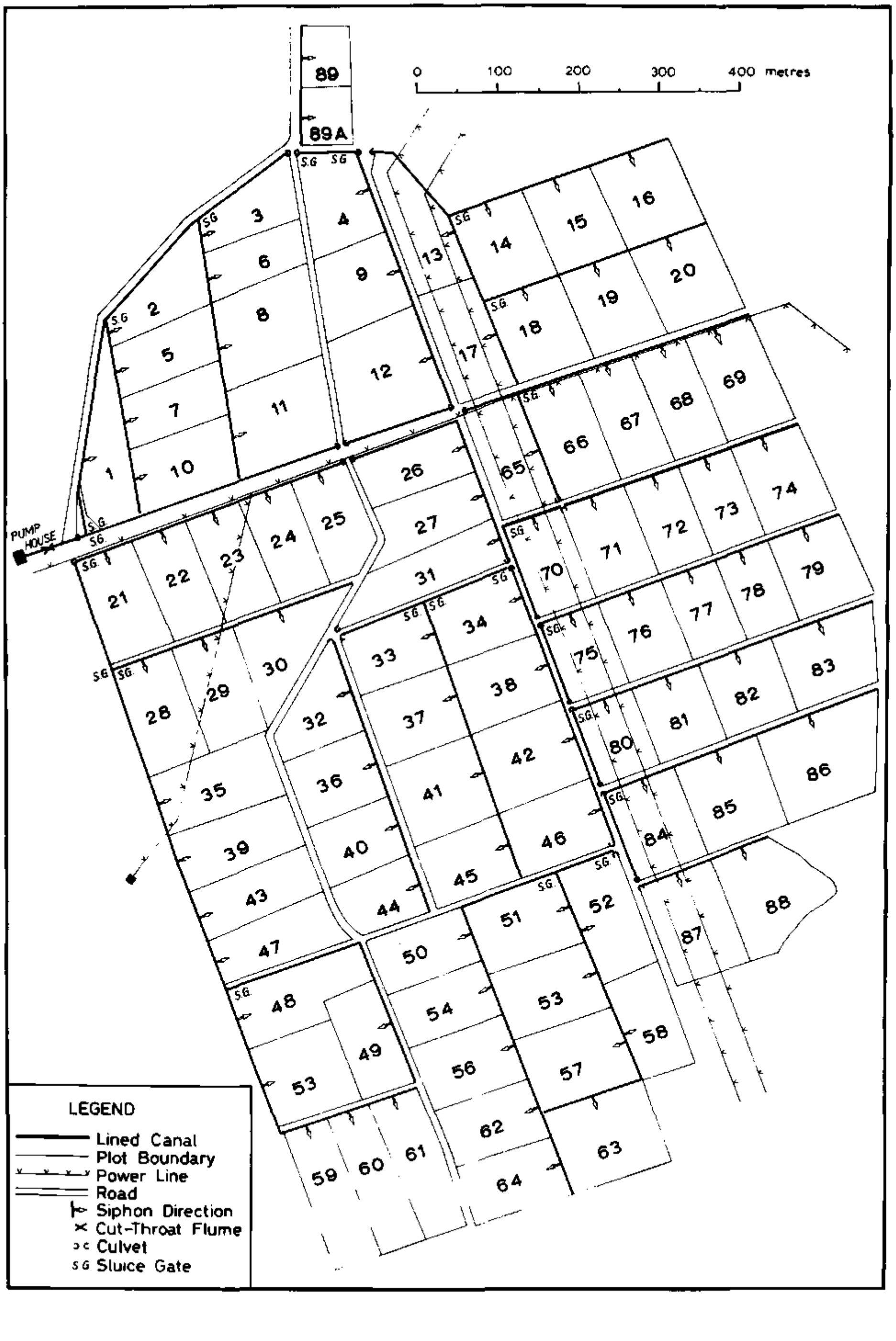


Figure 4.2 Irrigation groups in block A in Chibuwe

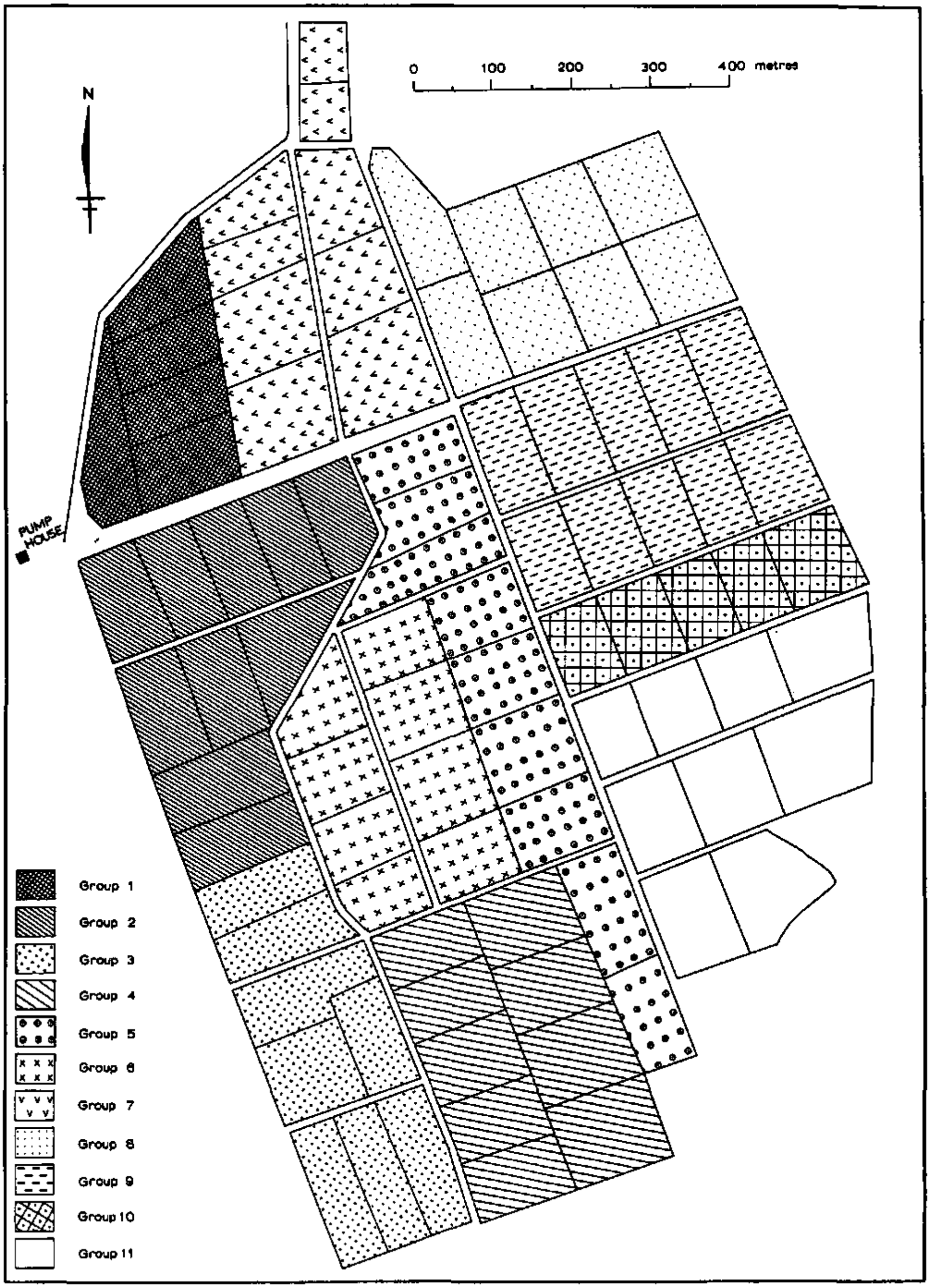


Table 4.1. Details of irrigation groups in block A

Name	No. of farmers	Total area (ha)	Plot number
[1]Tazira	6	10.3	35&39
[2]Nyamadzavo	5	4.8	N/A
[3]Tinonetsana	9	8.8	11
Albert Nkomo	8	8.3	13
[4]Hlahla	8	10.7	65
Janson Mapindu	6	7	75
Fumani	6	7.5	81
Hilda Chibuwe	7	9	N/A
Benhelda Makuyana	6	7.5	33
Kefas Chibuwe	7	8	43
[5]Total	**68**	**81.9**	-

Source: Field notes

Notes

1 This particular group required water continuously which was difficult to honour in practice. For this reason it was short of water for most of the times.

2 This group had a very comfortable rotation. The water bailiff in 1994 wanted to add another farmer to this rotation. Here 5 siphons were used instead of 10 because (a) water flows were swift since farmers drew water from one of three secondary canals and also because (b) the block was located near the main bifurcation point.

3 This group needed water every time as the water did not move as fast because the land was poorly levelled. The water bailiff planned to shift one person from here.

4 This group had continuous irrigation as it required a lot of water.

5 The block was originally mapped in acres. The water bailiff used a conversion of 1 acre = 0.4 ha (to one decimal place) which explains the difference between area obtained from adding the area irrigated by the irrigation groups and the official irrigated area.

The water bailiff had intimate knowledge of the irrigation groups. He could identify the respective geographical locations of the groups as well as tell the irrigation sequences that were followed. This he did without referring to a map or any written material. In fact an invitation to indicate the plots on a map produced the reply that "your map is confusing me." He had also information about the farmers themselves. This knowledge was complemented by observations about how farmers irrigated as well as the physical status of the different fields.

When a farmer received a water turn, he/she irrigated his/her plot until he/she finished after which water passed to the next farmer. If a farmer held onto water for too long, the next farmer negotiated with him. Changing of water from one farmer to the next, without the involvement of the water bailiff, was common as farmers were aware of the respective irrigation groups and the irrigation sequence. On his part the water bailiff made no fuss about being physically present at changeover time. In cases of disagreements he played a mediating role.

The water bailiff's intimate knowledge about the conditions in farmers' fields translated into different durations of water supply from irrigation group to the next and from farmer to farmer. Water was not simply rotated on a time basis e.g. 6 hours. Difficult fields were afforded more time (see Table 4.1). But in peak water requirements e.g. planting, the approach changed; time limits were more strictly enforced with the aim of giving each farmer "a chance" to irrigate. After an overview of how irrigation is organized the later paragraphs go into greater operational details.

4.2.2 Operation of Infrastructure

The pumps

From day to day the water bailiff, not only dealt with people, but with the infrastructure. He needed to coordinate pump operation as well as the opening of the head gate [5] and other gates so that the 'right' quantity of water got to the irrigators.

With regards to pump operation, he liaised with an experienced pump operator of the Ministry of Lands and Water Resources[6] with over 20 years job experience. The fact that the pump operator was from a different ministry did not pose major problems. The understanding was that the water bailiff, at the end of the day, assessed how many farmers were due to irrigate the next day. He then informed the pump operator on the number of pumps to be operated which was a choice of two since only two pumps were in place. From available records[7],it was clear that the overall discharge from the two pumps was fairly uniform.

Figure 4.3 shows the general discharge pattern plotted against the cutthroat flume depth. The relatively uniform pump discharges meant that the gates could be adjusted with some degree of certainity (see below).

Figure 4.4 shows that for most of the times two pumps were operated. The time when one pump accounted for more than 20 per cent of the pumping time coincided with near the end of the cropping season or at the very end of the cropping season.

February and September represented the end of summer and winter crops respectively. November signalled the beginning of the rainfall season while July represented the near end of the winter season.

Both the water bailiff and the pump operator took what could be called illegal[8] breaks from the block. This sometimes interfered with water distribution. Because of this the pump operator did not receive instruction on how many pumps to operate because of the absence of the water bailiff. In such cases the pump operator simply operated the two pumps. In most cases this worked out well, especially during peak periods. There were, however, cases when fewer-than-expected farmers turned up. Water would then go to waste. There was also another problem. When pumps had to be closed unexpectedly[9], the presence of the water bailiff was required so as to notify farmers. If not farmers blamed the pump operator for closing the pumps

[5] The gates are technically called undershot gates and are known to be difficult to use for water control (see Plusquellec et. al, 1994). If they are used as discharge measurement structures they are even worse (see Ankum, 1994).

[6] The Ministry has been known by a variety of names over time. The pump operator belonged to the same ministry with Agritex in 1993 when it was known as the Ministry of Lands, Agriculture and Water Development. These institutional changes, however, hardly affected day to day water management.

[7] These were based on the monthly forms filled in by the pump operator. The pump operator was however, not involved in the compilation. The Department had no rating curve/tables for this particular flume; instead they used the following formula to derive the discharge.

$Q = KW^{1.025} H^{n}$ cumecs, Where K is a factor; W is throat width of the flume; H is depth at the flume

$$K = \frac{1.8217}{\mathrm{L} - 0.1580} + 1.4343$$

where L is the length of the flume

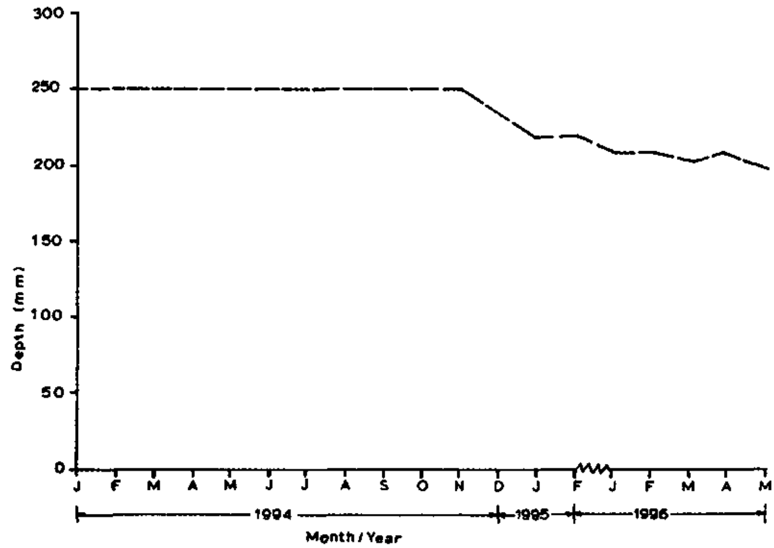
$$n = \frac{0.5506}{\mathrm{L} + 0.2565} + 1.3771$$

Significantly local Agritex had no rating tables or the formula.

[8] These are illegal in the sense that both of them are supposed to be in the block except during tea and lunch breaks. These breaks, it would appear, were compensating mechanisms to hedge themselves against long working hours and generally poor salaries.

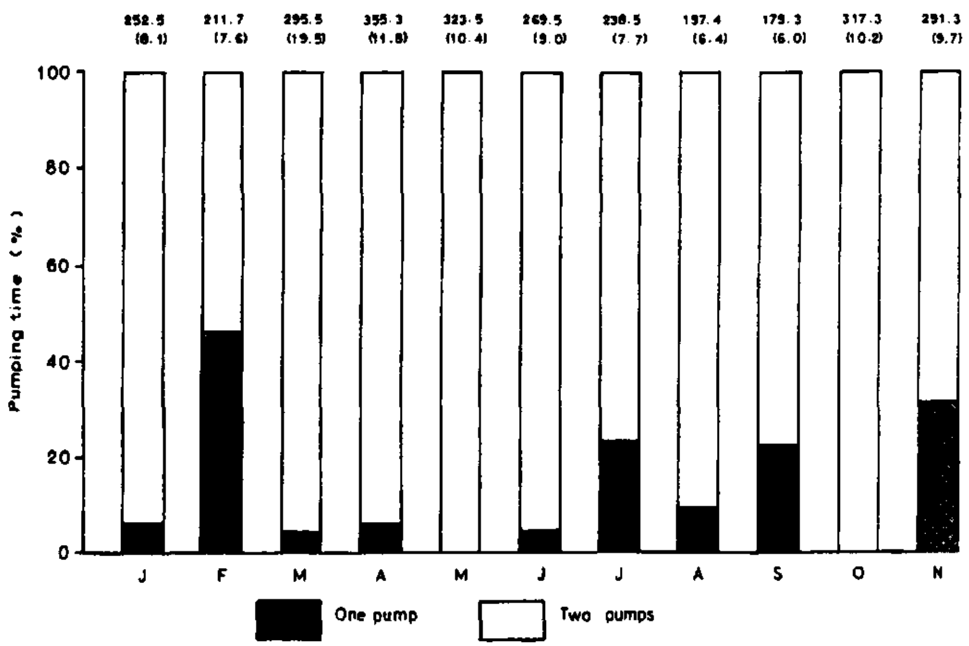
[9] This could be because of the low water level in the Save River, electrical or pump problems.

Figure 4.3 Block A pump discharge pattern in Chibuwe



Source: Field Notes

Figure 4.4 Number of pumps, total and average duration of pumping and pump discharge in block A in Chibuwe



Source: Based on DWR records

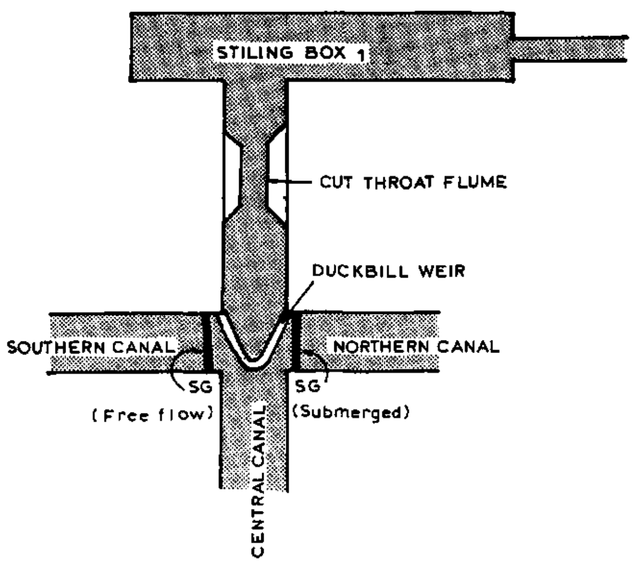
for no good reason.[10].

There were times, however, when the water bailiff initiated pump closure. This was mainly when fewer-than-expected farmers turned up. Such situations of pumps having to be operated, and then closed down after a few hours, tended to happen at non-peak water demand times. This was because in reality the system in use was an arranged supply where farmers did not put up requests for water. Instead predetermined rotations were in use. As a result there were times when the water bailiff did not have the required number of farmers due to irrigate on a particular day. The other problem was that the pumps were single capacity. This made it impossible for the water bailiff to precisely match the numbers of farmers irrigating and the pumps to be operated.

The gates

After pump operation the next task for the water bailiff was to allocate the flow to the various farmers due to irrigate on the day. The starting point was at the main bifurcation point with a head gate fitted with two sluice (or undershot) gates (see Figure 4.5). How did the water bailiff perform this hydraulically challenging task?

Figure 4.5. Schematic representation of the main bifurcation point in block A in Chibuwe



He explained that he used the rule of one notch on the gate to let out a flow sufficient for one farmer. This was not entirely correct as was illustrated during one demonstration. On the southern canal he used two notches per two farmers. On the northern canal he used seven notches per three farmers (which translated into 2.3 notches per one farmer).

[10] Such pump down times tend to be frequent when the water level decreases in the river necessitating the need to remove sand around the intake. The pump operator then removes sand immediately around the suction area. Sometimes he may be assisted by the water bailiff. Otherwise the Agritex maintenance gang is responsible for the general maintenance of the intake area.

"But you told me that one notch was one farmer?"
"Yes, but on this gate I use 7 notches for 3 farmers."
"Why?"

He shrugged his shoulders and explained that this canal was higher than the other canal. It might not have been the best of hydraulic explanations[11] but he had made his point. Table 4.2 shows the discharge measurements taken at the main bifurcation point over a period of five days. It can be seen that the central canal transmitted the swiftest flows and also irrigated the largest portion of the block. The discharge was by and large quite uniform as attested by the standard deviation (SD), a no mean achievement given that the operation of gates was not based on any numerical basis.

Table 4.2 Discharge measurements* at the bifurcation point in block A (Figures in parenthesis are flow percentages)

Day	Total flow (l/s)	Northern canal (l/s)	Central Canal (l/s)	Southern canal (l/s)
1	143 (100)	45 (31)	98 (69)	0 (0)
2	146 (100)	40 (27)	76 (52)	30 (21)
3	155 (100)	38 (25)	85 (55)	32 (20)
4	144 (100)	43 (30)	73 (51)	28 19)
5	140 (100)	38 (27)	72 (51)	30 (22)
Mean	146(100)	41(28)	72(51)	24(16)
SD	**5.7**	**3.1**	**10.9**	**13.5**

Source: Adapted from Mataranyika (1995)
* These were calculated using the Manning formula (see footnote 12)[12].

Gate operation did not always start at the main bifurcation point. As the water bailiff 's home lay opposite the intake, he sometimes adjusted the gates at the farmers' fields from the southern portion of the block first and worked his way upwards. This was in order to contain the water losses as he came into the block 20 to 40 minutes after operation of the pumps. His coming later in the block was in order to find the canals full of water rather than wait for them to fill up. For the whole system to stabilise, that is until there was, according to him, negligible water wastage at the end of the canals or because of overtopping, took him forty minutes to one hour. Once the system was stable he moved around the block checking for water thefts. Around 10 am he got on his bicycle to go for home to tea. For 60-70 per cent of the time he did not come back to the block until the following day. If he came back it was around 4 pm. He would then make the final round in the block and go on to talk to the pump operator who by then was on site ready for closing down the pumps. The many duties that the water bailiff understood to be his responsibilities was a contributing factor to his absence in the block (see Box 4.1).

[11] The correct hydraulic explanation is that one of the gates is submerged while the other one is overflow.

[12] The Manning formula for normal* flow reads:

$$V = K_m S^{1/2} R^{2/3}$$

v	=	flow velocity[m/sec]
k_m	=	flow factor related to the canal roughness [$m^{1/2}/s$]
R	=	hydraulic radius [m], R = [Water area]/[wetted perimeter]
S	=	hydraulic gradient or energy gradient [m/m]

* Normal flow conditions are reached in a canal with infinite length and equal water depth (in this case the bed slope equals the slope of the water level)

Box 4.1 Duties of the water bailiff based on his own submission

1. Distributing of water to farmers
2. Checking that weeding is done
3. Enforcing cropping programmes
4. Announcements of block meetings
5. Checking canal embankments that they are well maintained
6. Receiving visitors and answering questions posed by visitors
7. Recording of area irrigated daily
8. Record water level at the cut throat flume
9. Taking ZESA readings
10. Watching against intercropping
11. Checking that crop rows are straight
12. Checking for sub-letting

Source: Field notes

Each farmer in principle knew how the gate before his/her field was operated. In many instances the 'one notch one farmer' principle applied. However, farmers knew that this was not a 'water tight' technical arrangement. However, rather than challenge its technical basis, farmers decided to use it because if they refuted its validity, then there was little else around which social arrangements could be made. But farmers also adjusted the gates clandestinely to let out more water when they felt like it. Generally the gate adjustment by the water bailiff resulted in minimal flow variations between the flow received by farmers (Table 4.3). In the discharge of his duties the water bailiff also faced social challenges as illustrated below.

Table 4.3 Flow rates (l/s) to 30 individual farmers

Farmer	Northern Canal	Central Canal	Southern Canal
1	12.1	10.9	13.3
2	9.0	18.2	15.9
3	16.1	12.1	10.1
4	6.0	19.7	18.0
5	12.8	11.6	15.8
6	9.9	15.5	12.5
7	16.8	15.4	12.6
8	11.4	15.9	14.7
9	9.8	13.4	12.8
10	18.6	20.0	14.2
Mean	**12.25**	**15.27**	**13.99**
SD	**3.9**	**3.3**	**2.2**

Source: Adapted from Mataranyika (1995)

4.2.3 Social Aspects of Water Distribution

Social aspects of water distribution in this case has two meanings. First it refers to human relations that were not necessarily directly related to water distribution but nevertheless affected the practice of water distribution. The second meaning refers to those human relations that are occasioned by water distribution itself (which may be called the social effects of water distribution). In Chibuwe the latter was more evident.

In block A social aspects of water distribution centred on relations involving the water bailiff, farmers, the irrigation supervisor and the IMC. As a consequence dispute settling between farmers was one important task of the water bailiff. Farmers attached great importance to this role of the water bailiff. Many 'weak' farmers found him a real help as the incident contained in Box 4.2 shows.

Box 4.2 Conflict resolution by the water bailiff

Saturday 16 July 1994 was, as usual reserved for irrigating vegetables. Many farmers, particularly women and children, came out in large numbers. Children were many because it was a Saturday, as also happened during school holidays. In Chiwororo 's field (plot 17) his two male workers were waiting for water as the pumps had just been operated. They wanted to irrigate beans, which they had not finished irrigating from the previous day. How would they do that since this time was reserved for irrigating vegetables?

They were vague about it while complaining that "these people with gardens were a problem - they delay finishing irrigating" which kept them in the fields "all day long". As the water was approaching they got ready to irrigate. A row erupted between them and a woman who wanted to irrigate her vegetables. The woman reminded them that it was the vegetable day. The two workers insisted that they were going to use the water all the same. As the altercation continued the woman became less and less confident as she realised that she was physically powerless to do anything; "you may do that but it is against the law."

A second woman, who also wanted to irrigate her vegetables from the same canal, joined in the fray on the side of the first woman. Again Chiwororo 's workers did not have much of an argument but insisted they were going to irrigate anyway. Another woman who was irrigating in a nearby field overheard the altercation and came over to try and resolve the matter. The third woman delivered her verdict; it was the day for irrigating vegetables and Chiwororo 's workers had to surrender the water (they were now irrigating). As for the second woman she had no right to the water from that canal since she did not normally use it for her irrigation. In spite of that concise judgement Chiwororo workers continued to irrigate.

Soon afterwards the water bailiff appeared. The women wasted no time in reporting the matter. The water bailiff calmly told the Chiwororo workers to "respect the law". They complied.

Source: Field notes

The water bailiff also dealt with water thefts. Water theft fell into two categories. If a farmer tampered with gates and increased water to their plot, and no other farmer was seriously prejudiced, and there was no complaint, this went unpunished. In any case it was difficult to pinpoint the culprit. In such cases the water bailiff merely adjusted the gates and left it at that. There was, however, a serious water theft that attracted a fine. If a farmer irrigated when it was not his/her turn that was a punishable offence. Such cases tended to be quite common particularly at peak demand times. At times it was necessary for him to threaten to take the particularly at peak demand times. At times it was necessary for him to threaten to take the water away when water was being wasted, especially when children[13] undertook irrigation.

The above has set what can be called the water bailiff 's routine when he is 'in control'. But there were times when things were difficult for him. At one time the supervisor accused him, and the rest of the water bailiffs, of loitering around (this was because the supervisor came to the block and did not find the water bailiffs). To the supervisor this was a confirmation of the allegation by IMC that the water bailiffs did next to nothing. This explains the list of duties by the water bailiff contained in Box 4.1. (The water bailiffs on their part detested the IMC for insisting that it had jurisdiction over them. Fortunately for them the supervisor insisted that the water bailiffs were answerable to him).

In their defence the water bailiffs pointed out that they had other duties to perform like announcing field days and collecting money for agricultural shows. Some of these duties took them outside the block. The supervisor was not convinced so he made each water bailiff to write down exactly what he did everyday. The supervisor later admitted privately that the water bailiffs were too busy. This was after he had produced the position charter for the water bailiff (appendix 6) on the basis of the submissions of the all the water bailiffs. He said that the day of the water bailiff was actually too packed such that he could not fit their duties in the official eight-hour day. All the same the supervisor insisted that he was charge of all management aspects including water distribution. The organogram (Figure 4.4) was his reference point. However water distribution was clearly not his domain, and did not follow the organogram as illustrated by the following incident. During that very morning when he insisted that the IMC was below him, otherwise how could he "implement water scheduling" an incident proved him wrong. An hour later he was surprised to discover that the pumps in block A were not operating. Who had ordered that without his consent? The researcher told him that the water bailiff had done so because there were no farmers willing to irrigate as the day was cloudy. To his credit he did not try and reverse such a pragmatic decision.

For all his efforts the job paid him (in 1993) Z$600[14] per month. It was a meagre salary in relation to the amount of his work. But he was better off than most people in an area where living off the land especially in natural region 5, where only two out every five agricultural seasons were good was extremely difficult. Besides he had only four years of primary education which did not put him in a position to get a good job.

4.2.4 A Comparison with Block D

There were some notable similarities and differences between how the water bailiffs in block A and D operated. The water bailiff in block D had been in post since 1976. Before working in block D, he used to work in block C and E. Just like the block A water bailiff, he displayed a lot of knowledge about the farmers. However his way of operation was different in that he hardly came into the block. The reasons had mostly to do with the poor irrigation infrastructure as well as the poor water supply.

He attracted criticism from many people for "coming late and leaving early". This meant he came to the block around 9 am, and an hour later or less, went away. It was said for he went away for beer. This was the view of farmers.

[13] According to the bye-laws children are not supposed to irrigate in their own capacity as they are said to waste water. This, however, was not the practice. Some children skipped schools to irrigate. On weekends children were also very active as well as during school holidays.

[14] In 1995 the rate was one US dollar to 6 Zimbabwe dollars.

Zaka district office, who had similar experience. Irrigation rotations were thus introduced. This also appealed to district extension officers in Zaka because, as the first irrigation scheme in the district, irrigation rotations were preferred as they invoked notions of order. After some time it was discovered that these rosters were most of the time superfluous. As one farmer in block C put it, "rosters are not necessary because people do not plant on the same day; therefore we are already implementing irrigation rosters." Many farmers supported this view. The block C IMC chairman pointed out that soils in the block were so variable (there were eight different soils according to the feasibility report) that a fixed irrigation interval, enforced by irrigation rosters, would do more harm than good. But the irrigation turns were necessary at times as farmers found out. This coincided with the time when farmers planted cotton. Every farmer was required to plant between 20 October and 5 November so as to observe the pink bollworm-related dead period[15], as advised by Agritex. Water demand during such times was much higher also because by then the May/June-planted maize was also in need of more water. Rosters were also useful after rains or after some mishap, such as a burst pipe.

But some Agritex staff, particularly those not resident on the scheme, favoured irrigation rosters. The supervisor continued to be perturbed by the absence of them. To him there were necessary "so that irrigation water scheduling is expedited". For this to occur farmers were required to plant at the same time, [hence the block system (see chapter 7)] so that irrigation could be scheduled easily. It was, however, not apparent how irrigation scheduling would be done since there was no evaporating pans, for example. But the supervisor was not the only one who advocated for rosters to be put in place. The Zaka-based district officers were very much for the idea. The Masvingo principal agricultural extension officer (Field Division), in his talk on 6 October 1995 field day, also reiterated the importance of planting on the same day for purposes of better 'irrigation scheduling'.

But in the end the *on demand* system was (re)established, not according to design specifications, but according to the practical realities. For the water bailiff the challenge was how to operate the infrastructure to accommodate the (re)established *on demand* system.

4.3.2 Look and Learn in the Operation of Infrastructure

Optimistic assumptions

Successful water distribution in block C was dependent on the block reservoir holding enough water. This required operating two sets of infrastructure i.e. at the offtake canal and at the reservoir. The third set of infrastructure, the water meters located below the reservoir, had long ceased functioning. Figure 4.7 shows the various infrastructure under discussion.

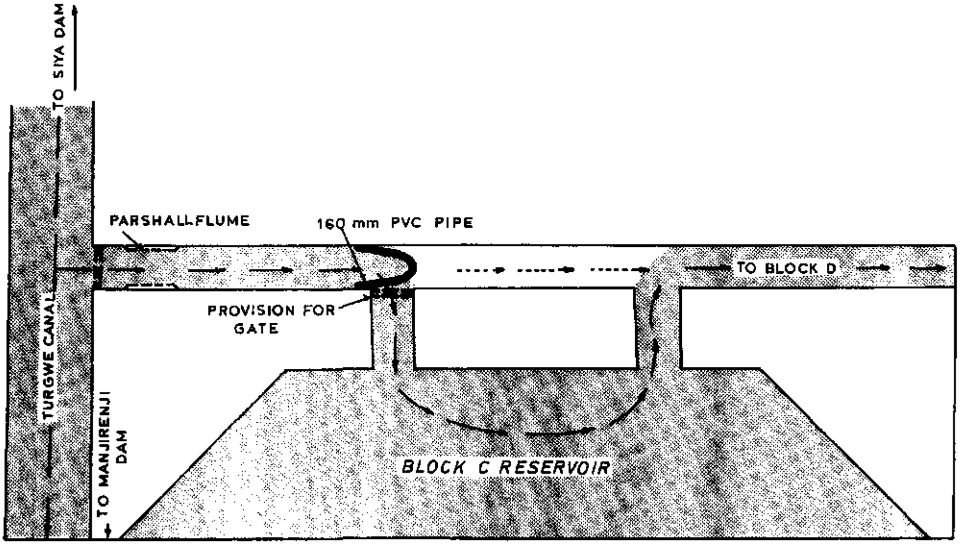
The first set included the gate that regulated the amount of water to the block from the offtake canal. Below it, about five metres away, was located a Parshall flume meant to keep track of the actual amount of water released to the block. The challenge for the extension worker, and the water bailiff, was to match the gate opening with water flows out of the block reservoir (or the amount of water used by farmers). The gate opening had to let out water sufficient for the 50 farmers in the block, who irrigated when they wanted, without running short of water. This meant allowing some water to remain in the reservoir so that farmers did not wait until the reservoir filled up each time they wanted to irrigate. The other challenge was to ensure that water was not wasted through overtopping during conveyance.

In theory one could quantify the flow by using the Parshall flume. (The rating table was available from the feasibility reports and also from the Regional Water Authority personnel; however there was no one who had it in the scheme). Equipped with the knowledge one could

[15] This pest cannot be controlled chemically. It can only be controlled by making sure that its life cycle is broken; hence the need to make sure that at certain times there was no host plant, cotton.

ascertain how long it took for the reservoir to fill up. (The figures were available in the feasibility reports although they did not reflect the actual reality). Assuming that one could persuade all farmers to stop irrigating until the reservoir filled up one could then monitor the water outflows as farmers used the water. Kent water meters on each of the main pipe branches could be used to monitor the outflows. However, the water meters had, as already said, broken down.

Figure 4.7 Important water distribution infrastructure in block C in Fuve Panganai



Such a 'calculating' logic could only work on the basis of very optimistic assumptions. These were:

- the extension worker and the water bailiff were trained to use the Parshall flume;
- the Parshall flume was not clogged up with sand deposits to enable one to assume with some certainty that a particular depth on the Parshall flume represented one specific flow;
- the delivery canal was not leaking in some sections;
- the Kent water meters were in perfect working order and one knew the units of measurement[16];
- the monitoring of water out of the reservoir had a predictable pattern (which depended on the behaviour of 50 individual farmers) such that one could use that as data inputs[17]. [After

[16] Besides the units of measurement were not known, not only by the extension worker and the water bailiff, but by the supervisor and the extension officers in the district office, including the Halcrow personnel who was installing similar pumps in block D.

[17] More fundamentally the behaviour of 50 individual farmers, who irrigated according to unknown parameters, remained a very grey area. A futuristic assumption could be that farmers irrigated according to weather patterns in which case one could calibrate their behaviour according to evaporation figures (translated into crop water requirements). The problem was that the block had eight different soil types scattered over 100 plots (each farmer was allocated 2 plots). Also the planting dates differed in spite of the block system. Besides this could only be useful if one could obtain daily weather data (which was possible since the Regional Water Authority sub-office, 10 km away, which kept such records).

that one had to make sense of the millimetres (from crop water requirement computation), the l/s off the Parshall flume and the m^3 from the Kent water meters];

- one had also to hope some villagers (with or without irrigated plots), wanting water in the adjoining streams, would not put barriers in the main canal to divert the flow and some would not set up gardens near the delivery canal and irrigate the much needed vegetables (since vegetables were not allowed to be grown in the scheme and also because the normal water sources used had dried up)
- the offtake gate (at the main canal) was intact and
- the infrastructure at the reservoir was structurally intact.

All these assumptions by and large, were not correct. So how was water distributed?

Facing reality

The offtake gate and the Parshall flume: As regards the operation of the offtake gate (which had been vandalised during the liberation war), the water bailiff was shown how to operate it by some casual workers who operated it during construction of the scheme. This involved one man diving into the water[18] in order to lift up gate which could not be reached because of the absence of the spindle. The challenge for the water bailiff (and one other water bailiff who later joined him) was to match the gate opening to the amount of water needed in the block. This meant reconciling the amount of water used by farmers and any other losses. The Parshall flume was used, but not according to technical specifications. As one person was in the water, the other person would monitor the water level at the Parshall flume. When the 'correct' water level was reached, which represented a certain depth, he would let his colleague know. The gate would then be maintained at that level. The depths were used as they were and not converted into flows.

The block C reservoir offtake: There were other problems. At the entrance to the night reservoir at block C was a provision for a gate. The gate was, however, not installed. As such water could not pass to block D without passing through the C reservoir except when the C reservoir was full and spilling (see Figure 4.7). When water was needed urgently in block D problems arose. The short 160-mm diameter PVC pipe, through which water passed before it reached the spilling level, was in the water bailiff 's opinion, not adequate. He would have preferred a "Keysec" (a sluice gate with notches. This became apparent after he had drawn it on the ground) with a lock in place for security. The result was that sometimes block C reservoir would get empty making farmers run short of water. In other cases block D farmers were the victims. The situation was worse there because farmers in block C did not want to see their reservoir "empty". They would interfere with plastic papers that the bailiff put at the mouth of the reservoir to divert the flow to block D. There were also cases when water would be lost to the wild because of overtopping of the delivery canal.

The solution: After a while the water bailiff discovered that if he operated the flume at a certain level, enough water would flow into the reservoir sufficient for farmers' needs. When block D started to operate the same experiments were repeated. The result of the experiments are presented in Table 4.4. With this problem fixed, the water bailiff, after setting the gate, could stay away from the offtake for two days. No disaster occurred due to water wastage or farmers running short of water occurred.

[18] But there was the lurking danger of being caught naked by women from the nearby homesteads. In the event of the other person being away e.g. the problem would worsen. In such cases the alternative was to use a long pole and with it grope for the improvised spindle. This improvised spindle consisted of a pick connected to the gate by a piece of barbed wire. On 12 June 1994 I watched an Agritex casual worker doing it. It took him more than an hour to complete, a job that should take just a minute or two to do.

Table 4.4 A summary of the operation of the block C and D offtake structure

Circumstances	Area serviced (ha)	Flume reading (mm)	Discharge (l/s)
Block C –peak demand	50	150	60
Block C – below peak demand	50	90	30
Blocks C and D - below peak demand	190	250	140
Blocks C and D - near peak demand	appr. 190	360	240
Blocks C and D - peak demand	190	390	270

Source: Field notes (1994 and 1995)

But the diligence of the water bailiff had an unexpected result. Once farmers realized that they could irrigate when they wanted, they began to resent the prospect of the water bailiff checking on them in their plots. This was difficult for the water bailiff to accept as he no longer commanded much respect from farmers. At first the diminished esteem was not easy to handle. In the end he stopped worrying and was content to spend more time at home which was a good compensation for the loss of esteem.

4.3.3 A COMPARISON WITH BLOCK B

Block B has two characteristics that are different from block C. These are the offtake structure and the underground delivery pipe (see chapter 3).

The offtake structure in block B was easy to operate as it was a complete unit. Moreover the block did not share water with any other block. But there were other problems. One related to the clogging up of the delivery pipe. This was because there was no silt trap at the mouth of the pipe as originally planned. As a result debris found its way to the pipe. The debris was particularly severe when Regional Water Authority personnel cut grass on the edges of the Turgwe canal[19]. It was important periodically to remove debris otherwise not enough water would be available to farmers. Farmers apportioned the blame to the water bailiff[20] for causing the clogging due to lack dedication to duty. Besides farmers were not allowed to assist in removing the debris. As a consequence the delivery pipe sometimes burst. The result was that farmers at times did not plant crops on time. At one time they lost a whole month. Because of this block B reverted to irrigation rosters more frequently than block C.

[19] Regional Water Authority personnel did have their own problems when it came to quantifying the amount of water used. According to them they had to quantify the water so that Agritex would get the correct bills. Everyday they took two readings (morning and afternoon) of the Parshall flume in block C. But they realised that the readings, which they sent at the end of the month to the office in Chiredzi, were compromised by the fact that any one could tamper with the gate. This happened quite often especially during the dry season when the streams dried up. They also accused Agritex water bailiffs of not notifying them when they adjusted the gate. In response to my enquiries they at one time (October 1994) took the flume reading at 7 am, 11 am, 2 pm and 4 pm. In block B (and also A) there were problems in estimating the amount of water being used since water meters stopped working. The Regional Water Authority water bailiff in the end resorted to estimating the amount of water. He expressed his dissatisfaction with the figures and sought help from the Manjirenji office. He was given a formula for which he did not know its basis. I later found out the formula was a extrapolation of pipes used in Bangala Dam. This did not work either. These figures that were generated were, however, not used for preparing water bills since Agritex paid for a stipulated amount of water. This fact was not known to the Regional Water Authority water bailiff, nor to Agritex personnel right up to the Irrigation Specialist.

[20] At one time there were two water bailiffs in the block. Still the incumbent attracted more criticism from farmers as the other water bailiff was considered more diligent.

4.3.4 Summary

Water distribution in Fuve Panganai was dominated by the infrastructure in place which determined the institutional arrangements of sharing water. The system of rotating water that was desired by the responsible agency did not take effect because the technology in place was favourable to an *on demand* system. As a consequence the job of the water bailiff in block C was affected in that he was no longer involved at the field level. However, it is important that due regard is paid to the water source. Siya dam was generally a secure water source which facilitated the installation of the low pressure buried pipe technology. An intermittent water supply, that characterises run-of-river schemes, would have not favoured the installation of the particular technology.

4.4 OF ROYALTY AND CASH CROPS IN MUTAMBARA

In chapter 3 socio-political struggles in Mutambara irrigation scheme were outlined. In this section the relevance of these struggles to water distribution are examined in the context of the 1995 and 1996 winter seasons. The focus on the winter seasons was because in summer farmers undertook supplementary irrigation which did not pose many water distribution problems. Before the descriptions of the two seasons a prologue to set the scene is given.

4.4.1 Prologue to the 1995 and 1996 Winter Seasons

Cracks in royal circles

The 'unity' within royal circles that characterised the 1990 take-over (see chapter 3) disappeared after a few years. The first crack related to water bailiffs.

At the start of the research in 1993 there were two water bailiffs who had been appointed by the Chief in line with the Chief 's supremacy: one served the upper Guta and Gonzoni blocks (hereafter water bailiff 1) who was a "son"[21] of the Chief while the second one worked in Zomba and Maunzani blocks (hereafter water bailiff 2). Water bailiff 2 was also related to the Chief although his family was not eligible for the Chieftainship. At the beginning of the research in 1993, water bailiff 2 was in the good books of the Chief and was highly intolerant of "outsiders"[22].

By September 1994 things had changed considerably for water bailiff 2. At his brother 's wheat plot in Maunzani, which had been irrigated only once, he sounded disillusioned. According to him, water distribution problems were caused by water bailiff 1 whom he alleged 'kept' most of the water in the upper blocks. The present committee was said to be weak as attested by its lack of intervention in such a desperate situation. He was no longer enjoying his job as he was now presiding over wilting crops.

A month later things turned out a little better for him. The Chief swopped the water bailiffs around. This was a direct result of an unplanned meeting that took place on 27 October 1994 at a seed (provided by the government) distribution exercise in the scheme. The Chief took

[21] These could be sons of his brother or sons of his half brothers.

[22] In answer to the extension worker's question about when the next irrigation meeting would be held his reply was a terse "just forget it." Instead he dwelt on the fact that the scheme belonged to Mutambara and that it has also been a struggle to keep it. While whites had been a problem before independence the current threat came from "squatters" (non-royal people) who wanted to rule. Some of "these squatters" wanted to bring in donors to have the scheme fenced but this was not acceptable. Now that the Chieftainship was in control there was no point of tolerating "outsiders" who wanted to take over the scheme. Outsiders included the researcher and the local Agritex officials.

the opportunity of the congregated people to hear out the grievances of the people which, he said, had reached him. Two things were discussed; water distribution and livestock intrusion. Nothing significant came out of the consultation.

Unimpressed, the Chief 's audience, raised fundamental issues. Directly questioning the legitimacy of the Chief as the IMC chairman, somebody from Maunzani asked when the Chief 's committee was going to relinquish power since the Chief and his people had promised to be temporarily in control for the sake of auditing books. Moreover, he said, no results of the audit were available. The Chief was not forthcoming on the issue. He was there 'not to discuss issues concerning the committee but people 's problems'. To placate the concerns of the people the Chief swopped the water bailiffs.

But the complaints did not die off. As the complaints mounted the Chief, two months later, dismissed the two water bailiffs. In their stead he appointed six caretaker ones. These were drawn from the marketing clubs (see below). The appointment of club water bailiffs seemed to have been based on the contribution of the clubs to the maintenance of the main canal (they bought cement and provided semi-skilled labour). The tenure of these club-based water bailiffs, however, was in jeopardy from the start as the Chieftainship people mounted covert operations to remove them.

The influence of marketing clubs in water distribution

In 1993 there was only one company, Cairns, which gave out contracts to farmers organized in clubs compared to two in the 1980s. Farmers were required to grow tomatoes and peas for the company at an agreed price. There were 13 such clubs spread in the different blocks (Table 4.5).

Table 4.5 Marketing clubs in Mutambara: Names, membership and location (the English equivalents of the names are in brackets)

Name	Location	No. of members
Kurimakwanaka *(Farming is good)*	Guta	19
Kugwinya *(Strength)*	Gonzoni	29
Zvikomborero *(Blessings)*	Gonzoni	15
Rutendo *(Faith/Hope)*	Gonzoni	16
Kuendamberi *(Going Forward)*	Gonzoni	14
Zvakanaka *(Things are okay)*	Gonzoni	14
Hatineti *(We will not tire)*	Zomba	13
Chipakonye*	Zomba	N/A
Zvipo *(Gifts)*	Zomba	N/A
Kufanebadza *(Dying with the hoe)*	Zomba	N/A
Kushanda *(Industry)*	Zomba	24
Masimba *(Power/Grit)*	Maunzani	N/A
Maunzani**	Maunzani	N/A

*Notes * This is a name of a nearby river ** This is the name of one of the irrigation blocks*

Source: ZFU Area Chairman 's records (1994)

These clubs split from the original Rufaro club. Farmers said that they had chosen to form new clubs because it was difficult to work in large numbers. The names of the clubs depicted farmers' enterprising spirit (see Table 4.5). According to the company representative, individual club contracts allowed the company to keep track of things which could not be done in schemes like the government-managed Mutema and Tawona irrigation schemes where all farmers were covered under one contract. In recognition of the success of Mutambara farmers, the company representative had driven the Zimbabwe Farmers Union (ZFU) area chairman, who co-ordinated the contracts, and two other farmers to go to Mutema so that they could teach the Mutema farmers how contract farming was done. He also persuaded the company in 1991 to give farmers inputs (sprayers and pesticides), apart from seed, on credit. This was discontinued after that one year because of side marketing by some farmers. But it was not only contracts and water that needed to be mobilised. Land was another crucial resource which impacted on water distribution as shown by cases in Box 4.3.

Box 4.3 Relationship between land ownership/access and water distribution

Case 1: Naison Mukonyerwa

Naison Mukonyerwa, aged 50 years in 1995, was born to a father who cultivated four acres in Guta with his two wives. Use of the plot was ceded to the two wives. Naison's own mother was the younger wife who bore three boys and nine girls while the first wife bore three boys and two girls. After working for a number of firms in Mutare Naison came and settled at home and worked in his father-mother plot. His father, who was now living with his mother, later gave him one acre for use in return for his labour. When his father died the plot became his mother's. She allowed him to continue using the one-acre plot his father gave to him. After his mother died in 1994 his name was registered on the two-acre plot. He was now sharing that with two of his sisters who had eight children between them. One had divorced while the other one had never married. He himself had three children. Meanwhile he had extended his plot 'illegally' because he had "a large family" and there was nothing he could do. The fact that his name was registered on the plot did not mean he was now the owner of the plot; it still belonged to all the three brothers. He was the second eldest brother. The eldest brother was farming in the nearby rainfed plot while the other brother was in self-employment in Norton, a town that is 40 km southwest of Harare. He explained that the eldest brother had the right to give guidelines about how the plot was to be used. If he wanted a part of it he could not be barred neither could his other brother in Norton. He however hoped that due consideration would be given to the fact that he had been the person who had taken custody of the plot and had invested a lot of labour in it. He particularly hoped that he would keep his one-acre plot which his father had given him. But everything was up for negotiations which were to be held once other necessary ceremonial steps concerning his late mother were finalised. He said that plot sub-division was a common occurrence on the scheme because of there were many people now who wanted a piece of land to cultivate. In 1995 his elder brother said he was not keen on the irrigation plot. However in 1996 he asked to cultivate a small portion.

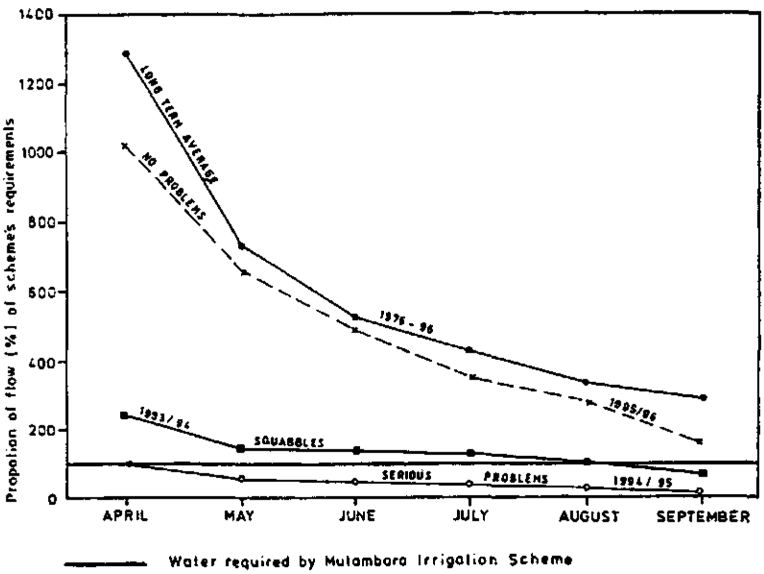
Case 2: Muchakagara 's daughter

Muchakagara 's daughter is in her 40s and was divorced. She lived with two children who were over 20 but were still dependent on her. She said she was cultivating one 3/4 of an acre which was a plot given to her brother (who was working in Bulawayo) by their father. Her father had divided his plot between his sons who were younger than her. She was bitter about it because she was not considered in the plot allocation. Every child should be treated the same, she said. After all she was looking after her father more than her brothers. At any rate a daughter was just like any child and was entitled to receive something of her father. Nevertheless she was a *de facto* irrigator in the scheme.

The increased demand for irrigated plots illustrated by sub-division, extension and renting of plots caused water distribution problems in that there were no longer a defined number of irrigators.

Water Flows
The preceding discussion has set the scene for a closer look at water distribution in the winter of 1995 and 1996. This, however, is best understood if the flow in the river is taken into account. Figure 4.7 presents on overview of the water flows (computed from Department of Water Resources gauging station E125) and the ensuing relations between the different actors. The relations followed the model advanced by some authors, whereby in situations of severe water scarcity or too much water, there is little co-operation among the irrigators (Uphoff, 1986).

Figure 4.8 Relationship between water availability and social dynamics in the Umvumvumvu river (1995-96)



Source: Based on DWR records

4.4.2 Winter 1995: Scramble Over a Scarce Resource

A number of events and activities occurred in the 1995 winter season which brought out the complexities of water distribution in Mutambara. These complexities touched on the marketing clubs and the protracted social-political struggles in the scheme.

First things first: securing the seed
When seed distribution for the 1995 season came up, only 30 acres worth of seed were on offer. The question was who was going to receive the seed, and by default the water?

As per practice previous records were consulted. The aim was to give seed to the best farmers[23]. The 1994 records were used as the basis. In 1994 seven clubs had received seed

[23] The notion of best farmers in a way hides away what actually was happening. Farmers who had well-developed water networks produced good crops of tomatoes and in the end were labelled the best farmers. Next time around they received not only tomato seed, but also water, thereby reproducing water inequality.

enough for 60 acres of tomato (Table 4.6).

Table 4.6 Tomato contracts and results in 1994 in Mutambara

Club	Target yield(t)	Actual yield (t)	Shortfall (t)	Gross income (Z$)	Average income (Z$)
Hatineti	70	64	-6	25,600	1,969
Kushanda	90	94	+4	37,600	1,567
Zvakanaka	80	52	-28	20,800	1,486
Rutendo	90	53	-37	21,200	1,325
Zvikomborero	80	38	-42	15,200	1,013
Kugwinya	90	83	-7	33,200	1,145
Kuendamberi	90	50	-40	20,000	1,429

Source: Cairns records (1996)

The seven clubs had signed contracts on the strength of delivering the targeted yields (second column Table 4.6) based on each acre producing 10 metric tonnes of tomatoes. After delivery Kushanda club exceeded the target and got a plough prize from the company (the plough was still at Chairman 's premises as the club has not decided what to do with it)[24]. In 1995 Kushanda consequently received the highest amount of seed (Table 4.7).

Table 4.7 Tomato contract results in 1995

Club	**Target yield(t)**	**Actual yield (t)**	**Shortfall (t)**	**Gross income ($)**	**Average income ($)**
Hatineti	40	15	-25	7,500	577
Kushanda	80	22	-58	11,000	458
Zvakanaka	30	9	-21	4,500	321
Rutendo	30	30	0	15,000	938
Zvikomborero	20	25			
Kugwinya	50	28	-22	14,000	483
Kuendamberi	20	12	-8	6,000	429
Zvakanaka	30	9	-21	4,500	321
Kurimakwakanaka	30	15	-15	7,500	395
Kufanebadza	N/A	0	N/A	0	0

Source: ZFU area chairman and Cairns records

Meanwhile clubs that were left out of seed distribution were desperate. One such club, Kufanebadza, pleaded for a contract. The seed distribution committee maintained that the club was unlikely to receive water hence it could not be given a contract. When the members insisted it was decided to placate them by giving them some seed. It turned out that the seed distribution committee was right: the club did not harvest any tomatoes.

At the end of the season Kushanda was not the best but Rutendo (see Table 4.7). Part of the explanation was that the 1995 season turned out to be a dry season. In the end Rutendo, where close contacts of the Chief were in the majority, secured water for themselves in four ways. First they received their 'legal' allocation from the water bailiff who was their close

[24] Although Kushanda won the prize the highest average income belonged to Hatineti which was a direct result of its low membership. This fact caused more sub-divisions of the clubs highlighting that the small units that were organizationally better had also to do with expected incomes. By 9 November 1995 one elite club, Kushingaira consisting of the best farmers, including Mwandichiya was formed. However there was too much rain and nothing much was gained.

associate. Second they took water with impunity with little fear of any reprisals. Third they expanded the area of production by using other seed not supplied by the company. Fourth they rented plots in the better-watered sections of the scheme such Guta.

The contract crop in danger

Group-assisted individual irrigation: In the early part of the season the clubs managed to gain a voice into how water was distributed because of the appointment of the club-based water bailiffs. The clubs agreed on irrigation turns for the contract crop. Non-contract farmers were not specifically catered for except to say they would receive water with the exception of those in Guta and Gonzoni blocks. These were given the priority of irrigating during the day in recognition of the fact that these would take water anyway, thanks to their upstream location. During the night Guta and Gonzoni farmers were supposed to let the water flow to the dam so that the Zomba people could irrigate. This well-thought out arrangement did not work as some farmers, especially those in Guta, continued to irrigate at night. This mainly involved those farmers who did not get the contract. The problem was also worsened by the fact that some farmers in Gonzoni and Zomba, even in the clubs, went to rent plots in Guta because of the better water supply there.

Worse still the Chief had reinstated the two water bailiffs. (However water bailiff 2 resigned three weeks later leaving water bailiff 1 in charge). For some time there were thus two parallel water distribution arrangements. First was that by water bailiff 1 which was alleged to be restricted to a group of favourites who included associates of the Chief. Money was also said to be used to secure water for those outside the inner circle. Perhaps realizing that he was losing a lot of money (the price had appreciably increased because it was now a scarce resource), a powerful "son" of the Chief, who had virtually taken over from the Chief as chairman of the IMC, ordered water bailiff 1 not to give anyone any water without informing him. The water bailiff was thus no longer in charge of day to day water distribution. He was also not happy that his salary was not only low (Z$150 per month) but was not paid on time. He had just received his September 1995 salary, six months late. The second was the club-based water distribution, which became ill fated once water bailiff 1 was reinstated.

Group irrigation: When the clubs realised that there was not much water available for irrigation they devised another plan. Those farmers who had a turn to irrigate would go and sleep at the dam. At periods they would go up and down the canal making sure that no one was stealing water. They would arm themselves with axes because some of the farmers who were stealing water had similar weapons. During the day those farmers with a turn would irrigate.

This did not work for long. Many farmers in August-September told stories of water being diverted from the dam while they were sleeping. By end of September the futility of sleeping at the dam to ensure irrigation water was widely established. There was generally no more water security in the scheme. Even royal-connected personnel were affected.

'Co-operative' irrigation: From late September another strategy was tried by the clubs. Since storing water in the badly silted dam first was no longer useful, it was decided to irrigate at night without storing water first. Because a number of people were required to walk up and down, as well irrigate, it was decided to undertake 'co-operative' irrigation. This meant irrigation was undertaken by part of the club in one plot while the other club members were busy policing the canal. Each club was given three days to irrigate. The irrigation cycle was fixed at nine days. In addition, the Ruvaka flow was also included in the turns. This flow, which was less than 5 l/s on 6 September 1995, was meant for Zomba clubs. But this arrangement did not last for long either.

The demonstration crop in danger: A farmer in Guta block volunteered to grow a wheat variety demonstration plot sponsored by a seed company, Seed-Cop. This was in consultation with the extension worker. The farmer was assured that water would be available since other farmers would benefit. Towards the end of the season water became increasingly difficult to secure. He tried to secure water by asking the self-styled new chairman of the management committee and water bailiff 1 to visit his plot. Nothing materialized from the visit. Later, it was said, water bailiff 1 asked the farmer for money in exchange of water (he refused to pay). The farmer appealed to the extension worker to use his influence (for example to indicate that the Seed Cop people were coming so that water would be released). That did not help. In the end he managed to irrigate half of the area at night after he had begged one farmer to let him irrigate. Fortunately the farmer managed to salvage a crop[25]. It was obvious that there was little collective responsibility in the scheme.

Legality and legitimacy in water entitlements: By October the situation deteriorated even further. No one was sleeping at the dam any more because there was little water coming down the main furrow. The main cause was another "son" of the Chief, seldom discussed in public (see below), as well as diminished water in the river. The scheme authorities did not act decisively on the issue. Instead the nearby Mutambara Mission was considered guilty of robbing the scheme of its water since its intake was upstream of that of the scheme. Scuffles between the water bailiffs and Mission staff occurred. It was then decided by the Chief and his close associates to engage the Mission in a dialogue. A meeting was planned on a certain Friday but a death in the vicinity disturbed the programme. The meeting was rescheduled to the following Tuesday or Wednesday. This did not take place.

In actual fact there was no progress made on the issue. The Mission took up the matter with the district administrator and the police. After failing to resolve the issue the matter went to the High Court. The Chief sent a word throughout the district asking each village leader (kraalhead) to contribute towards the legal costs. The matter was subsequently withdrawn after the intervention of the district administrator. He convinced the Mission to settle the matter out of court since a Chief could not be humiliated thus. The matter was, however, not resolved.

Apart from the Mission other names such as Mandima Co-operative, Quaggas Hook and Maraisi came into the discussion. This new discussion map (Figure 4.9) was considerably different from the usual discussion map (that is presented as an inset which included many more places and actors).

The discussion centred around who had water rights. The language of water rights was used in quite different contexts and, as can be expected, from positions of self-interest. Table 4.8 presents the various legal entitlements to the water.

[25] He also faced problems in his capacity as chairman of Kurimakwakanaka club (which had grown out of Zvikomborero club of Gonzoni). He had pushed the idea of forming a Guta-based club for ease of co-ordination because they were too many farmers in the clubs then. In 1994 Kurimakwakanaka had been denied seed because the previous year a good number of the farmers had opted to sell their tomatoes for cash and not to the company. Because of its position the club faced no serious water shortages unless there was a severe water shortage. When water was scarce he suffered because he did not command enough clout to demand water. Even his duties as a mediator or *nyamai* of the Chief, a position which he had inherited from his father, which entitled being an advisor to the Chief was not useful in that regard. There were also problems of plot renting by people from the dryland as well as other farmers from the downstream blocks. They openly had boasted that they were using "dollar power". These had thwarted attempts to keep people within the agreed 1/4-acre limit in line with the seed received. He thought he could not go on like this; it was time to call it a day. In November 1995, fed up of some people who were playing truant, he was talking of forming another club!

Table 4.8 Water users and their legal entitlements

User	Legal water entitlements
Mutambara Mission	- Water right no. 66, priority 16/3/1916 to abstract 56 l/s for agricultural purposes - Water right no. 2469 priority date 7/10/1949, to abstract 3 lps for agricultural purposes
Mutambara Irrigation Scheme	First granted in 1941 with the final grant in 1953. A flow of 89 l/s may be abstracted when the flow in the river was in excess of 344 l/s, but when the flow was less, abstraction was supposed to be 42 l/s
Mandima Co-op	15 l/s when flow is greater than 56 l/s
Svinurai Co-op	No water right
Maraisi	No water right

Source: DWR, Mutare files

The Mission wanted enforcement of the legal water rights as this would guarantee it more water. The Mission was particularly concerned with Mandima Co-operative with which it shared a furrow (apart from problems with the Scheme). The co-operative did not respect this legality; indeed its allusion to having water rights meant taking enough for itself. The co-operative did not understand why a population of about 300 people, with a primary school of all grades, and dependent mainly on agriculture, should have less priority than a Mission station which got external funds and received school fees. For Mutambara irrigation scheme, which was the most downstream of all the users (see Figure 4.9), there were many competitors to contend with. As a result water bailiff 1 periodically went up the river trying to persuade the upstream users to let water flow down. The argument was that the scheme has a water right [(never mind the fact that scheme itself did not adhere to the provisions of the water right (GOZ, 1985)]. But these attempts were not fruitful. Quaggas Hook did not have water rights because the former commercial owner did not get a final water right. Maraisi co-operative was in a similar situation to Quaggas Hook.

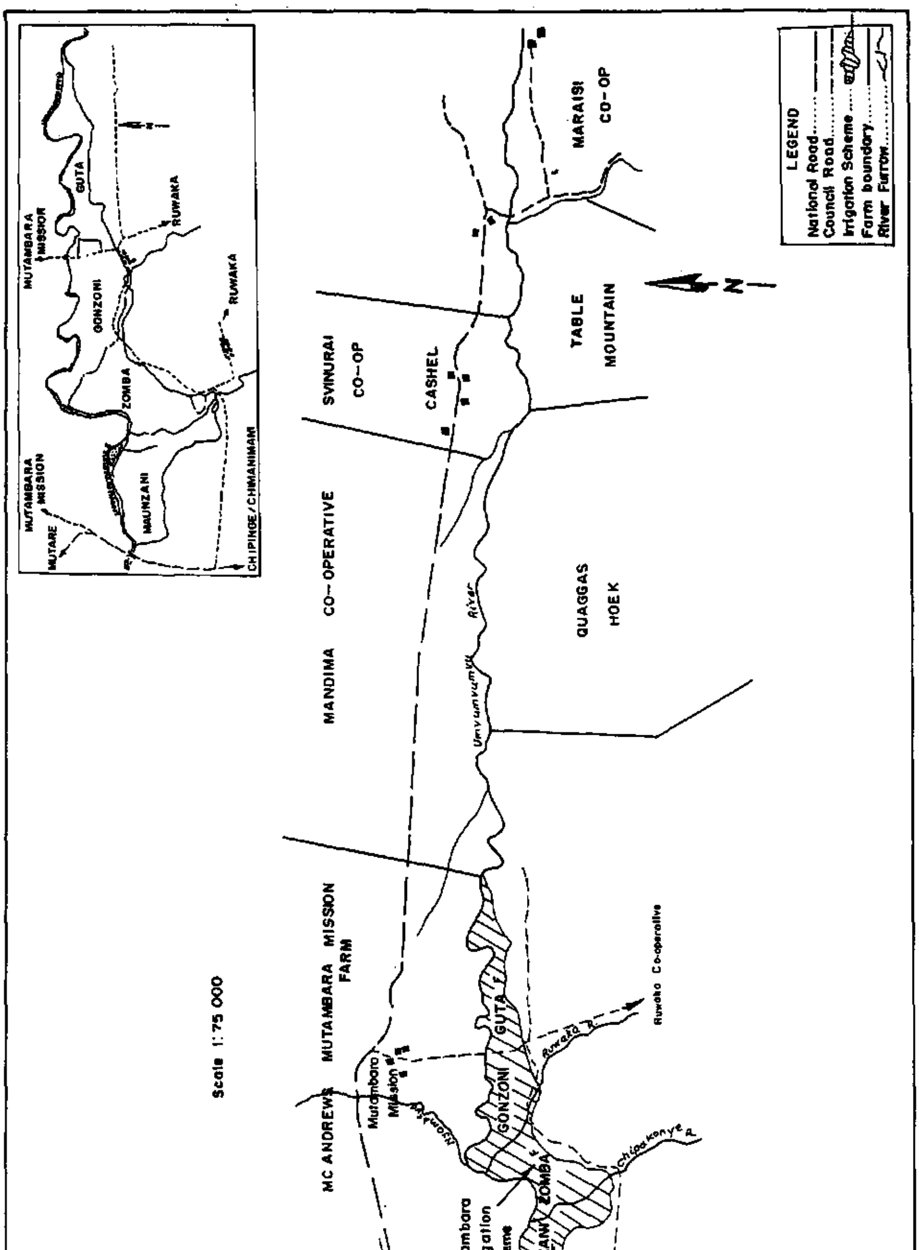
The situation was made worse by the legalities that did not count for much on the ground. This came to light when the researcher went up the river in the company of the Mutambara irrigation scheme water bailiff. Although the idea of water sharing was welcomed it was not really taken seriously. Water bailiff 1, in an effort to stress impartiality in water sharing, said that the time had come to "share out the water since there was now a machine available". This was with reference to the current meter that the researcher had. The people were excited by the machine but not to the extent of changing water practices. The ploy by water bailiff 1 to use "the machine" as a 'bargaining chip' as well as to elicit some respectability for himself, did not work as no party gave any concession.

Political problems

Water bailiff 2 seeks to take-over: Water bailiff 2 was completely disillusioned with what was happening in the scheme. On 7 September 1995 he claimed he had invested a lot in the scheme through his skills which could not easily be matched. But what did he get in return? Five months salary arrears and yet water bailiff 1 was being given his salary[26]. He was also no longer prepared to work with someone whom he accused of corruption. To rectify the

[26] His daughter had intervened saying that there was no more point for he father to continue as a water bailiff when he was not being paid. He was an old man "who should drink tea to warm himself up after being subjected to the cold during the course of the work." But he was not being paid. Instead she had to look for the money for the tea. She added that he had been a very good water bailiff who had distributed water without fear or favour not as those "people up there". So it was right that he gave up the job.

Figure 4.9 The 1995 Upper Umvumvumvu river discussion map



Source: Field notes

situation he believed that the Chief should not be the Chairman of the IMC.

To save the scheme something drastic needed to be done he asserted. There should be "a war" otherwise nothing could be achieved, he said. His 'war' plan, for a man who had been antagonistic to donors, was quite ironic. By then he was aligned to a donor linked to World Council of Churches[27] who wanted to build a dam across the Ruvaka river and also (concrete)line the main canal. Once that was done then they (he and others) would take-over and dictate what was to be done. He did not care about the Chief, he would treat him as a child. Moreover, he claimed that is own father had been instrumental in initiating the second furrow (see chapter 3) which now was claimed by the Chief to be his own.

Brother of water bailiff 1 reigns unchallenged: There was another dimension to royalty in water distribution which only came to the fore in the winter of 1995. This related to the role of the brother of water bailiff 1. His homestead was less than 200 metres from the intake. It was easy for him to take water whenever he wanted it. No one in the scheme had complained before then when water was reasonably available. However the low flow in the 1995 season seemed to have changed the usual silence about the situation. There was now reference to him as an important actor. Many people were aware what he was doing but no one was prepared to act. People said that he sometimes re-directed the water back to the river out of spite. Measurements at the intake and below his homestead clearly revealed that the bulk of the water, about 50 per cent, was going to his farm. It was said that he developed this attitude because of his father whose Chieftainship was stripped by the colonial authorities. As a consequence neither the water bailiff nor Chairman[28] could do anything. Some farmers wanted the matter related to the police or the army if need be. However, nothing concrete was done.

Aspiring Chief seeks government intervention: Calls for the government to come back were initiated by a number of people. One such man was part of the Chieftainship who claimed that he was next in line for the Chieftainship. He took it upon himself to make government 's intervention a reality. He teamed up with a number of disgruntled farmers and formed a "committee" for that purpose. Part of the plan was going to oversee the Chipakonye water being harnessed for Maunzani. The Chief was said to have been informed of the efforts.

By September 1995 he had embarked on a more serious attempt to have the water supply situation in the scheme rectified. He went to the district administrator in Chimanimani twice who promised to come to Mutambara and solve the issue. He felt the district administrator had been intimidated by the Chief. The district administrator on his part in a 9 November 1995 interview acknowledged that he saw him. He, however, said that the politics of Mutambara were very complicated. He also said that he had just received a call because the Chief was allocating land on Mutambara Mission land. As far back as 1992 he had recommended that the Chief be removed as the Chairman but nothing happened. He thought Agritex and the police should do more in enforcing order in the scheme.

4.4.3 Winter 1996: A Season of Euphoria

The 1996 winter season turned out to be opposite to the theatrics of water distribution in 1995. The 1995/96-rainfall season turned out to a record one. Water in the river was plenty (see Figure 4.8). Every club got a contract. The area chairman said he made it a point that

---

[27] By now he was posing as a Christian as shown by his profuse quotations from the bible. He also displayed a photograph of himself in a church attire standing next to a white (church) person. He maintained that he had always been a Christian.

[28] By this time he was commonly referred to as the Chairman of Irrigation. This signified a royal coup that had taken place as far as the control of the scheme was concerned.

every club got a share[29]. Practically all farmers confirmed that they did not run short of water.

The vastly improved water supply meant that water bailiff 1 could not apportion it to his favourites. With water being plentiful, even in the lower blocks, there was no market for the water. Nobody would, for example, pay for a water turn when water was so plentiful. Because of that water bailiff 1 was desperate for his wages. It appeared, however, that money was also not flowing that much to the self-styled chairman either. For example he called for a meeting (which was a rare thing since the take-over by the Chief in 1990) of the chairmen of the clubs to come and discuss how people could be persuaded to pay the fee. The meeting was largely boycotted by the clubs' chairmen except by the ZFU area chairman who said his club would pay since they did not want to jeopardize the Z$5, 000 he would get from selling tomatoes.

4.4.4 Summary

Water distribution in Mutambara in the 1995 and 1996 seasons was a function of local politics, the hydrologic environment, socio-political relations and commoditization, represented by contract farming (through marketing clubs). To some extent the clubs filled in the vacuum left behind by the popularly elected management committees as this represented an alternative to the Chief 's dominance. These factors made the actual water distribution practice not only complex but unpredictable. The hydrologic environment, in the form of water scarcity in 1995, precipitated the breaking point as all types of tactics were employed to secure water. Social relations in Mutambara were shown to be an ever-present backcloth to water distribution. These were affected and mediated to different degrees by the hydrologic environment, the physical state of the infrastructure and contract cropping.

4.5 CONCLUSIONS

Three main conclusions can be derived from the above empirical material. These relate to the constituents of water distribution, the inter-relationships between the various constituents, and the importance of focusing on how water is actually distributed rather than dwelling on formalized accounts of water distribution.

Constituents of water distribution

From the empirical material a number of observations can be made about what influenced water distribution. In general it can be said that water distribution was affected by:

i. water source (or the hydrological environment),
ii. irrigation technology and the requisite skills
iii. social interactions and
iv. commoditisation of certain crops (in relation to Mutambara).

The importance of these factors differed in the three schemes. For example in Chibuwe the combination of the first two factors: the source of the water supply and the infrastructure, played a critical role in the way water distribution was undertaken. As a run-of-river scheme with a fluctuating water supply, water posed a problem (although not to the same extent in all the different blocks). The type and physical condition of the infrastructure also affected how was water distributed. This was aptly illustrated by the events in block A and D. Thus the

[29] In this the researcher played a role by emphasizing the need to ensure that people in Maunzani were not unnecessarily excluded from the contracts as this only succeeded in fragmenting the scheme.

uncertainty of water supply, due to the water source and the physical infrastructure, formed the basis of the inter-relations in water sharing.

In Fuve Panganai the irrigation technology, at face value, singly affected water distribution as witnessed by the fact the *on demand* system was (re)established over irrigation rosters that were favoured by government officials. However the water source played an influential role in the dynamics of water distribution. The generally secure water source meant that the technology of the low-pressure pipe technology facilitated the *on demand* system. This consequently affected relations between farmers and the agency (in the form of water bailiff and farmers) as well as between farmers (represented by upstream and downstream farmers).

In Mutambara there was no water delivery policy that could be said to exist because of the prevailing social relations. Instead the delivery policy was constructed on a weekly, daily and in some cases, hourly basis. This was, however, largely a construction of a few (royal) personalities, which however, was 'contested' by a heterogeneous set of elements that included humans (other farmers), the infrastructure and the hydrologic environment. The unfavourable hydrologic circumstances of the scheme neutralised the autocratic water distribution that the royalty wanted to impose. The infrastructure also mediated water distribution. As it was a poorly constructed gravity scheme with an open canal system which leaked and allowed farmers to easily take water, it was impossible that the preferred delivery policy (that favoured the royal people) could easily be established. However, the inexpensive infrastructure allowed the Chief to sideline to some extent the other farmers, which would not have been possible with an expensive set up requiring financial contribution from farmers for day to day operations. In winter in Mutambara commoditization in the form of contract farming was very influential. Even the royal people had to be in one club or another and were generally subject to the same water sharing rules as everybody. The other effect was that cash cropping or commoditization resulted in another source of inequitable water distribution.

The inter-relationships

The individual factors did not work in isolation; there was an 'equilibrium point' between the various factors that facilitated 'orderly' water distribution. One factor out of place disturbed the delicate balance. The 'equilibrium point', it was demonstrated, could not be determined *a priori*. That is to say it could not be decided beforehand, for example, as to which was the most influential factor as well as the nature of the relationship with the other factors. These constituents, it should be underlined, could be different from other schemes, in other parts of the country, and certainly in other countries and were not equally important in all the schemes. Moreover the configurations of how these various factors combined and re-combined differed from scheme to scheme.

Reality and formalized accounts of water distribution

The challenge of identifying constituents of water distribution is not just a theoretical one in terms of its conceptualization, but also a methodological one relating to how one can arrive at these constituents. This chapter chose to find out this by examining the coping strategies of the main actors in water distribution. Coping strategies, according to Johnson (1992), involve engaging in many different activities simultaneously in the short rather than long term. Coping strategies arise out of a desire to solve urgent needs and wants (these are different from long drawn out strategies that may be futuristic and idealistic). Coping strategies are basically a form of opportunistic management which recognizes the fact that no one way of a management system works in all situations. The fact that the actors brought together history, social relationships, technology (hardware), water source as well as crops, and juggled these around to find a workable scenario, provides clues for understanding the basis of the management strategies of the different actors. This is briefly explored below.

At this juncture it is important to recall the administrative structure of the scheme. In government-managed schemes (Chibuwe and Fuve Panganai) the administrative structure seemed clear enough; water bailiffs were instructed by the superiors to distribute water to farmers. A general point, which was aptly illustrated, was that in government-managed schemes the administrative structure did not coincide with the practical demands of water distribution. It was also clear that water bailiffs in Chibuwe and Fuve Pangani did not really receive instructions from their superiors about how to distribute water. Actually instructions were largely absent and if there, were often contrary to the hydrological, social and technological realities. Consequently the water bailiffs had to 'work out a deal' in water distribution which involved negotiating with various actors. In addition, and to their credit, the water bailiffs came up with credible systems of allocating water, which although lacking a numerical basis, were impressive. The implicit operation of the infrastructure produced figures that were remarkable (see Tables 4.3 and 4.4). This observation illustrates that, apart from the social skills that were obviously needed to interact with the variety of actors, technical skills were also a must. Because these were not formally provided the bailiffs internalized the infrastructure and mastered its behaviour (see van der Zaag, 1992:102). An interesting parallel was the block D water bailiff in Chibuwe. Realizing that he could not internalize such a variable system he resorted to symbolic acts of arbitrary gate adjustments.

The same observations apply to Mutambara. In Mutambara where there were 'non technical' people, the technological imperative was well understood. This was aptly demonstrated by the water bailiff 1's increasingly difficult task which on the surface appeared social and yet was technical. The hydrological dimension 'interfered' in the social dimension in that the flow in the river altered the terms of the relations between him and the farmers and between him and his superiors. Even the chairman and the Chief's inner circle had to acknowledge the technical-hydrological imperative and seek solutions in the social realm, through negotiations, to solve a technical-hydrological problem.

One other point that needs to be mentioned is the role of the water bailiffs. There were different roles in each scheme because of the technical and social peculiarities of the scheme. This means that the job description of the water bailiff cannot be accurately be based on national blueprints.

By way of conclusion it can be said that comparing water distribution in the three study schemes was able to yield some insights about what constituted water distribution. A necessary key to this was the methodology which made it possible to engage with the practice of water distribution. It emerged that water distribution was not a passive sample that could be studied on the basis of pre-drawn objective criteria as it was actively constituted and reconstituted continuously. On the strength of the evidence presented it can be said that there is a need not to focus on formal water allocation, dealing with formal rules about water sharing, but on water distribution, focusing on operational aspects dealing with how water is actually shared between farmers (Hoogendam, 1996; Mollinga and Bolding, 1996).

5 FIELD IRRIGATION IN PRACTICE

This chapter examines how farmers managed water in their fields, examining what explicit or implicit factors they considered critical. In this effort the chapter documents how farmers grappled with three important aspects of field irrigation, namely timing of irrigation, quantity of water and the actual application of water in the field. The premise of this chapter is that it is only through an understanding of the realities of field irrigation that the problem of poor water management at the field level in smallholder irrigation schemes in Zimbabwe, which has been widely documented (see Pearce and Armstrong, 1990; Makadho, 1994), can be successfully addressed.

The case studies presented hereunder are from Chibuwe and Fuve Panganai irrigation schemes. Socio-political problems in Mutambara, as reported in chapters 3 and 4, precluded any meaningful study of field irrigation practice there. The cases were selected to illustrate different aspects of field irrigation. The first case, documented in section 5.2, looks at land preparation and sowing, two critical activities that precede field irrigation. The evidence shows that farmers improvised in both activities as they did not have the recommended equipment to adequately prepare their fields. Section 5.3 looks at how irrigation frequencies and amount of water to be applied were determined by farmers. It will be clear that farmers implicitly factored in technical and social factors in the determination of these. This is at variance with the 'normal' practice where technical parameters are mostly considered. The third case (section 5.4) documents how farmers actually executed field irrigation. The variety of circumstances and conditions of their individual fields made farmers adapt a variety of techniques to suit their own particular realities.

In the concluding section attention is drawn to three main points. The first critical point in understanding field irrigation is to appreciate the linkages between what happens in at the field level and the 'upstream' factors (of the plot). That is to say improvements in field irrigation are related to water delivery and its distribution (see chapter 4 for some of the critical issues affecting water distribution). Second, field irrigation is also subject to socio-economic factors in that farmers undertake field irrigation against a backdrop of social and economic limitations. This in the end affects technical aspects of field irrigation. This in a sense justifies the socio-technical perspective to irrigation that was adopted in this study. The third point is more of a recommendation. A 'new' philosophy of field irrigation, that is less concerned with the rigours of irrigation scheduling is advocated for the simple reason that there are practical limitations in a smallholder irrigation setting. The discussion of field irrigation undertaken in this chapter is prefaced by highlighting some basics of field irrigation.

5.1 SOME BASICS OF FIELD IRRIGATION

5.1.1 Field Application Methods

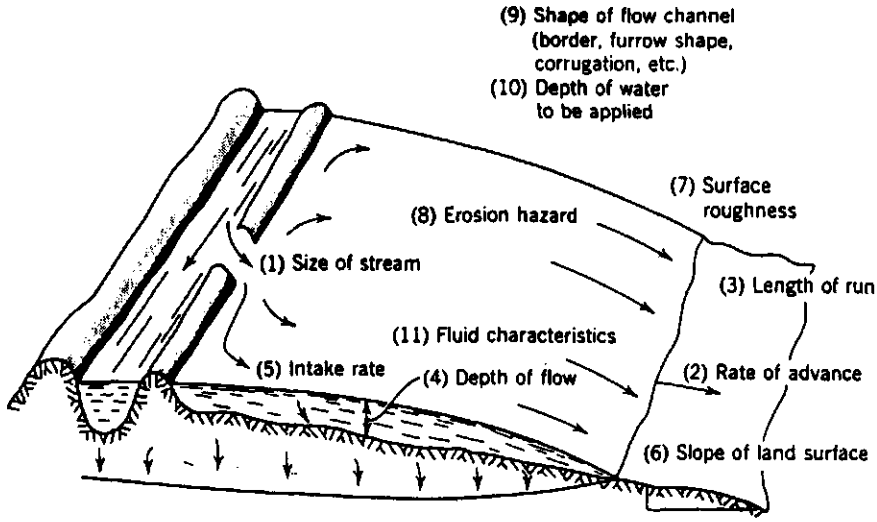
Field irrigation is about transferring water from a conveyance/distribution system of pipes or channels to the soil within a usable range of the roots of growing plants (Withers and Vipond, 1974: 35). This can be accomplished by;

a. running water over the surface so that water infiltrates into the soil (surface irrigation),
b. passing water into the soil at depth until capillary action raises it to the root zone (sub-surface irrigation) and
c. causing water to fall to the ground in such a way that it damages neither crop or soil (overhead irrigation).

This chapter limits itself to field application methods found in the study schemes - surface irrigation in the form of border strips for all crops in Chibuwe, and border strips for wheat and groundnuts, and furrow irrigation for maize and cotton in Fuve Panganai.

Surface irrigation is preferred where there are uniform gentle slopes, soils have high water holding capacity with medium infiltration rates, water flows are not too small and labour is not limiting. Success in surface irrigation depends on a host of technical factors, which must be well interrelated. A schematic representation of these factors as is shown in Figure 5.1. The multiplicity of these factors begs the question how these are taken into account in day-to-day field irrigation.

Figure 5.1 A schematic representation of factors affecting surface irrigation



(**Source:** Schwab, et. al 1996 after Hansen, 1980)

At the design stage field irrigation essentially incorporates technical and economic considerations in relation to what method is suitable to the particular locality and the attendant costs. In the operational stage technical aspects of field irrigation include;

a. when irrigation is due (timing or frequency),
b. how much water is to be applied,
c. how well the actual application of water is executed and
d. quality of irrigation water supply, or utility of water supply.

The determination of (a) and (b) is based on the water holding characteristics of the soil, meteorological data (mainly evaporation), and the crop growth stages (see for example Doorenbos and Kassam, 1979). In this conception, field irrigation is ostensibly a technical-physical phenomenon. This explains why many field irrigation (evaluation) studies have commonly followed the technical-physical mould where quantitative data are regarded as critical. How well the actual water application in the field is often determined by performance studies. It is argued here that field irrigation practice cannot be captured sufficiently by quantitative performance data alone.

5.1.2 Utility of Irrigation Water Supply

Recently there has been an acknowledgement that while farmers were concerned about the quantity of supply (as reflected in adequacy and equity), they were equally concerned about the utility of water supply. Utility of supply is defined as the ease with which farmers manage the water they receive or that is delivered to them (Gowing *et al.*, 1996: 332).

Field irrigation can be said to be composed of three important dimensions; supply quantity, supply quality and supply utility (Gowing *et. al*, 1996). Supply utility has, however, been largely ignored. The aim in this chapter is to demonstrate how day to day field irrigation practice was conducted taking into account the supply utility. Such an understanding can result in better insights into what factors most concern farmers in the practice of field irrigation. This will result in better water management because, at the end of the day, it is farmers and not technicians, who have a greater influence on improving field irrigation.

5.2 LAND PREPARATION AND SOWING

Successful field irrigation starts by achieving a soil texture that allows water to move expeditiously into the soil, both vertically and horizontally. This is achieved in part by good land preparation. In the first years of operation of new schemes, it is easy to achieve a good soil tilth that is ideal for irrigation. At that time land levelling is usually undertaken by contractors who have sophisticated tractor-mounted equipment. This is also true for schemes that are under rehabilitation. Thereafter such equipment, which guarantees good land preparation, is generally unavailable to many smallholder farmers. In addition, lack of draught power and reduced labour availability means that what may be regarded as technically sound land preparation is usually not undertaken. This case explores how farmers approached the problem.

5.2.1 Variable Slopes and Soil Types in Fuve Panganai

As outlined in chapter 3, Fuve Panganai irrigation scheme is characterised by variable slopes and consists of a variety of soil types. There are gentle and steep slopes as well as soils of differing water holding capacities. These have serious implications on the practice of field irrigation. The problems facing farmers in block C were captured by the researcher on the morning of 19 May 1994.

First to be encountered was a woman who was preparing to sow wheat. With her husband, she said, she had left a big rainfed plot as irrigation guaranteed higher yields. She, however, complained that the plot had a steep slope and consequently was difficult to irrigate. She had not received help from the extension worker[1] who helped farmers with alignment of border strips for growing wheat. Further on there was a young man with a similar story. He was irrigating and talked of the difficulties encountered during field irrigation. This was because the soil had a high silt content, which made water movement through the soil profile difficult. The surface would be wet while a few centimetres below the soil would be dry. This was a characteristic of this soil locally known as *chivavanhi*.

The most illustrative case was yet to come. The researcher was waved down by a woman who was busy trying to mark out border strips in conformity with pegs inserted by the extension worker (with the help of surveying equipment). The job was not made any easier with a baby on her back. She was being assisted by a young man in his teens. The young man led the span of oxen while she attended the plough. At this juncture she was confused because she did

[1] This was a difficult job for the extension worker as he serviced both blocks B and C.

giving rise to plough pans. Farmers were aware of this problem. They, however, balanced that with other competing demands for their cash. For example opting to be particular about land preparation to ensure smooth water movement meant more expenditure, which could jeopardize other farming operations such as seed acquisition. This well-considered and pragmatic land preparation by farmers sometimes faced official censure. The wire-planting dispute is a case in point.

After a disastrous 1995 winter season, when no farmer could grow crops because of unavailability of water, farmers began to prepare for the 1995/96-summer crop. The Agritex supervisor, after consulting with extension workers, sent a word reminding farmers that they needed to show physically that they had fertilizer before they could plant. In block A there was another requirement which was unsettling to all farmers. The water bailiff announced that he would enforce a new ruling on behalf of the supervisor. Since block A was the best block in the scheme, high standards had to be maintained there so as to impress visitors. As such crop rows had to be absolutely straight. Farmers were required to do wire planting. This meant that, after ploughing and harrowing, planting rows were to be marked out by a wire line. If this was not done no farmer would be allowed to plant. Farmers complained bitterly. Rules were to be kept, the water bailiff insisted. A meeting with the supervisor was arranged. Farmers argued they had neither the time nor the labour to pursue such a triviality. Instead they would plant as they have always done; they would open the planting rows with an ox-drawn plough. At the meeting the Secretary of the Irrigation Management Committee, who was really infuriated by this whole episode, asked the supervisor a simple question. He showed the rows that had been opened up by a mouldboard plough and asked him whether the rows were not straight enough. The supervisor admitted that they were straight enough. It would appear that the supervisor was caught between farmers, who demanded practical issues to be addressed, and his official role that insisted on certain requirements that sometimes were in conflict with the practical realities.

5.3 DECIDING WHEN TO IRRIGATE AND HOW MUCH TO APPLY

The next two sections turn to how farmers determined when to apply the water and how much to apply.

5.3.1 Timing of Irrigation

Farmers in both Chibuwe and Fuve Panganai first irrigated their bare plots for the purpose of ease of ploughing them up. The second irrigation was meant to help crop germination. In Chibuwe the timing of the second irrigation was problematic because of the rotational irrigation system in place. Subsequent irrigations were scheduled differently in the two schemes. Tables 5.1 through to 5.3 illustrate the differences[5]. In Fuve Panganai, where farmers could irrigate by and large when they wanted (see chapter 4), there were more irrigations per crop compared to Chibuwe. Both the maximum and minimum irrigation intervals in Chibuwe were much larger because of the irrigation rotations practised there[6].

[5] The data that are presented refer only to winter crops since irrigation in summer tended to be disrupted because of rainfall. In Chibuwe beans is mostly grown.

[6] It is important to underline the fact the data presented are indicative. For example the data cannot be definitive about block B and C irrigation.

Table 5.1 Irrigated maize data in Fuve Panganai

Block	Average no. of irrigations	Average maximum Irrigation interval (days)	Average minimum irrigation interval (days)
B	8.2	19.0	4.5
C	9.2	20.8	4.8

N = 5 farmers per block

Source: Field notes (Winter 1996)

Table 5.2. Irrigated wheat data in Fuve Panganai

Block	Average no. of irrigations	Average maximum Irrigation interval (days)	Average minimum irrigation interval (days)
B	9.6	18	7
C	8.8	19	9

N= 6 farmers per block

Source: Field notes (Winter 1996)

Table 5.3. Consolidated irrigation bean data for blocks A and D in Chibuwe[7]

Average no. of irrigations	4.4
Average maximum irrigation interval (days)	23.6
Average minimum irrigation interval (days)	14.9

N = 19 farmers

Source: Field notes (Winter 1996)

Below is a description of how irrigation frequency was determined in Fuve Panganai. Fuve Panganai was suitable for this exercise because of the type of irrigation technology there which allowed farmers to irrigate when they wanted. This affords an opportunity to assess how farmers, on their own, determined when to irrigate their crops and how much water they applied.

The relatively greater number of irrigations that farmers undertook seemed to be a mechanism to ensure that the crops did not suffer any form of stress. Interviews with farmers revealed that farmers used close observations of both the soil and crop in determining when to irrigate. In the early stages when the crop was small, and the crop was not a good indicator upon which to base the timing of irrigation, the wetness of the soil was used. During this stage the idea was to keep the soil moist. In the vegetative stage, irrigation was based on first signs of wilting in the crop. This was an assessment that took account of the specific soils and crops in specific fields. However, all farmers concurred with the fact that flowering was a moisture sensitive stage which demanded generous irrigations in terms of frequency and amount of water. Irrigation was also timed to coincide with the maturing phase with one or two irrigations being applied. They were also times when water was applied purely for crop management. For example irrigation was used to facilitate fertilization of the crops or to make ridges. In groundnuts irrigation was done to facilitate harvesting. Table 5.4 summarises the details of how Fuve Panganai farmers scheduled field irrigation.

[7] The data were aggregated for both blocks because of gaps in the collection of data.

Table 5.4. Timing of irrigation by Fuve Panganai farmers

Crop stage	Basis/purpose of irrigation
Before planting (pre-irrigation)	To make land preparation easier
Planting	To facilitate sowing
At germination	For germination
Early vegetative phase	Soil wetness
Later vegetative phase	Wilting of leaves
Flowering	To assist flowering
Post-flowering	To ensure grain filling

Source: Field notes (1994-1996)

5.3.2 Amount of Water to be Applied

After looking at how irrigation was timed, this sub-section turns to the issue of how much water was applied to the fields. A fitting introduction to the subject is to reiterate the fact that irrigation methods varied between and within the two schemes. Figures 5.3 and 5.4 show the methods of applying water in the Chibuwe and Fuve Panganai respectively.

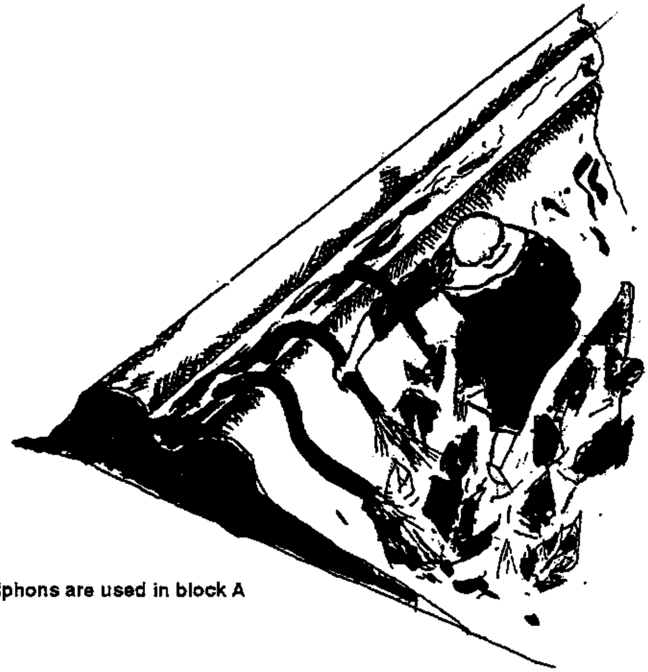
Figure 5.3 shows that in Chibuwe in block A siphons were used to let the water onto their field while in block D farmers used shovels as there were no siphons in the block. As can be expected, it was much more difficult to manage water in block D than A, moreso because block D contained unlined furrows. This was compounded by an insecure water supply. The practical implication was that a farmer in block D was not in a position to control how much water went into his field. Apart from the difficulties posed by the irrigation method, water flows in the approach canals varied considerably. Nyakudya (1995) found that farmers in the two blocks farmers received different amounts of water (Table 5.5) depending on their geographical position (Nyakudya, 1995: 44, 47). Meanwhile farmers in block A received what could be considered to be steady flows. This advantage, however, was compromised by the fact that the size and number of siphons used varied because of replacement problems. Siphons used to be replaced by government. However, over the years, this has fallen on farmers due to government financial constraints. When replacing siphons, farmers were concerned about maximising their returns per the money they invested resulting in a situation where not all old siphons were replaced with new ones at the same time. Some farmers, faced with reduced number of siphons used their own, hence the variation in the sizes used.

Table 5.5 Flows reaching individual fields in blocks A and D in Chibuwe

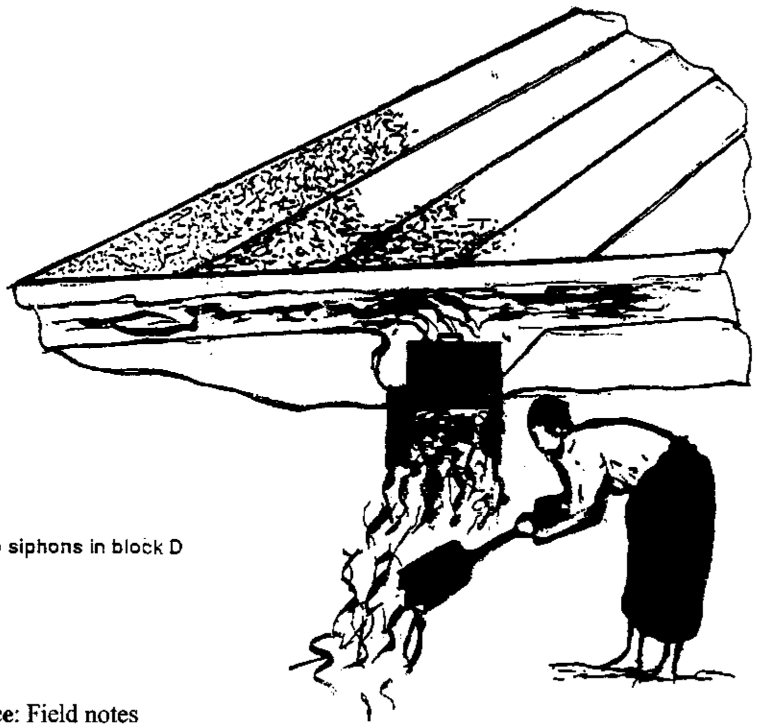
Block	LS	
A	1	16.0
	2	16.3
	3	19.8
	Mean	17.4
D	1	26.1
	2	39.8
	3	27.8
	Mean	

Source: Adapted from Nyakudya (1995)

Figure 5.3 Water application methods in Chibuwe



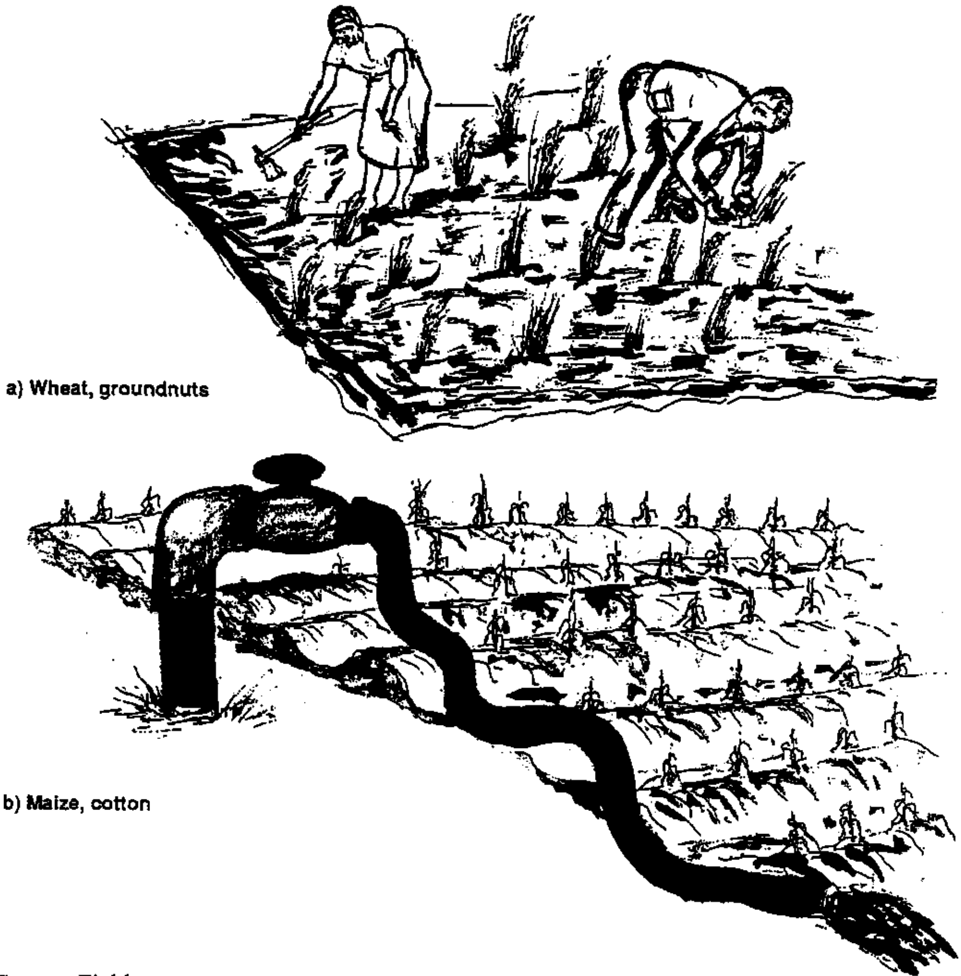
a) Siphons are used in block A



b) No siphons in block D

Source: Field notes

Figure 5.4 Water application methods in Fuve Panganai

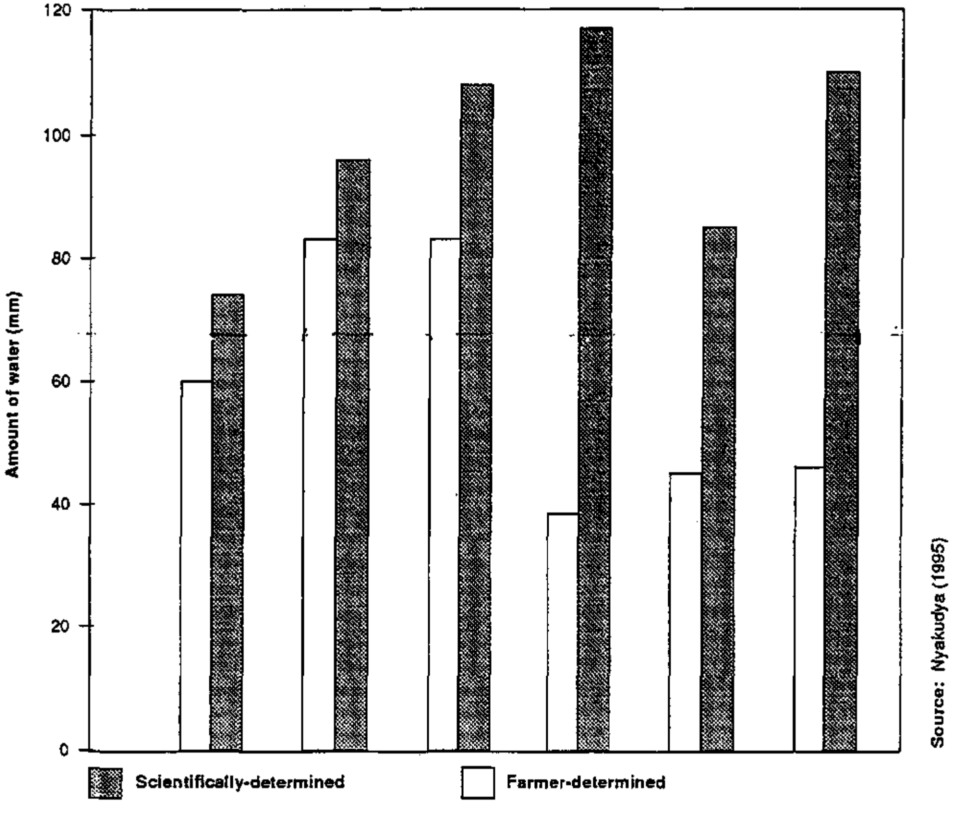


Source: Field notes

In Fuve Panganai the factors that interfered with the ability of farmers to gauge the amount of water they used were the steep slopes and variable soils as already noted. As such the principal problem was one of matching the discharge from the hosepipes to the different field conditions. In general farmers tended to use higher discharges than the those recommended. They used 6 l/s compared to the recommended 2 l/s. This had also to do with the fact that farmers were keen to complete irrigating as soon as was possible. Figure 5.4 shows how water was applied to the fields in Fuve Panganai.

One factor that needs re-emphasis is the uncertainties of water supply. In this regard Fuve Panganai was more secure as can be seen from the number of irrigations (see Table 5.1, 5.2 and 5.3), showing that farmers on the whole had adequate water, not only in absolute terms, but for their felt needs. The unpredictable supply of water in Chibwe meant that farmers, when they received water, tended to (technically) over-irrigate their fields. Figure 5.5 shows that there was much more water applied than 'technically' optimal. This, however, was an understandable reaction to the vagaries of water supply. On the other hand farmers in Fuve Panganai, who generally had a more assured water supply, irrigated more frequently and less intensely. This was shown by soil augerings done 48 hours after irrigation (data not presented).

Figure 5.5 A comparison between scientifically and farmer-determined depth of water application depth



Source: Nyakudya (1995)

In conclusion it can be said that field irrigation in the two schemes was not based on any known application depth as the necessary calculations were not done. A technical interpretation would be that these calculations were not done due to the lack of adequate knowledge and the necessary devices such as evaporations pans. While this is true, it is important to note that even if the requisite calculations were made, their applicability, given the varying physical, technical and social conditions, would be limited. Field irrigation, by farmers, as already said, was based on implicit notions on the basis of past experiences and present observations. Given the prevailing circumstances this 'method' of determining irrigation application, it is contended, was not inferior to scientific irrigation scheduling in the circumstances.

5.4 EXECUTING FIELD IRRIGATION

This section turns to how farmers actually irrigated their fields. It shows that farmers had an idea of some of the scientifically recommended practices such as cutting back the flow in surface irrigation. It will also be clear that farmers faced limitations during field irrigation. Consequently farmers were forced to compromise on a number of points during water application.

5.4.1 Chibuwe

Field observations were made on a selection of farmers' fields. Some technical parameters were determined during the 1995 winter season concentrating on how farmers managed the flow they received. To monitor field irrigation, pegs were drilled at 20m intervals into the soil in some plots. The advance of the water down the border strip was then observed. Some of the observations are given below.

Block A

Farmer 1: The farmer, as most other farmers, did not irrigate the 3m wide border strips one by one and in sequence. Between 60 and 80m pegs, water was allowed to flow from the previously irrigated border strip to the next border strip. The farmer stopped irrigating three minutes after the two waterfronts met. He indicated that inter-border strip flow of water was achieved deliberately. This represented, it seems, a variation of flow cut back. Blocking of water in the channel was satisfactory as only about one per cent of the arriving flow was by passing the farm intake.

Farmer 2: Between 75 and 95m along the border strip there was a good wetting of the soil profile. On the other hand, between 110 and 120m, the soil was dry in some parts. From 120m onwards the soil was already flooded and water flowed to the next border strip. Some water overflowed beyond the lower end. The farmer used intra-border strips across the ridges to achieve uniformity in the cross slope direction. The field was not well levelled which made irrigation difficult to implement. During the irrigation session water broke the border strips twice without the farmer 's notice underlining the difficulty of executing sound field irrigation.

In general, in block A, it was found that the application efficiency, which indicates what percentage of the water applied to the field was used by plants, was relatively high (up to 80 %) as reported by Nyakudya (1995). Deep percolation was found to be small. Farmers were observed to be making equalising ridges within border strips in order to increase uniformity of field application. Stover was used to reduce the impact (from siphons) of water on the soil as were plastics.

Block D

Farmer 1: The *bunds* were in a good condition. Also in place were equalising bunds. The farmer used inter-border strip flow. At about 75m from the head of the border strip the advancing stream front met water flowing across from the previously irrigated adjacent border strip. There was great variability in discharge during the irrigation session because of misunderstandings between the farmer and the water bailiff. As such irrigation was not uniform.

Farmer 2: At about 40m from the head of the border strip water flowed into the water that had overflowed from the previously irrigated adjacent border strip. At the time these observations were made the farmer was visibly tired. She had spent the whole night irrigating her field and neighbour's . This was because the water bailiff issued a short notice for the water turn when her neighbour was absent. The discharge varied enormously during the irrigation session. From time to time the farmer would leave her field to check why a very low amount of water was reaching her field. She said this was a result of water theft and siltation in the earth furrows. The farmer claimed that she had only irrigated her bean crop three times while other farmers had irrigated more than five times. The demands posed by irrigation in terms of labour requirements, placed a lot of challenges on her, moreso because she was a widow. She had two school age going sons who helped her out. Sometimes she requested the children to miss school so as to irrigate. Missing school because of irrigation was a common phenomenon in the scheme.

5.4.2 Fuve Panganai

The closed pipe system in Fuve Panganai had one remarkable effect at the field level. The top-tail end problem, where farmers in the lower reaches of the scheme do not get enough water in comparison to the top sections, was not known in the scheme. In fact when water became scarce it was farmers in the upper reaches that felt the effects first. Consequently it is these farmers who requested for rosters to be effected.

As far as field irrigation was concerned farmers had to fend for themselves as the design guidelines were either unknown, vague or unsuitable. Farmers did not use the hose pipes connected to the hydrants throughout the plot, as some parts of the plots were not reachable by these. They watered such portions by letting water run through furrows made in the upper section of the plot. Water was then directed by a shovel to the relevant portion. If spare pipes were available they were joined end to end to irrigate the difficult-to-water portions.

Very few people had the planned eight hours to devote to irrigation. Consequently they tried to reduce the time they spent irrigating. The availability of spare pipes, due to the fact that farmers did not irrigate at the same time, facilitated this. Farmers borrowed and lent pipes especially those whose plots were close to each other. Problems with this arrangement arose from time to time though. In September 1994, in block B and C meetings, some farmers complained about people who clandestinely took pipes and did not bother to return them. Some farmers had, as a consequence, resorted to irrigating without pipes. For some, irrigating without pipes, was not a matter of missing pipes but a desire to finish irrigating early. Women eager to go and prepare the evening meal usually used higher flows, as did children who did not fancy the task.

Leaking hydrants were a problem particularly in block B. An increasing number were leaking every year. At that rate, farmers feared that some fields would in the future be unirrigable as the brass 2-inch gate valves wore out. Replacing each valve cost Z$245, nearly twice the annual maintenance fees paid by each farmer on a one hectare plot. Two groups of people were blamed for this. School children, in search of drinking water on their way from school, were said to use stones to turn the valves and by so doing damaged them. It was also said that school children learnt it from the women who caused damage as they used the valves as leverage to place their 20 litre water tins onto their heads when fetching domestic water. A meeting held on 10 October 1994 failed to resolve the issue. Some farmers wanted women not to use hydrants for domestic water arguing that a borehole was available for that. Besides, it was against the byelaws[8], they said. Not everyone agreed with the drastic recommendation. There was no point in insisting on rules which "you very well know will be flouted".

The women themselves did not join in the heated debate probably because they knew what was being said was partially true. Instead of publicly voicing their concerns, some women, in subdued voices, said the men would not get supper if they were barred from getting water from hydrants! Who after a long day in the fields, together with the men, would find the energy to walk great distances to a far away borehole? The fact that the water from the hydrants was dirtier was not considered at all. What mattered was the distance to the water source.

---

[8] An examination of the bye-laws revealed that there was no such provision. Since this was not disputed at the meeting it can only be assumed that there were some of the unwritten bye-laws that farmers on their own devised to cope with an emerging situation.

In block C the domestic-irrigation water problem existed but to a lesser extent because people got water from the open delivery canal. The block C homesteads were also removed from the fields. The open canal system also gave a chance for women to do their laundry even though it was supposed to be prohibited.

5.5 CONCLUSIONS

The evidence presented in this chapter about field irrigation can be described as unconventional in that no 'hard' quantitative data were given. Instead a choice was made to shed light on the daily challenges of field irrigation faced by farmers as well as how these were confronted. While such an approach does not produce conventional scientific indices and efficiencies, it nevertheless gives insights into how field irrigation is understood and implemented by farmers. This focus on farmers' practices is critical since, it is they, at the end of the day, that largely determine the success of field irrigation and water management in general. The reason is that it is farmers and not technicians that apply water to the fields. Three concluding points can be made on the strength of the empirical evidence that has been presented.

It was demonstrated that most factors affecting field irrigation lay outside the immediate control of farmers[9]. For example unreliable water supplies and siltation could not be controlled by farmers, at least immediately. This was the case in Chibuwe, particularly in block D, where the odds against farmers were many. The lack of siphons, the unreliable earth furrows and the leaking main canal, meant that farmers were not in a position to exactly determine the amount of water they applied. The technical recommendations themselves were largely absent. In this situation, it was up to farmers to tie up all the loose ends. In Fuve Panganai it was clear that farmers used their personal experience to come to grips with technical issues of field irrigation. They used soil moisture and crop phenology to good effect. Moreover they preferred frequent light irrigations. In other words, left on their own with predictable water supplies, farmers had no reasons to over-irrigate. However, unpredictable water supplies, like those encountered in Chibuwe, made farmers soak their fields. This was an understandable reaction. In a way these farmers wanted to hoard as much water as possible in their fields, which of course, caused problems of deep percolation and possible leaching[10]. This fact was amply illustrated by farmer 2 in block D in Chibuwe. The small flow size combined with unpredictable water supply caused by water theft meant that the woman farmer took much longer to irrigate which caused fatigue. These upstream factors therefore materially affected field irrigation. Nyakudya put it most convincingly:

> .... one cannot understand fully the reasons behind any management strategies at field level without relating the farm practices to what will be happening at the head works and in the conveyance sub-system. Recurrent phenomena, namely pump breakdowns, erosion of the temporary dam wall that diverts water into the diversion canal..siltation problems and the frequent electricity failure are among the factors that affect the dynamics of water flow to the farms intakes and indirectly affect the water management at field level (Nyakudya, 1995: 40).

While the above observation was made in relation to Chibuwe it is also true for Fuve Panganai. Here variable slopes and soil types, among other factors, meant that farmers dealt with a dynamic situation, sometimes within a single plot. This was not only a challenge to farmers but to the extension worker as well, who tried his level best to help farmers. In the end

[9] In the following discussion these are referred to as 'upstream' factors.
[10] Wade (1988) has discussed this phenomenon and its causes which he titled technical factors of hoarding.

the best solution was for farmers to experiment and strike a compromise between a number of not only technical, but also social factors as well (see below). This reinforces opportunistic management (also called contingency management) because of changing realities (see chapter 8).

This then makes a case for comparing to technical-oriented and farmer-centred irrigation parameters (see Box 5.1).

Box 5.1 Some important field irrigation parameters

TECHNICAL-ORIENTED PARAMETERS
Adequacy refers to the average depth of water delivered over a season
Equity refers to fairness in the way water is shared among irrigators
Timeliness relates to the distribution of water across the season relative to some utility-based standard

FARMER-CENTRED PARAMETERS
Predictability refers to the knowledge of future supplies planned by the water supply organization and the degree of uncertainty associated with the knowledge
Tractability refers to the ease with which an irrigator can control the flow rate supplied to him and the time he needs to spend in the field attending to irrigation
Convenience refers to the time of arrival of the water at the farmers' outlet (principally whether it is during the day or night

Source: Svendsen and Small (1992); Gowing *et al* (1996)

Apart from the hydrologic and hydraulic issues, socio-economic factors also affected field irrigation practice. For example, to achieve level fields, farmers needed to mobilise draught power, suitable equipment and labour, all of which were not easy to achieve. In such situations water management considerations were subservient to the more immediate need of ensuring that a crop was sown.

All these dynamics found expression in the way field irrigation was actually undertaken. From block to block, from plot to plot, and sometimes from one corner of a plot to the next, field irrigation took different forms. In such situations uniform technical recommendations were clearly unsuitable for the different circumstances that farmers faced. Moreover field irrigation practice at the farm level, it was shown, cannot sufficiently be described by a unitary quantitative statistical description. This casts doubt on instituting time-based irrigations as alluded to by Tiffen and Harland (1990), a fact which was profoundly appreciated by the water bailiff in Chibuwe 's block A.

The material presented in this chapter has provided some but by no means conclusive evidence about some of the relevant aspects of field irrigation. For example women farmers in Fuve Panganai used irrigation water as domestic water because of the new opportunities they obtained from saving labour to carry domestic water. There was thus a continuum between field irrigation and domestic chores. How can such a continuum be depicted in performance studies is the question? Labour was also demonstrated to be important, which is relevant in the African situation where labour shortage is a constraint to agriculture. This also demonstrates the merit of having field irrigation studies that are not entirely water-focused.

Since field irrigation is clearly a farmers' domain it is important that this fact be reflected in the way experts approach the subject of field irrigation. For a start some practical measures can be instituted. For example field irrigation should be based on a philosophy of letting

> every farmer (should) know in advance..how much water will be delivered to him and when he will receive it..it is far better to provide a reliable division of the water and let the farmers use his skills and enterprise in the full exploitation of a known predictable resource, than to attempt to regulate the resource to an individual farmer 's demand (Shanan, 1992: 151, 171).

This also applies to the design stage

> ..projects (should be) designed to involve a minimum amount of discretion and intervention by the operating staff..(there must be a) trade off (between) the theoretical advantages of supplying the precise requirements of each crop against the practical advantages of a reliable, preplanned irrigation schedule. (Shanan, 1992: 171).

From the evidence presented in this chapter, field irrigation is simultaneously shaped by three dimensions; supply quantity, supply quality and supply utility (Gowing *et. al*, 1996) with local agrarian, biophysical and social conditions shaping the utility of supply. The chapter also argued that the supply utility and its documentation could be strengthened by focusing on how actually farmers handled field irrigation. Such an approach is likely to challenge the normative standards about field irrigation which tend to cloud the reality faced by farmers. The next two chapters go into detail about some of the reasons that militate against the 'new' philosophy of water management that is proposed here.

6 INSTITUTIONALIZATION IN WATER CONTROL

This chapter looks at the role played by design engineers in water management, through an examination of how the technical infrastructure influences water control. From an operational point of view water control can be said to have been achieved when the infrastructure enables farmers to receive their respective water shares and they can also easily and effectively apply water to their fields[1].

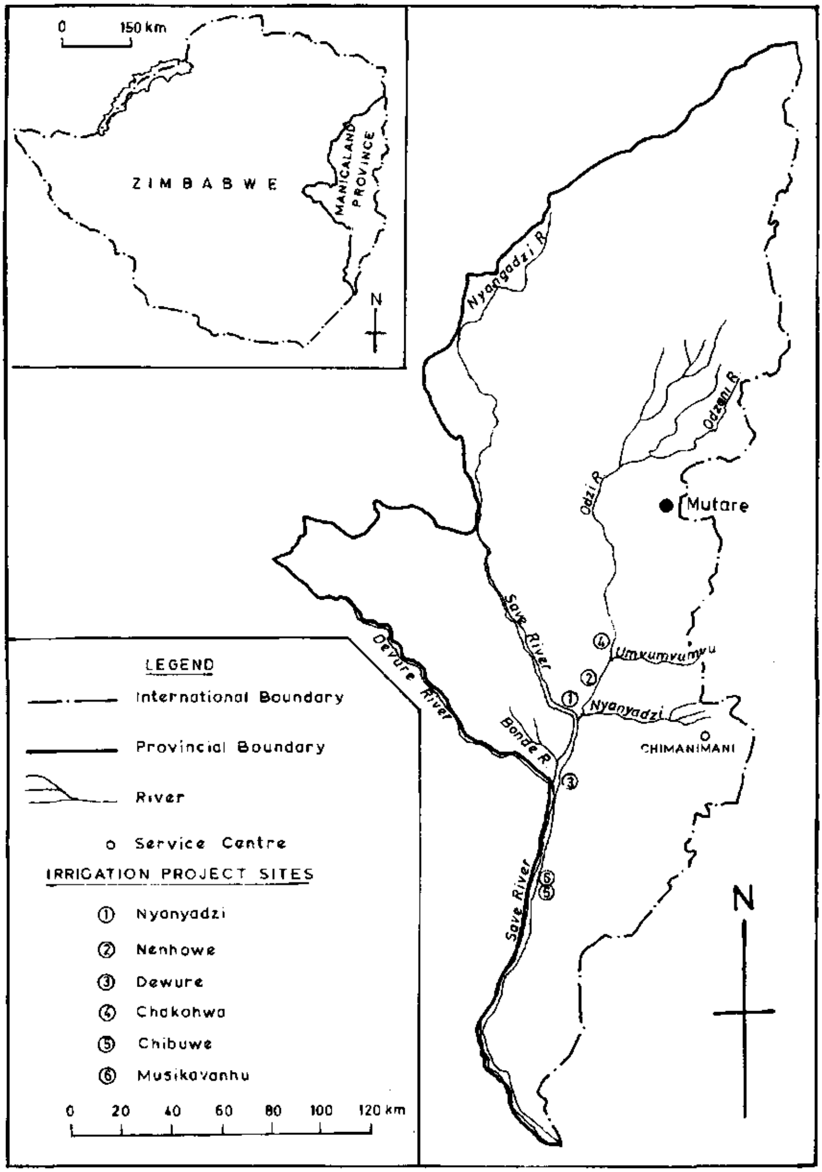
In assessing how the infrastructure influences water control, and in line with a socio-technical perspective to irrigation that has been adopted in this study, irrigation technology is not treated as a given. Technology is socially constructed (see chapter 1) and as such technology reflects certain societal dynamics. In this chapter the dynamics of interest revolve around operators, farmers and the design engineers. It is important to note that there is, however, little to no face to face interaction between operators and farmers on the one hand and design engineers on the other. The interactions are played around the hydraulic structures in place, or more specifically the technological repertoire, referring to canals, reservoirs, check structures etc (Treacy, 1994: 101). In this chapter hydraulic structures are analysed in relation to why they occur and where they occur, focusing on any detectable patterns *vis-à-vis* design protocols as well as usage of the structures. To this extent this chapter is not an evaluation of the hydraulic performance of the structures that are in place. There is however, reference to and explanations of relevant hydraulic terms.

The empirical material is based on case studies from Chibuwe, Musikavanhu, Nyanyadzi and Nenhowe irrigation schemes (see Figure 6.1). (Fuve Panganai was left out because of its unique technology while Mutambara was excluded because of its poor infrastructure, in terms of physical soundness). The schemes were chosen to capture any changes over time in the design and construction of hydraulic structures as well as to assess donor influence. The inclusion of donor influence was based on the fact that since independence, donor support to smallholder irrigation schemes in Zimbabwe (and in Africa in general) has been substantial (see chapter 2) and is likely to continue in the future. The case studies are preceded by a small discussion of the relationship between hydraulic structures and water control in section 6.1.

It will be concluded that despite the empirical differences *vis-à-vis* the structures found in the schemes, there is a common thread that links the different cases. Hydraulic structures in the four schemes demonstrate that institutionalization is at play. This refers to the fact hydraulic structures in the schemes are not a consequence of hydraulic logic *per se* but a result of socialization that gives rise to certain design protocols being established which tend to be repeated. The point to note is that it should not be assumed that the choice of hydraulic structures is purely a technical phenomenon.

[1] To emphasize the importance of water control, it has been said that water is '...an untamed and unpredictable substance that presents irrigators with hydraulic challenges' (Treacy, 1994: 109). This is all the more relevant given that farmers in smallholder irrigation schemes are closely hydraulic interdependent (Moore, 1989) since they share the same water source and irrigation infrastructure. This raises the challenge of how individual water entitlements are honoured in practice.

Figure 6.1 Location of Chibuwe, Musikavanhu, Nyanyadzi and Nenhowe irrigation schemes



6.1 HYDRAULIC STRUCTURES AND WATER CONTROL

6.1.1 Dimensions of Water Control

In irrigation literature the subject of water control enjoys a wide coverage. Mollinga (1998) has identified three dimensions of water control in the irrigation literature. First it is used to refer to physical control of water flow by means of irrigation technology, with emphasis on different methods of technical control of water. Second, from the irrigation management perspective, water control refers to managerial control of water distribution and related organizational issues. Third, water control refers to political control dealing with how power is wielded over access and utilization of water. In this chapter water control incorporates these three dimensions of water control. However, the main argument of this chapter is that there is a need to recognize the influential role played by institutions in the selection of hydraulic structures. In other words individual design engineers, by design or by default, do not have a *carte blanche* in the design process.

6.1.2 Hydraulic Structures in Water Control

Hydraulic structures have a bearing on the actual physical control of water, staffing levels and project costs (Horst, 1998). In general terms simple structures are easy to operate do not require much skill and demand fewer operating staff. Hydraulic structures also reflect different design schools in which the role of colonialism has been significant *(ibid.)*. Table 6.1 and Box 6.1 presents the types and functions of hydraulic structures that are relevant to this study. Hydraulic structures can be classified according to their functions namely water conyenance, flow regulation and flow measurement. In the assessment of the structures, this chapter, as already said, does not indulge in hydraulic analysis. It, however, makes reference to some hydraulic aspects of structures (see appendix 7).

Table 6.1. Types and functions of some hydraulic structures

Function	Name of Structure
Upstream water level control and discharge of excess flow	check structures, cross regulators, drop structures
Flow measurement	weirs and flumes
Flow regulation and measurement	headworks, offtakes, turnouts
Flow division and measurement	division structures, division boxes
Removal of excess flow	escapes, spillways

Source: Adapted from Boiten (1993)

These different structures, however, complement each other in their functioning. For example a canal, a prominent conveyance structure, functions together with at least two other structures, a regulator at the head to control inflow and an escape at the tail end to allow excess water to pass into the drainage system (Withers and Vipond, 1974).

6.1.3 Ensuring Water Control: Layout of the Physical Infrastructure

Two options are available as far as the physical manipulation of water is concerned: *simplification* and *modernization* (Horst, 1998; Plusquellec, *et. al* 1994). Simplification opts for structures that require fewer manual adjustments and fewer measurements e.g. proportional division and on/off structures. The simplicity of the structures, which is easily understood by farmers, renders the system transparent to all users. When water is scarce the simple structures allow farmers to devise equitable water sharing arrangements. Besides, any tampering with the structures is easily detectable. Furthermore, the structures can easily be made out of cheap locally available materials. Low maintenance requirements are also an advantage. In modernization, adjustable structures, that may include some form of automation, are used. These have the potential of being efficient but have the disadvantage in that they can easily be tampered with which is of practical consequence since the structures tend to be sensitive. Costs are also another disadvantage in relation to installation and maintenance. Further the systems do not lend themselves to easy interpretation by farmers.

Box 6.1 Some flow regulation structures and their functions

Head regulator: Structure at the beginning or head of the canal system meant to control and measure flow with a minimum of head loss. A head regulator can either be of the weir or the orifice/gate type
Drop structure is required to lose excess elevation in the canal system
Stilling basin is needed to dissipate energy before flow continues into a lower channel
Tail escape or end structure: Consists of a weir with free or inclined fall to a stilling basin at the end of drain bed
End structure is required at the end of the tertiary canal to convey any excess water safely into the drainage channels
Cross regulator/water level regulator: In the main canal the cross regulator is meant to control water level and measure flow; in a distributary canal it is meant for controlling the water level. Cross regulators are important when there is a change in hydraulic gradient or the canals are too long and too steep. In steep areas cross regulators are spaced close together
Offtake structures and division boxes: Structures meant to divide the flow
Sluice gate: A type of orifice widely used in smallholder irrigation schemes in Zimbabwe
Night storage dams are used as intermediate water reservoirs where delivery distances from the water source are too long. In some cases night storage dams are used as management tools where the aim is to have independent irrigation in the various sections

Source: Various

6.2 AN INVENTORY OF HYDRAULIC STRUCTURES

6.2.1 Methodology

The investigation into the type of structures was conducted in four surface irrigation systems, namely Chibuwe, Musikavanhu, Nyanyadzi and Nenhowe. The schemes were chosen to represent;

i. new scheme designed by Agritex – Nenhowe
ii. new scheme where a donor organization was involved in the design - Musikavanhu
iii. a scheme rehabilitated by Agritex - Chibuwe
iv. a scheme 'rehabilitated' by a donor organization - Nyanyadzi.

Table 6.2 contains some details of the schemes as at the beginning of 1996.

Table 6.2. Characteristics of selected schemes as at February 1996

Scheme	First operated in	Operational area (ha)/ no. of blocks	Source of water	Remarks
Chibuwe	1940	300/5	Save River	Designed and constructed by various govt depts
Musikavanhu	1994	72/1	Boreholes	Designed by Euroconsult and constructed by a private contractor
Nyanyadzi	1934	420/4	Nyanyadzi & Odzi rivers	Designed and constructed by various colonial and post-colonial govt depts. Rehabilitated by Hydraulics Institute, Wallingford
Nenhowe	1994	50/1	Odzi	Designed and constructed by Agritex

Notes
Chibuwe and Nyanyadzi schemes contain old and new sections. New sections are those containing structures that are similar to those found in the new schemes of Musikavanhu and Nenhowe.

Source: Field Notes (1996)

The starting point in data gathering was a familiarization tour of the schemes. Thereafter different canals in each scheme were followed to the end during which structures were observed, sketched and measured, in some cases. Observations of the type, construction details and the general state of the structures were made. Where possible observations on the actual use of structures was done. This was, however, compromised by incessant rains, which precluded any significant irrigation during the research period. The observations were complemented by interviews with different Agritex personnel. These included engineers, water bailiffs, extension workers and irrigation supervisors.

Relevant Agritex documents relating to the subject were consulted for clues on selection of hydraulic structures. These in the main were the Irrigation Manuals (Savva *et al,* 1991, 1994). Project documents for the scheme, where available, were also consulted.

6.2.2 Main Findings

A summary of the survey of structures appear in Table 6.3

Conveyance structures

Generally old sections of Chibuwe and Nyanyadzi irrigation schemes contained mainly rectangular, semi-circular and circular concrete canals as well as earth furrows. The presence of these predated Agritex's involvement in the design and construction of smallholder schemes in 1985, when it took over from Derude. In fact many of the canals were constructed before independence in *an ad hoc* fashion when smallholder irrigation fell under different departments such as Ministry of Internal Affairs and Native Department. It can be expected that the irrigation expertise was limited in such departments.

Table 6.3. Types of structures in Chibuwe, Nyanyadzi, Musikavanhu and Nenhowe irrigation schemes

	Chibuwe	Nyanyadzi	Musikavanhu	Nenhowe
Conveyance structures	Rectangular, semi-circular, trapezoidal concrete canals, earth furrows	rectangular, semi-circular, trapezoidal concrete canals, earth furrows	trapezoidal concrete	Trapezoidal concrete
Head regulators	Sluice gate	sluice gate	fayoum weir	sluice gate
Offtake structures	Duckbill weir without draining holes, long weir with sluice gates	duckbill weirs without draining holes, long weirs, division boxes with sluice gates	fayoum weir	Duckbill weirs with draining holes, long weirs, division boxes
Drop structures (with sunken or unsunken stilling basins)	Sunken	sunken	N/A	Unsunken
Measurement structures	cut throat flume, V-notch	rectangular thin plate weir, V-notch, sluice gates	V notch	Parshall flume
Night storage dam	no	yes	yes	Yes

Source: Field notes

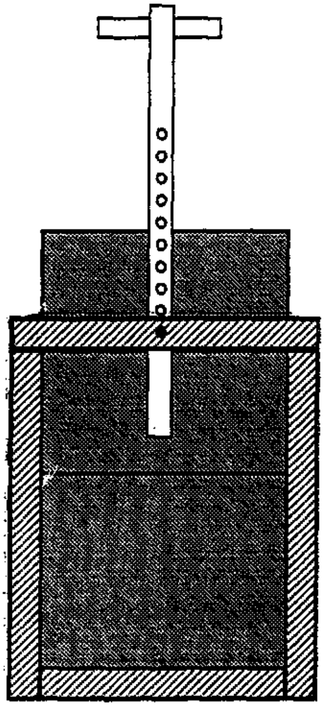
In newer sections of Chibuwe and Nyanyadzi, as well as in Musikavanhu and Nenhowe, trapezoidal canals were in place. Trapezoidal canals seem to have become the preferred type of canals. It is, however, significant that the Agritex Irrigation Manuals do not enter into discussion regarding the issue of canal choice. In an interview, a senior Agritex engineer expressed misgivings concerning the ability of the Agritex Construction Unit to properly construct trapezoidal canals.

The only documented reference as to why the trapezoidal canals were preferred was provided by Ball (1978, 1983). This had to do with the ease of construction (see next section) facilitated by the prefabricated steel frames that could be used as templates during construction. It is, however, important to note that some trapezoidal canals have become standards in Agritex-designed schemes since some of them are referred to as the 'Agritex canal' (see Savva *et al*, 1991, 1994). Most canals were lined, which was a common practice in Zimbabwe as a means to cut down on water losses (Bolton, 1989).

Flow regulation structures

Head regulators: The type of head regulators commonly found was the undershot or (sluice) gate rather than the weir type. Figure 6.2 shows a typical sluice gate. The exception was Musikavanhu, which had a fayoum weir as a head regulator (Figure 6.3). This was also meant to divide the flow to the various sections of the block. This latter function was, however, compromised because submerged undershot gates (on and off gates) which had been ordered for installation were not available from the manufacturers, Metfab in Bulawayo. These were used in conjunction with free flow ones contrary to design specifications, which materially changed the hydraulic behaviour of the system. This was the explanation offered by the expatriate design engineer.

Figure 6.2 A typical sluice gate



Various Agritex engineers are not in agreement about the effectiveness of the system in Musikavanhu. One view is that, strictly speaking, the structures that were installed were not really fayoum weirs. One other view is that the *on demand* system as per the design, based on water flowing through all the canals all the time (hence the smaller canals), was based on unrealistic assumptions. For example at times fewer than anticipated farmers turned to irrigate which resulted in water wastage. There is another view that the system is all right -it is only the variable discharge from the boreholes supplying Musikavanhu that are a problem.

The presence of fayoum weirs in Musikavanhu needs further comment. During the construction of the scheme it was claimed that this was an Agritex-designed scheme with help from the expatriate engineer. However, today it is commonly accepted this was designed by the Euroconsult engineer. (Euroconsult was the company that was chosen to design the scheme by the funding organization, the European Union). This seems to be the correct version of what transpired. For example there is no scheme designed by Agritex where fayoum weirs were installed. Secondly Euroconsult is known to have designed a scheme with similar structures in Egypt. It takes no stretch of imagination to conclude that this was a question of somebody treading on familiar grounds. It is therefore safe to assume that the concerned Euroconsult engineer 'transplanted' it from one of their projects in Egypt.

Figure 6.3a The headgate in Musikavanhu (isometric)

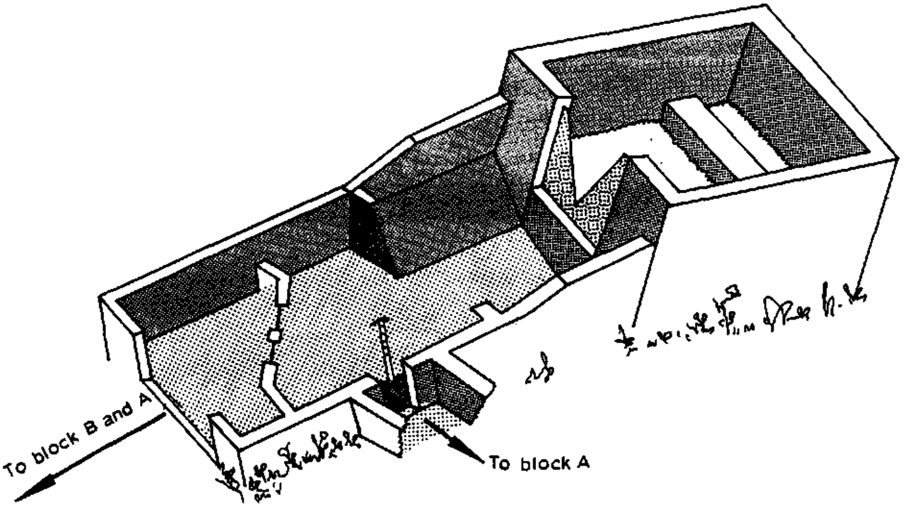
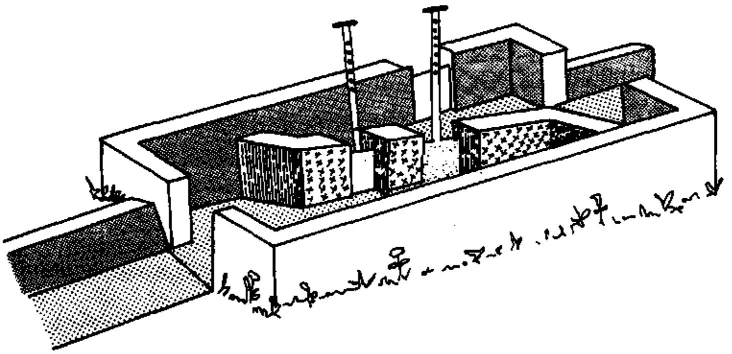


Figure 6.3b The headgate in Musikavanhu (side view)



Drop structures: Drop structures in the schemes included those with or without sunken stilling basins. Sunken basins are effective energy dissipators, which help in reducing erosion of channels. However, sunken basins pond water, which creates health problems as ponded water forms a breeding ground for mosquitoes and bilharzia parasites. The origin of these health concerns was Mushandike Irrigation Scheme in Masvingo province, where there was special emphasis on the issue of how hydraulic structures influenced health aspects. The project had the objective of coming up with suitable hydraulic structures to reduce bilharzia and malaria problems by eliminating standing water in the canals (Bolton, 1989). (Suggestions of totally changing the structures were shelved because water control would have been very difficult. Instead the 'traditional' structures were retained and improved by puncturing holes to facilitate drainage.). In general Nenhowe and Musikavanhu had drop structures without sunken basins and were free draining. Old sections of Nyanyadzi had drop structures with sunken stilling basins. Figure 6.4 shows the two types of drop structures.

Offtake structures and division boxes: The most common method of diverting flow from the parent canal to another or from a canal to the field was by means of sluice gates in combination with duckbill or long weir cross regulators (Figure 6.5). Apart from diverting the flow of the parent canal to the tertiary canal the structure, this also served to reduce variation in water depth in the parent canal so that the abstracted discharge would be more-or-less constant for a given gate opening irrespective of the flow in the parent canal (Bolton, 1989).

Across irrigation schemes there was no discernible pattern concerning the structures. This observation held even for Agritex-designed schemes. The rehabilitated portion of block C in Chibuwe was such a case. The portion was fitted with old on-and-off gates (salvaged from the destroyed canals) instead of the more common sluice gates.

Nenhowe, however, had slight but important differences. The duckbill and long weirs had holes punctured at a certain portion along the perimeter (Figure 6.6). The holes were meant to make the structures free draining to cut down on bilharzia and malaria incidence.

Apart from the structures illustrated in Figures 6.5 and 6.6, division boxes were also used to divide the flow (Figure 6.7). Old sections in Chibuwe and Nyanyadzi had more division boxes than new ones while the offtakes shown in Figure 6.6 were preferred in the new schemes. In Musikavanhu and Nenhowe and, in the new sections of Chibuwe and Nyanyadzi, division boxes were used on a limited scale. Invariably these were free draining.

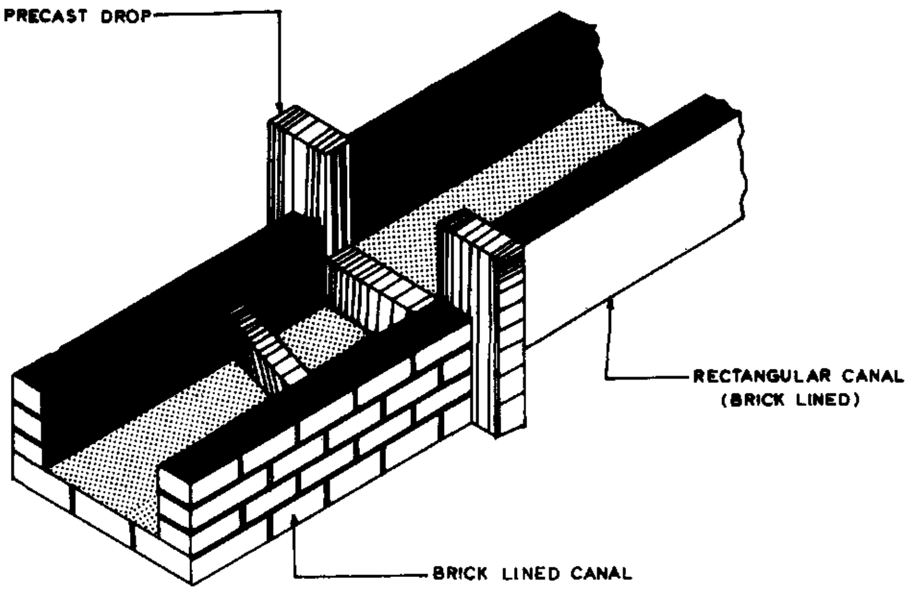
Tertiary checks: In all schemes there were no tertiary checks (end structures) except Musikavanhu where the rubber checks were in place. In Chibuwe a few concrete ones were tried in block C. This was discontinued because of lack of money to fabricate them. The lack of tertiary checks affected water usage as water was lost at the end of the canals. Instead soil was used to check the water by damming up the water in order to create the necessary head. This contributed to siltation of canals.

A striking finding was that the measuring structures were not used as expected including in Nyanyadzi where detailed guidelines were produced by the United Kingdom based Wallingford Hydraulics Research Institute (Lewis,1984). The unavailability of rating tables did not help the situation either.

Ironically there was a high usage of sluice gates for water measurement (which is significant given that the sluice gate is really not a flow-measuring device). This was used by the low ranking Agritex staff, the water bailiff, as well as by farmers. The use was, however, not according to strict hydraulic principles although these were taken into account implicitly. Water bailiffs and farmers used the principle that a flow passing when a gate was set at the first notch/hole one hole was equivalent to one farmer while two notches/holes represented a flow adequate for two farmers. As reported in chapter 4 close observations revealed that the one notch one farmer principle was not strictly adhered to.

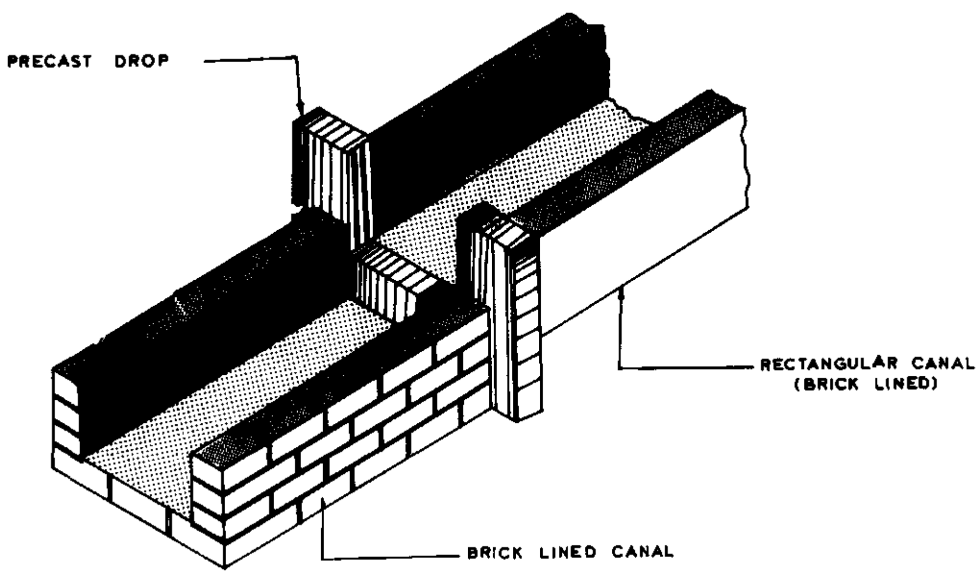
Figure 6.4 Types of drop structures

DROP STRUCTURE WITH A SUNKEN BASIN



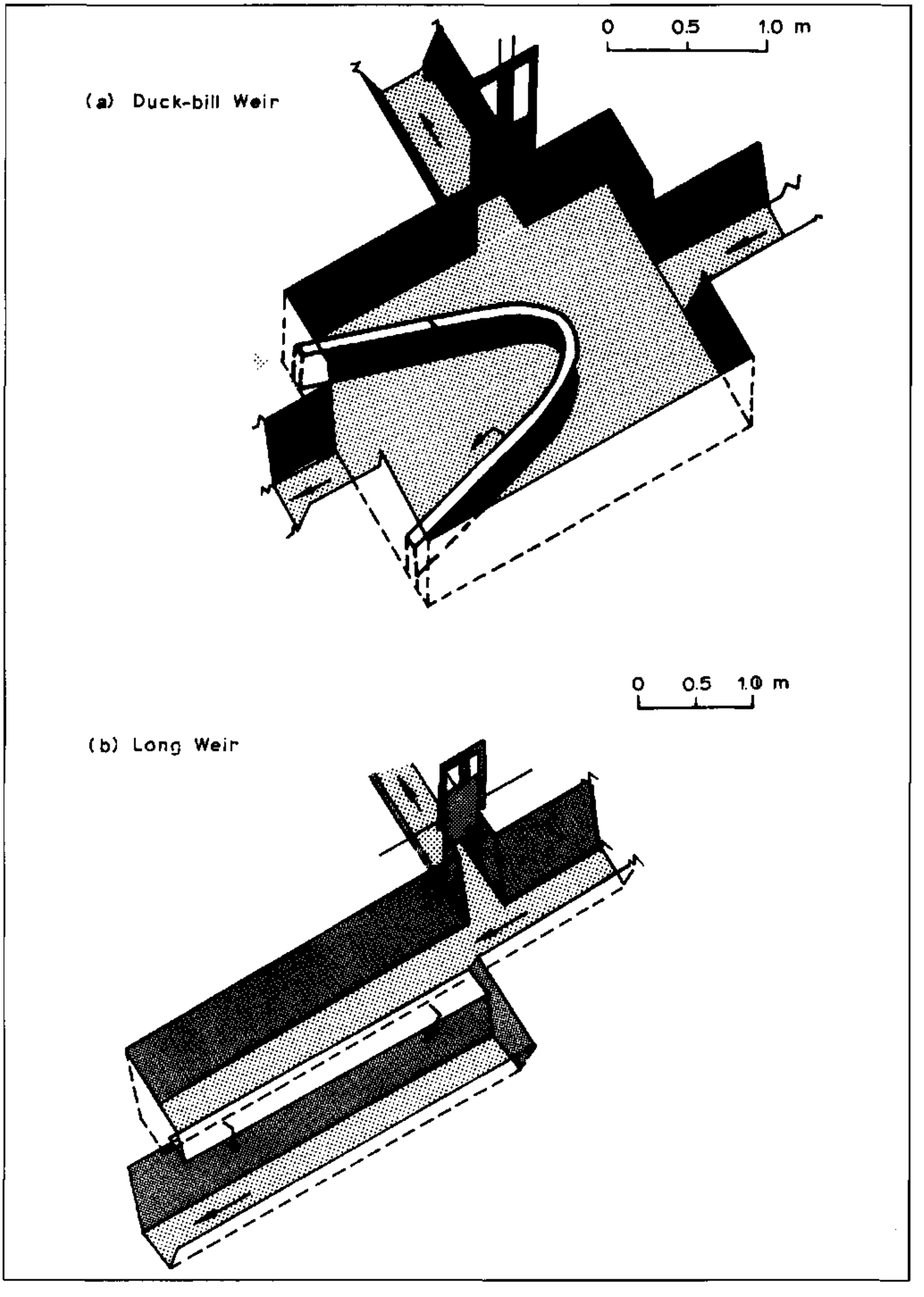
Isometric view of canal line with precast drop structure with a sunken basin. (not to scale).

DROP STRUCTURE WITHOUT A SUNKEN BASIN



Isometric view of canal line with precast drop structure without a sunken basin. (not to scale).

Figure 6.5 Commonly used offtakes in Zimbabwean smallholder irrigation schemes



(Source: Bolton, 1989)

Figure 6.6 Offtake structures with holes in Nenhowe irrigation scheme

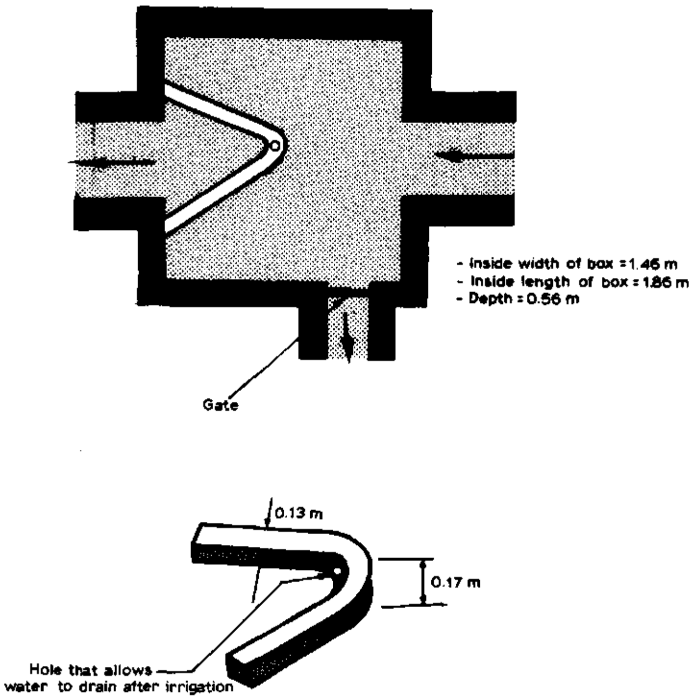


Figure 6.7 Typical division boxes in Zimbabwean schemes

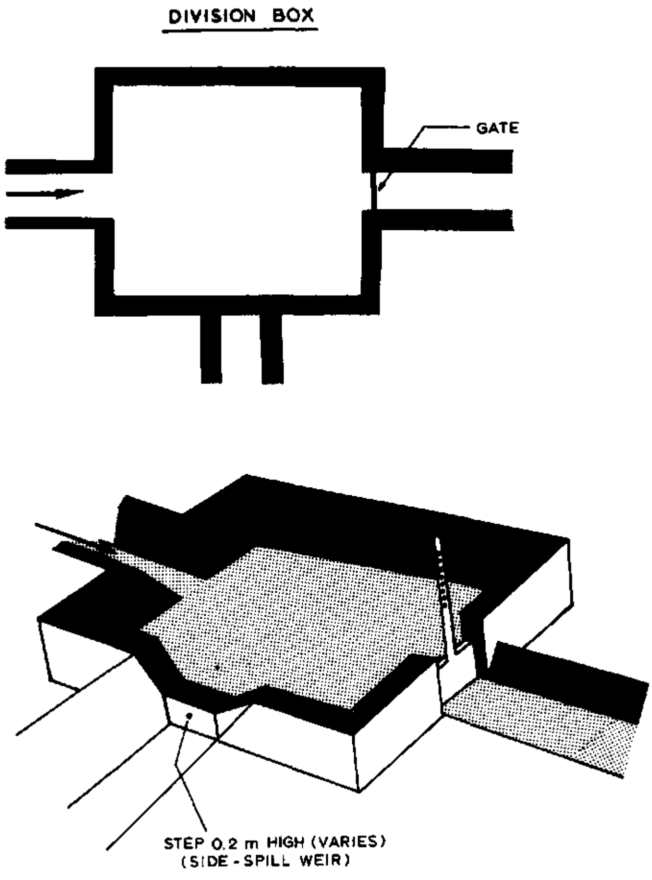


Figure 6.8 Common water measurement structures in Chibuwe, Nyanyadzi, Musikavanhu and Nenhowe schemes

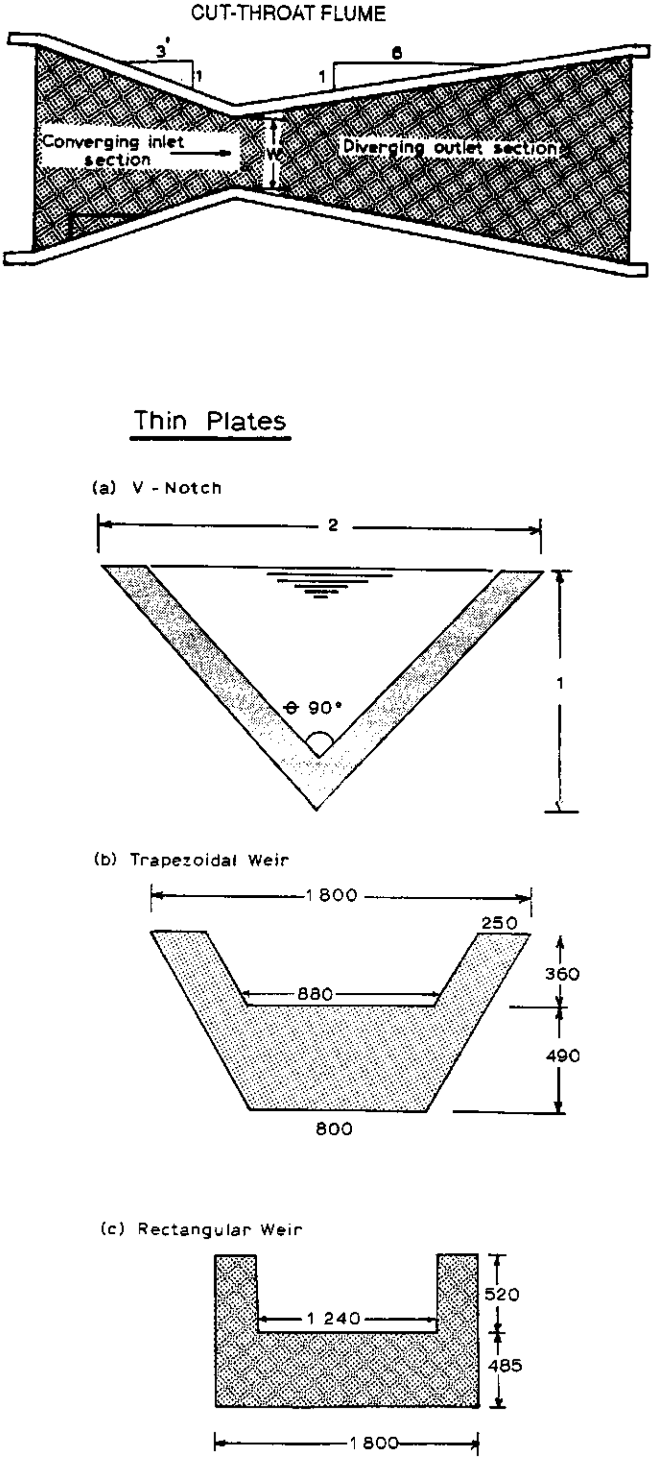
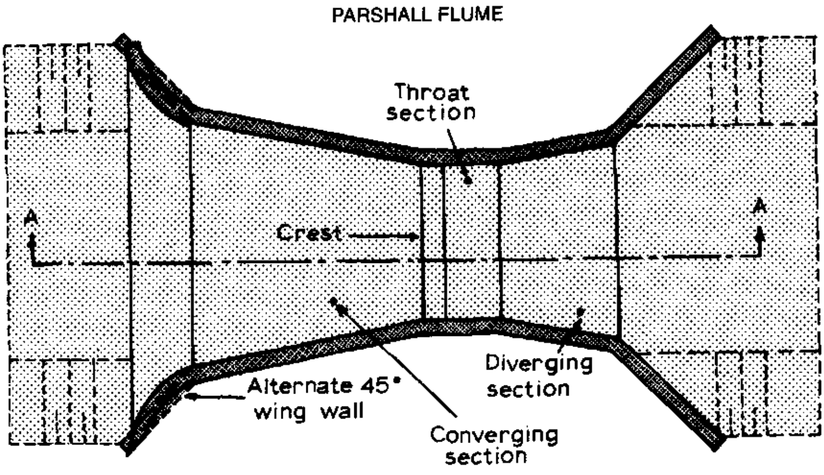


Figure 6.8 Common water measurement structures in Chibuwe, Nyanyadzi, Musikavanhu and Nenhowe schemes (continued)



6.2.3 Summary

It is difficult to say that there were any definite patterns with regards to hydraulic structures *vis-à-vis* smallholder irrigation in Zimbabwe. However some trends were observed:

- Trapezoidal canals were the favourite type ostensibly for ease of construction;
- Lining of canals was encouraged to stem water losses;
- Duckbill and long weirs in combination with sluice gates were the common offtake structures. A number of division boxes were present with the new schemes or new sections of old schemes containing free draining structures;
- Measurement structures included V notches, cut throat flumes and Parshall flumes. There were no obvious patterns or explicit reasons for choosing any of these;
- Presence of measurement structures such as the flumes and V notches was not matched by the actual use of such structures, for no known reason. However junior staff used some structures according to their own understanding;

From an operational perspective it can be said that there were some gaps *vis-à-vis* the choice of the hydraulic structures. That is to say it was not clear why particular structures were chosen. The Agritex Irrigation Manual did also not shed any light: all structures were mentioned without any recommendation as to which was more suitable from an operational perspective. It can also be said there appeared to be no national standards in place, which because of Agritex's prominent role, could have spearheaded. However there were some common developments e.g. preference for lined trapezoidal canals and the incorporation of free draining structures. We also saw that donor involvement in Musikavanhu vitiated any (small) patterns of standardization of technology choice that were emerging. In the concluding section it will be argued that this institutionalization of certain structures plays a more critical role in the choice of hydraulic structures than has been hithero thought.

6.3 OPTIONS AT THE GATE: ALTERNATIVE USES OF THE SLUICE GATE

A look at how hydraulic structures are designed, manufactured and used is important. It may give insights to the engineering profession on how users conceptualize different technical devices, which can be used to design user-friendly structures. Using the case of the sluice gate, which is used in both small and large[2] irrigation schemes in Zimbabwe, this section demonstrates how technology is influenced by local socio-economic considerations rather than by a technical logic (which challenges the notion of technology determinism).

6.3.1 The Options

The 'design' and manufacture of the sluice gate

The 'design' of the sluice gate, commonly used in smallholder irrigation in Zimbabwe today, can be attributed to an engineer called J.S. Ball, who served as an Irrigation Specialist in the Department of Conservation and Extension Services (CONEX), a department which served white farmers[3] in colonial Rhodesia (now Zimbabwe). As Ball shows in an article *Design and Construction of Screeded Concrete Irrigation Furrows*, written in 1973 and 'revised' in 1983, the design of the gate was incidental to the design and construction of furrows as 'the gate (.....) was designed to fit the furrows described' (Ball, 1973: 5). In order to understand the frame of mind, which brought about this gate, it is necessary to examine the ideas underlying the design and construction of Ball's concrete irrigation furrows'.

Ball used the workshop facilities of Metfab (Pvt.) Ltd., a metal sheet fabrication company in Bulawayo where he was based, 'to develop the equipment'. His goal in doing the exercise is given in the opening sentence of his article,

> The cost of constructing lined furrows leading into surface irrigation systems can account for up to $70 per hectare in capital cost; it is therefore essential that detailed survey work and design works precede(s) the installation of any permanent structures.

Having pointed out that construction costs were uppermost in his exercise, he in subsequent paragraphs, gave more details as to how his aim was to be achieved. Firstly he concentrated on choosing a canal that was easy to construct. The 60° trapezoid canal was recommended as it 'proved easier to construct (the narrowest invert, 250 mm, could easily be cleaned with a shovel) with a smooth finish than round to parabolic shapes'. As for canal dimensions the recommendation was a flow depth of 300mm plus a freeboard of 50 mm, with invert widths of 250 mm, 300 mm, 375mm and 500mm respectively depending on the capacity required. The depth of 350mm was chosen because 'this total depth of 350mm is easily reached by labourers while placing concrete, keeps the embankments small, provides an adequate siphon head and gives efficient flows within the given range.'

[2] Here large refers to three commercial sugar estates two of which are over 8, 000 hectares in extent. In the context of Zimbabwe these are quite large given that the average scheme size in the communal areas is 43 ha (see chapter 2).

[3] Black farmers were serviced by a separate department, the Development of African Agriculture (DEVAG) which fell under the Ministry of Internal Affairs. After independence in 1981 CONEX and DEVAG merged to form Agritex.

He advocated that the same depth in the canals was to be maintained in all cases;

> By varying invert width only and not depth, transition from one section to another is simplified. This involves no loss of head, and also overcomes the need to make an allowance when pegging the canal invert; a streamlined transition over 2 m results in smooth flows.

The dimensions of the sluice gates had some relationship with the dimensions of the canals because 'canal gates were designed to fit the furrows described'. The gate was designed using the dimensions of 325mm wide by 300mm deep. It was, however, not made clear how the gate would fit in the other canal sizes, i.e. the 250mm, 375mm and 500mm wide canals. It was only the 300mm wide canal whose width somewhat resembled the width of the gate under discussion. The only reference as to how the gates could be installed in wider canals was that 'for larger flows two or more gates are used side by side .... cheaper than having special gates made up. The cost was given as '$6 ex-Bulawayo'.

It was said that ' it (the gate) passes 0.1 m^3/s with a 300mm head'. The basis of these figures was not given. Ball did not change the 'design' of the gate between 1973 and 1983 when he undertook a 'revision' of the original article. Since Ball left, the only changes that have been made to the gate relate to its dimensions. Metfab, who are today the main suppliers of the gates, manufacture them in widths of 250 mm, 300 mm, 460mm and 500 mm. The basis of the 'new' depth of 610 mm, which is now common to all gates, is not known. The gate has equidistant (about 25mm apart) holes which makes the gate "adjustable and lockable" (Ball, 1973, 1983). It is not clear whether the number of holes have changed from the original 'design' as Ball writes of gates "being lockable in 12 positions", while in irrigation schemes such as Chibuwe gates have 16 holes.

Metfab confirmed the importance of Agritex as a major client of the gates and also that very few changes have been incorporated into the present gate. According to the Works Director of Metfab, the gates were a small part of their activities. He explained that

> The first gate was manufactured about 25 years ago as a result of co-operation between Conex and the company. Nothing much has changed about the gate. The changes we have incorporated are those suggested by Agritex which mostly relate of the size of the gates. The distance between the holes/notches has not changed as well as the (2 mm) thickness of the steel used. The company can manufacture any size of gate depending on orders. However, we mostly manufacture "standard"[4] gates which are 250, 300, 460 and 500mm wide, with 610mm being the common depth and the prices per unit being Z$250.30, Z$320.85, Z$383.54 and Z$407.82 respectively. This metallic gate is useful because it is suitable in rural areas where there is no need for sophisticated gadgets. You can also use it to let out a certain amount of flow[5]. The gate can last a lifetime as it has little if any maintenance problems. The company also manufactures canal formers and check plates (or templates). Canal formers and check plates are mostly sold to Agritex. Canal gates are sold to individuals and Plate Glass company for resale to individuals, and to other concerns in the Lowveld, such as Hippo Valley. By far our major client is Agritex who buy about 40 to 60 gates per year in multiples of 20. In some years Agritex does not order anything though.[6]

How did the company envisage how the gate would be used? He stressed the importance

[4] This refers to those with widths coinciding with Agritex's canals.

[5] He could not tell what that flow was in figures.

[6] Field notes 3/1/95

of practical knowledge, as through practice, farmers can know to what extent to open the gate to let out what amount of flow for what purpose. He warned of the danger of being too theoretical;

> You may have the theoretical knowledge about how much water is required by the crop, but you can with that knowledge, open that gate too much and flood the field while a farmer with experience knows to what level to operate that gate. You see, hydraulics will never come into the practical situation[7].

There is evidence that the sluice gate was used elsewhere in the country before Ball 's 'design'. In Triangle the researcher was presented with a diagram of the sluice gate dated 1959, which was apparently was in use then. It could therefore be that Ball copied the sluice gate from there.

As for the manufacture of this early gate in Triangle, it could have been done locally at the estate as Triangle still fabricates its own modified Neyrpic gates as reported later. In Hippo Valley the gate is widely used but the historical account is not known.

Different uses of the sluice gate

After looking at how the sluice gate was 'designed' and how it is currently manufactured, attention is now turned to how it is used. Four scenarios are described. The first two cases refer to Agritex-managed schemes. The third 'scenario' is Hippo Valley Estates, a private sugar estate 8,000 ha in size where the sluice gate is in use today. Reference is then made to Triangle Sugar Estates of similar size to Hippo Valley where the gate has been discontinued or rejected[8]. The other case is Mkwasine Sugar Estates, 4,000 ha in size that is jointly owned by Hippo and Triangle where the gate is used in half of the irrigated area.

Junior staff experiment in Agritex schemes: Junior staff in Agritex schemes have tried to make sense of gate settings in relation to day to day water distribution. The water bailiff was practically left to his own devices as neither the extension worker or the supervisor at the scheme level, or the district extension officer, provincial extension officers or irrigation specialists assisted in this regard. Over time a maxim (in the world of the water bailiff) developed; one notch one farmer, meaning that water flowing through one hole is enough for one farmer. Hydraulically speaking this cannot be true since this depends on whether the gates are submerged or free flow. However close observation of the practices of one of these water bailiffs in Chibuwe revealed that this was not the case; it was only discourse (see chapter 4). In reality only a few notches were used. The rest were more of a temptation to farmers to want to increase the supply of water reaching them.

Gate movements were thus a shorthand developed by the water bailiff to 'work out' a gate adjustment programme that took account of the head in approach canal, the fluctuating water levels and the installation characteristics of the gate. These complex movements were also appreciated by farmers who shared the intimate knowledge of the way individual gates behaved, especially those that affected them.

Thus the water bailiff had over time learnt the behaviour of the individual gates. With no apparent support from the superiors, this system was working because the water bailiff, as a frontline worker, had to make do as he needed to justify his worth to his employer as well as to farmers. In relation to farmers, there was a common understanding where his gates movements were a means of communicating with farmers how water was being distributed.

Outside help fails: As said before the Hydraulics Research (HR, Wallingford, and UK) is one institution that attempted to come to grips with the hydraulics of the sluice gate. The attempt at Nyanyadzi had this objective

---

[7] Field notes 3/1/95.

[8] I have no good information on when the gate was rejected.

> to collect basic data on the performance of a typical irrigation scheme ... information will be used in two ways; firstly to identify how the day-to-day running of the Nyanyadzi scheme could be improved, and secondly for the design of smallholder irrigation schemes many of which are to be installed throughout southern Africa in the future (Lewis, 1984: 1).

To this end *in situ* calibration of the sluice gate was undertaken (alongside other structures e.g. thin plate weirs). In Nyanyadzi two types of the sluice gate were identified; the screw-operated and the other with peg-in-hole lifters. Screw-threaded gates were set in either a (brick or lined) rectangular channel or earth bunds. The second type, identified as the "standard field offtake gate" (operated by peg-in whole lifters with sixteen hole spaced at 0.024 m which allow 16 different gate settings), was associated with concrete-lined trapezoidal canals which were quite common.

The second attempt by HR was at Mushandike Irrigation Scheme in Masvingo Province. In 1988 a small investigation on the hydraulic performance of the gate was undertaken. There was no direct interest in the gate itself, but in designing free-draining structures that would cut down on schistomiasis incidence (see above). It was observed that the gate was commonly used in the country in combination with duckbill weirs and long side weirs. According to Bolton (1989) there were problems in using the gate in combination with duckbill weirs or long side weirs. Firstly the duckbill and long weirs tended to pond water which increased the chances of schistomiasis. The gate was also susceptible to being drowned which 'complicates the introduction of a simple relationship between the gate opening and discharge to enable quantification of supply.'

HR's work in Nyanyadzi has apparently not found application in Chibuwe even in Nyanyadzi itself. The supervisor in Chibuwe, who was present during the work in Nyanyadzi before his transfer, was still searching for answers concerning gate settings.

The sluice gate as a tap in Hippo Valley: The agricultural manager of Hippo Valley Estates said that they used to buy sluice gates from Metfab as a "tap or valve" as they used it in combination with a Parshall flume (locally fabricated) downstream of every gate. He explained that the operator fiddled with the gate until the right discharge (read off the Parshall flume) was achieved. For this the operator relied on his experience. Once the right flow was achieved that position would be secured by a lock. The flow that was let out by each gate was normally fit for 21 siphons which was the number of siphons used by one irrigator. The organization in the estates meant that it was easy to use the sluice gate as a discharge regulator.

The sluice gate fails to impress in Triangle and loses ground in Mkwasine :In Triangle the story was different. The agricultural technical manager explained that the sluice gate used to be use in Triangle. Its use was discontinued. The major objection to the gate was its propensity to let out non-modular flow.

As an alternative Triangle opted for a structure that would give modular flow. A local modified Neyrpic gate was devised. This gate was calibrated *in situ* using a 45^0 V notch weir. The improvised Neyrpic gate, it was claimed, depended on visual assessment for its operation because of the preset markings, which corresponded to certain flows. In the field one irrigator was said to use 21 lps, although flows of 14 lps were preferred especially in earth furrows. To cater for all field possibilities three types of gates with discharges of 14, 21, 28 lps; 28, 35, 42 lps and 28, 42, 84 lps were designed respectively. The manager also said that the modified Neyrpic gate was becoming popular with Mkwasine who were now replacing the sluice gate. He estimated that half of the scheme was now using the modified Neyrpic gate. Over time the scheme was likely to phase out the sluice gate.

6.4 CONCLUSIONS

The empirical evidence indicates that operational aspects of hydraulic structures, dealing with how operators and farmers were to use the infrastructure, did not receive adequate attention from designers of smallholder irrigation schemes in Zimbabwe, be they nationals or expatriates. There were four main reasons responsible for this state of affairs. First, because of a general lack of focus on operational aspects of irrigation management, there was no due regard paid to the operational implications of the structures. Second, and related to the first point, there was generally not much debate about issues facing smallholder irrigation in Zimbabwe which meant restricted sharing of knowledge. Third, where operational aspects were considered, this tended to be cast from the perspectives of design engineers rather than farmers as was the case in Musikavanhu. As a consequence operators and farmers did their best to fill in the gaps. The use of the sluice gate as a measuring device by the water bailiff and farmers in government-managed schemes is a case in point. (There was also a paradox in that the designated measuring devices in the form of cut throat, Parshall flumes and V notches were neglected in favour of the sluice gate.) Fourthly, the involvement of donors tended to disrupt whatever patterns were being established. These points will be briefly expanded below and also in chapter 7.

These pragmatic observations, however, leave us with no clue as to why such operational aspects of irrigation management were not adequately covered. It is suggested here that this can be better understood if we apply the notion of institutionalization. Institutionalization refers to the fact that any repeated human action is frequently cast into some pattern or habit, which can then be reproduced with minimum and economic effort in the future (Berger and Luckmannn, 1966). Institutionalization explains that human action is determined not always by rational action but sometimes by mundane things like getting used to certain protocols. For example, there is no design engineer who during designing starts from scratch by verifying Manning 's formula, for example. This observation assumes greater significance when the empirical evidence is viewed from this perspective.

When Ball chose the trapezoidal canal with a 60° inclination, and fabricated the appropriate steel frames, he unleashed unknowingly the institutionalization of the 60° trapezoidal canal. The result was that subsequent designers did not need to start from scratch. Reference to the 'standard Agritex canal' supports this assertion. But the institutionalization of the trapezoidal canal also gave birth to the usage of the sluice gate, which could not have been institutionalized without the involvement of Metfab, the fabricating company in Bulawayo. However the insitutionalizaion of the sluice gate had undesirable consequences. Because the sluice gate was now a norm, Metfab did not entertain any changes to their institutionalized product. As such the functioning of the fayoum weir in Musikavanhu scheme was compromised because Metfab was not in a position to fabricate a new gate, according to the claims of the design engineer.

It is suggested that there is a need to view insitutionalization as part of the socialization processes that happen in organizations. The argument of institutionalization as part of an organization's culture can be supported by a number of observations. Agritex's Irrigation Division is largely a design rather than a management outfit. The Irrigation Branch does not, for example, have its own staff at the field level to oversee the operational aspects of its designs. That job is left to the Field Branch staff who are largely trained in extension. It is no surprise therefore that operational aspects of irrigation management fall into no man's land.

The intention of Wallingford Hydraulics Institute, as an organization, towards producing quantitative data that could be 'replicated in Africa' resulted in a lot of calibrations and guide lines for measurements which did not last beyond the life of the project. The reference to ideas being institutionalised shows us that there can be a linkage between ideology and institutionalization (see chapter 7). It should also be clear that there seemed to be some competition between ideas or artefacts, resulting in some artefacts or ideas being more institutionalized than others should. Power relations have something to do with it as discussed in chapter 7.

But Agritex had no free hand in the schemes. Donors had a hand in this as they, through their appointees, determined what was prioritised in some of the schemes. The case of fayoum weir in Musikavanhu is a case in point. This particular structure, the only one of its kind in Zimbabwe, as far as could be ascertained, was there because it was 'transplanted' from Egypt where the company to which the design engineer belonged, had been involved. While this may be unfair, available evidence points in this direction.

After dwelling on theoretical aspects regarding why operational aspects of irrigation management are often overlooked, a pragmatic point can be made. Designers should give explicit reasons behind the choice of the structures. It should be clear whether a structure is being chosen for its hydraulic performance, economy of construction or ease of operation. Designers should also consider how the ultimate users, the operators and farmers, are going to use them. Questions like; do the operators and users have the expertise skills to use them or do the structures fit within the general framework of operation, need to be answered. Their appropriateness to the supply of water at the source and costs to farmers of operating them is also relevant.

7 IDEOLOGICAL PURSUITS

The case of block irrigation[1]

This chapter continues the investigation into the lack of focus on real operational needs of smallholder irrigation schemes in Zimbabwe. It uses ideology as a point of departure to explain differences between state officials and farmers -the two main groups of actors in the schemes regarding the conceptualization and execution of some crop and water management aspects.

The promotion of 'block irrigation' is used as a case study to explore the rationale of state officials who promote it and the challenges facing operators and farmers who have to implement it. State officials regard block irrigation as the epitome of scientific farming. The cornerstone of block irrigation is said to be 'scientific' irrigation scheduling. Irrigation scheduling is concerned with the accurate determination of when and how much water to apply to maximise crop production and /or profit while maintaining a reasonably high irrigation efficiency (Pereira, 1996: 91; Burt, 1996: 273 van Hofwegen, 1996: 325; among others). Other related advantages of block irrigation are said to be better pest and disease control, implementation of crop rotation (to ensure soil fertility) and co-ordinated marketing of crops. It is significant that the block irrigation has not been critically examined to determine its advantages as well as its applicability in smallholder irrigation schemes. This is the task of this chapter. This chapter will show that these assumed advantages amount to ideological pursuits when juxtaposed to the operational reality in smallholder irrigation schemes. There are two main reasons why this is the case.

First, the agronomic concept of irrigation scheduling, which focuses on soil-water-plant relationships and efficiency considerations (Horst, 1996: 297), is emphasized to the detriment of two other important concepts of irrigation scheduling, namely the water delivery engineer's concept (Burt, 1996) and the institutional concept (van Hofwegen, 1996: 325). The water delivery engineer's concept of irrigation scheduling is about developing and implementing a schedule of deliveries which is compatible with the water delivery system's capabilities and constraints (*ibid.*). Both the agronomic and water delivery engineer's concepts presuppose a set of rules and regulations, which govern water distribution. This normally reflects the social arrangements and power relations among and within communities, their water entitlements and their capability to adjust to their socio-cultural environment. This is the institutional concept of irrigation scheduling. Unfortunately only agronomic irrigation scheduling is considered in block irrigation. This is worsened by the lack of consideration of preconditions that guarantee successful on-farm irrigation scheduling. These preconditions include a) reliability of water supply to make crop-based irrigation scheduling a reality b) predictable delivery schedules and c) infrastructure, which ensures flexibility in water supply that in turn ensures farmers' room for manoeuvre.

The chapter identifies unequal power relationships between the state and the farmers as the reason why state ideology thrives at the expense of reality. That is to say without relying on institutional power, it is doubtful that the state would persuade farmers to take up block irrigation on its own merits. This is related to the broader issue of governance in smallholder irrigation schemes, and in particular to the degree of state accountability to farmers. This is why farmers regard block irrigation as nothing more than state overbearance that jeopardizes their farming enterprises and livelihoods. As such it is often resisted by farmers who seem not to see its advantages. Some farmers tend to view it as an attempt to force them to grow crops or crop combinations which are not of their choice. In 'old' schemes where block irrigation is implemented and reorganization of plots is necessary, block irrigation is seen by farmers as an

[1] Parts of this chapter were published in earlier version (see Manzungu, 1996b).

official mechanism designed to dislodge them from their fields, which they have so long tended. This underlines the importance of understanding the modes of domination in water management.

The evidence presented in this chapter was gathered from Fuve Panganai and Chibuwe irrigation schemes. In Fuve Panganai block irrigation was instituted in blocks B, C and D when cultivation commenced (see chapter 3). In Chibuwe there were attempts to introduce block irrigation in 1995. The rationale, central tenets and the operational and managerial requirements of block irrigation are described before presentation of the empirical material.

7.1 THE RATIONALE OF BLOCK IRRIGATION

Block irrigation was introduced in smallholder irrigation schemes in Zimbabwe as a mechanism to save irrigation water by using it efficiently. This was to be achieved through scientific irrigation scheduling. Irrigation scheduling is applicable within certain narrowly defined parameters. First, the crops must be in pure stands. This explains why, in block irrigation, farmers are required to grow the same crop in one stretch of land. Second, the crops must be planted at the same time in order that management operations are synchronized. Consequently crops belonging to different farmers are treated as one crop as far as irrigation scheduling and other related management aspects are concerned. It will be argued below that this seemingly 'simple' synchronicity in planting crops is organizationally and managerially complex.

The emphasis on using water 'efficiently' is however not misplaced. Water scarcity remains a perennial problem for many irrigation schemes in Zimbabwe. The fact that poor water use is cited as one common problem in the schemes exacerbates the situation. Water is reportedly lost during conveyance, distribution and application in the field. The cited causes of this problem are varied. Most of the losses are said to be at or below the field channel gate (Pearce and Armstrong 1990: 18). Inequitable distribution of water between blocks, between head and tail users along canals, and differential water distribution at field level have been documented (Pazvakavambwa 1984a; Pearce and Armstrong 1990; Donkor 1991). Over-irrigating has also been cited as another problem, particularly in gravity schemes (Makadho 1993, 1994). These studies, in various ways, have underlined the need for solutions to be found to the water management problematic in smallholder irrigation schemes in Zimbabwe.

Agritex has taken steps to address the problem of poor water use, hence the introduction of the block system of irrigation. Its origin was in Mushandike Irrigation Scheme in Masvingo Province, a scheme that was opened up for irrigation in 1985[2]. This system is currently used in most 'new' schemes constructed after 1985, in those that are under rehabilitation, as well as in some 'old' schemes undergoing re-organization. There are perceived advantages associated with this system. These advantages gleaned by the author from interviews and discussions with a number of Agritex engineers and extensionists, fall into three categories. The most frequently advanced reason is efficient water use through scientific irrigation scheduling. The second advantage, which relates to economic aspects of crop production, is that it is easier to market the crop produce. Thirdly, block irrigation is conceived as making crop rotations easier to implement which ultimately results in improved maintenance of soil fertility. A related advantage is the possibility of better pest and disease control.

In the following section (7.2) block irrigation is described and compared to the irrigation system that has been in place, hereafter called the conventional system. Then, the four tenets of block irrigation, *viz.* 'efficient' irrigation scheduling, 'better' pest and disease control, 'ease' of

[2] It is, however, reported that block irrigation was practised during the colonial period e.g. in Nyanyadzi; irrigation scheme (Bolding, 1997; pers. comm.)

marketing and 'improved' soil fertility are examined. After the review of the tenets, the next section concentrates on the core principle of block irrigation, i.e. irrigation scheduling. The section explores the theory and practice of irrigation scheduling in block irrigation.

7.2 A COMPARISON OF BLOCK AND CONVENTIONAL IRRIGATION

7.2.1 Field Layout

Block irrigation involves growing one crop per block of land. A block in this case is an aggregation of many plots belonging to different farmers which, are treated as one big plot. Farmers in a particular block are supplied with water to irrigate 'one' crop that belongs to different farmers. Each farmer is allocated two or more plots in different blocks of the irrigation scheme. A typical landholding per farmer in 'new' schemes where block irrigation is practised is 1.0 to 1.5 ha. Depending on the number of plots a farmer is entitled to, and crops being grown per season, a farmer may have two or three crops growing in different blocks at the same time.

In 'old' schemes farmers have their plots in one stretch of land, which contrasts with block irrigation where farmers have part of their landholding in different sections of the scheme (see Figure 7.1 for an illustration). Individual blocks are served by different supply canals.

7.2.2 Water Distribution in the Two Systems

Block irrigation is premised on 'accurate' irrigation scheduling. Irrigation scheduling is defined as 'determining when to irrigate and how much water to apply, or deciding when to start and when to stop an irrigation' (Martin *et al*, 1990: 156). Quantitative irrigation scheduling methods are based on two approaches: (a) *soil and/or crop monitoring* and (b) *soil water balance computations*.

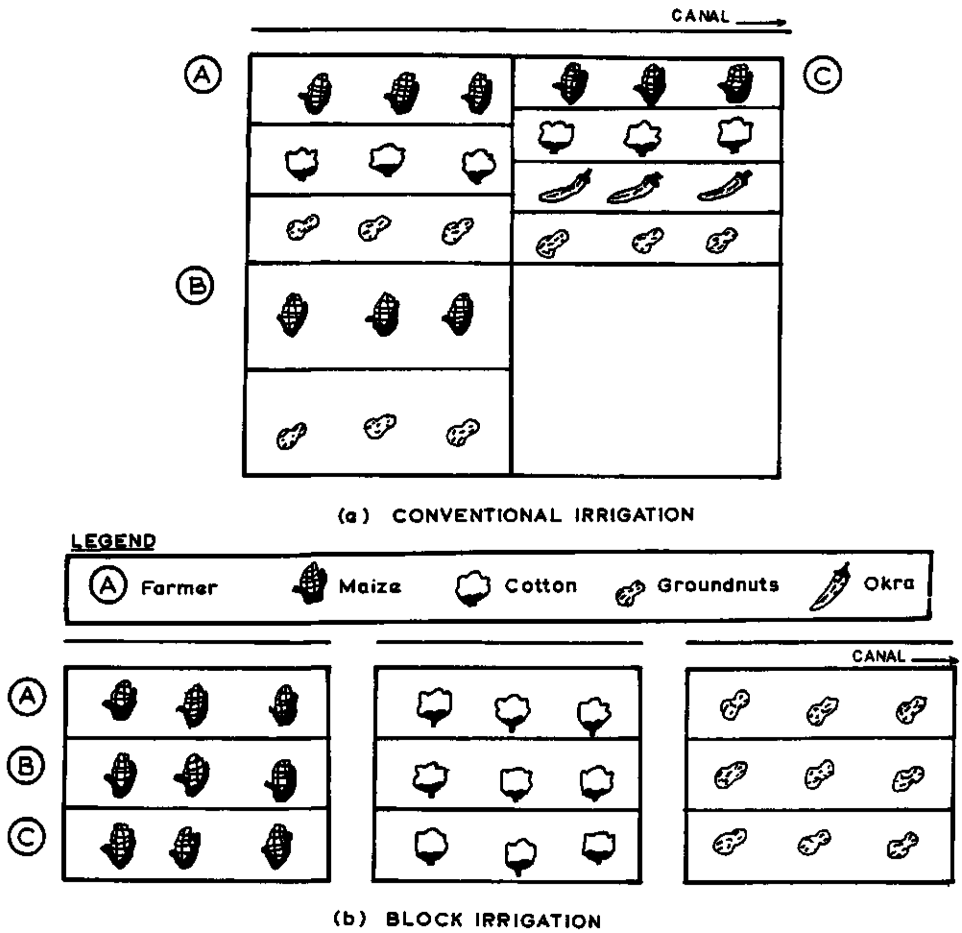
Monitoring methods involve measuring soil water content or matric potential at several places in the field to decide when to irrigate. Soil water balance computations require estimates of soil storage capacity, rooting depth, allowable depletion and crop evapotranspiration to develop an irrigation schedule (*ibid.*). In Zimbabwe irrigation scheduling is by and large according to the soil water balance approach (see below). Water distribution, as it is conceptualized in block irrigation, can be described as crop-based scheduling designed to meet crop water requirements.

However, in practice it is *supply-oriented* as the irrigation agency, Agritex, shares out water to farmers. As will be illustrated later on the sharing of water in many cases does not satisfy crop water demand (determined by computing crop water requirements (CWR)[3]. This, however, is the premise of block irrigation. (In *on demand*[4] systems farmer's request irrigation water according to their felt needs and irrigate not necessarily according to theoretically determined crop water demands. It is however, pertinent to note that a theoretically based approach to irrigation is not as easy as it sounds, as highlighted below).

[3] Crop water requirements represent the amount of water which must be applied to the soil to replace that lost to *evapotranspiration,* a combined term for water loss as a result of evaporation and transpiration.

[4] There are different classifications as regards water delivery to the farm. For more elaborations see for example Horst (Clemmens, 1987 and Ankum, 1992: 245-254).

Figure 7.1 Field layout in conventional and block irrigation (schematic)



Irrigation as it is organized in conventional schemes in Zimbabwe can be viewed as flexible. Water distribution here is a consequence of negotiations between farmers and operators or water bailiffs. Farmers receive water allotments for their crops from water bailiffs and take turns to irrigate. Under this rotational system, once a farmer has received water he/she can apply it to one, or two or three crops that are on his/her plot, since the farmer is not under obligation to grow one crop per plot. The crops grown may be in strips or may be intercropped. (Intercropping is, however, actively discouraged). When water is in short supply farmers are obliged by operators and other irrigators to closely stick to their turn so that each farmer has a chance to irrigate his/her crops. In a water abundant situation farmers are left to irrigate their crops as they wish.

Two points can be identified in the conventional system. Firstly, there is some degree of flexibility[5] in organising irrigation depending on the circumstances. Secondly, as already hinted, there is a high level of consultation and negotiation at changeover time involving the water bailiff, the present irrigator and the next in line. When the water bailiff is not there for some reason, water may pass from one farmer to the next, although this is officially not allowed. In those instances, the water bailiffs, aware of the need to maintain good social relations with farmers, prefer to turn a blind eye.

These negotiations and interactions between the different actors make the conventional system a people-centred system based on social-technical[6] considerations. An interesting question is: is water distribution based on social-technical considerations inferior to one where standard technical procedures are followed as in block irrigation? This question is pursued in subsequent sections.

7.3 THE FOUR TENETS OF BLOCK IRRIGATION

The tenets of block irrigation relate to irrigation scheduling, pest and disease control, soil fertility and crop markets. These are based on an overarching technical frame, which will be shown to fall short of the practical requirements of farmers and the organizational requirements necessary for them to work. Because of the centrality of irrigation scheduling in block irrigation, this tenet is covered in greater detail in section 7.4.

7.3.1 Ease of Marketing Co-ordination

The economic rationale of bulk marketing

Smallholder irrigation schemes are commonly reported to face marketing problems. The problem has been diagnosed as a scarcity of business acumen, exemplified by a lack of forward planning, e.g. crops are usually grown before a market is identified. In order to find secure markets for produce, it is argued that there is a need for market co-ordination. Block irrigation then is seen as a way of addressing the marketing problems. Planting at the same time helps synchronize harvesting which results in better market co-ordination. Synchronised harvesting makes it possible to implement bulk marketing of produce, which, among other things, uses resources more 'efficiently'. This is more relevant in negotiating contracts with canning factories and other bulk buyers.

This notion of bulk marketing appears to have its origin in the type of training that agriculturalists on the schemes undergo. What is offered is large-scale commercial marketing, which is reflected in the standard crop budgets that are drawn up. These budgets tend to be an extrapolation from large-scale commercial farms. As such the experiences of the smallholder farmers are not into taken account (see below). It would appear that controlled marketing of most agricultural produce, which used to obtain in the country before 1990, has left its mark. Crop budgets are still drawn up as if markets can be guaranteed. The return on investment,

---

[5] The notion of flexibility in irrigation is ill-defined (see Van der Zaag 1993). In the context of this chapter it is used to refer to a situation where farmers have the possibility and ability of having a say in the way the water is shared out or distributed.

[6] By socio-technical I refer to the fact that there is an attempt by farmers and water bailiffs to reconcile social and technical factors (although the technical are not labelled as such), while block irrigation is premised only on technical aspects. As will be shown later, the Agritex/FAO Irrigation Manual, prepared for Agritex engineers who exclusively work in smallholder irrigation, recognises the fact that irrigation schedules should take account of farmers' circumstances. However, this realization is a mere anecdote to the technical discourse which the Manual espouses.

based on a comparison between the money invested and the money obtained, assumes that the market is assured. This is no longer the case for all categories of crops, from maize to cabbages. For example the 1995/96 wheat crop in Fuve Panganai attracted a price of Z$700/t while farmers were expecting a price of around Z$2,000/t. Moreover a significant cost, labour, is omitted in the budgets thereby inflating the expected returns.

The opposing view to bulk marketing

There is evidence that the economic rationale behind bulk marketing sometimes fails in the context of smallholder farmers. Smallholder irrigation schemes, where single crops are insisted upon, are known to overproduce one type of produce, thereby flooding the market (see IAP-WASAD n.d., Peacock 1995). Besides, the markets for block irrigation produce, as already said, are not guaranteed. In this way prospective buyers are in a position to take advantage by offering low prices when there is a glut of produce.

Local crop distribution networks are ignored in bulk marketing. These networks are, however, quite important as shown by Vijfhuizen (1995), who concluded that agricultural produce in smallholder irrigation schemes were more than market commodities. They were also part of social networks that guaranteed personal relationships as well as labour supply through gifts and exchange. Nzima (1990) illustrated that if farmers grow different crops there was a lot of intra-scheme marketing, which resulted in bigger gross margins. This not only prevented waste of agricultural produce but substantially cut down on transport costs. Madondo observed (1993, pers. comm.) that farmers who grew 'forbidden' crops such as okra in Devure irrigation scheme made profit locally. The fact that farmers in Chibuwe, particularly women farmers, insisted on intercropping 'forbidden' vegetable crops among the main 'legal' crops, confirm that the economic rationale of the block system clashes with farmers' perceptions of what is economic.

Apart from crops disposed of at the farm, the bulk marketing economic rationale misses one other important dimension. Diversity in crop production, among other things, ensures a greater variety of foods. Block irrigation, on the other hand, presupposes that smallholder irrigation is mostly about production of saleable surplus. While it is true that a proportion of the produce is sold to suffice the cash requirements of farmers, the food requirement is often underplayed. During a field day on 6 October 1994 in Fuve Panganai, presentations by senior Agritex officials concentrated on how much money could be made from a unit of land without any mention of food requirements. Farmers were told that they could make a lot of money from the 0.5 ha maize plot, assuming a crop yield of 6 t/ha. The assumption was that each maize cob would sell at Z$1. The price, however, eventually dropped to Z$0.30 per cob as farmers flooded the market with the same product.

From a food security perspective, the enforcement of block irrigation in Fuve Panganai resulted in a maize (the staple food crop) deficit in many households, as every household was required to grow 0.5 ha of maize. This did not take account of the number of people constituting the different households, which a feasibility report on the scheme reported to vary from 2 to 25, with an average of 9.3. The total available grain per capita using the optimistic yield estimate of 6 tonnes/ha under irrigation, was therefore less than required for most families. In fact it was much less, since some of the maize was sold green. This was also worsened by the fact that farmers were required to quickly remove their winter maize crop so as to plant the next summer crop. Farmers in the end were forced to rely on the unpopular wheat *sadza* (a thickened porridge used as the staple carbohydrate source) or to look for grain to purchase from rainfed farmers. The underlying problem in this case was that state officials conceived smallholder farmers as commercial farmers, whilst farmers were on a subsistence-commercial farming continuum *(ibid)*.

Besides the loss of freedom to choose which crops to grow, block irrigation reduces the number of crops grown per annum. In block irrigation, crop choice is usually limited to a maximum of three, as it is unlikely that farmers can have more than three plots allocated to them. For example, because of the preoccupation with market-oriented crops, which tend to be grown in block irrigation, women farmers tend to suffer as they are sometimes not allowed crops of their choice e.g. in Fuve Panganai they were denied the growing of vegetables. In conventional irrigation more crops can be grown.

7.3.2 Ease of Implementing Crop Rotations

Block irrigation is also legitimised on the basis of better crop rotations. Claims of improvement in soil fertility are predicated upon harnessing the complementary characteristics of the crops being grown. Shallow rooted crops can be alternated with deep-rooted crops because the different crops abstract nutrients at different levels. This allows nutrient uptake from the soil to be balanced. Similarly crops that require different types of nutrients, such as legumes and non-leguminous crops, e.g. maize, are rotated. A well maintained soil results in good yields and increased agricultural productivity (see Savva *et. al*, 1994).

It is important to note that rotation is not exclusive to block irrigation. Farmers can practise crop rotation on sections of their plots. Moreover, classical rotation methods, such as those that add nitrogen through the inclusion of a legume, or those that add organic matter to the soil, are generally uneconomic. Consequently, instead of relying on crop rotations for soil fertility improvement, farmers rely on inorganic fertilizers. Besides, farmers pressed with the need to keep planting dates, generally burn crop residues or ferry them to their homes to feed their cattle. By so doing they defeat the noble idea of crop residue incorporation into the soil.

7.3.3 Easy and Effective Pest and Disease Control

Pest and disease control is also given as another main advantage of block irrigation. Sole cropping, defined as growing one crop variety grown in pure stands at normal density (Andrews and Kassam 1976), which is practised in the individual blocks in block irrigation, is claimed to result in easier and more effective pest and disease control. These 'advantages' are based on the following claims:

- spraying is easily done on a block basis as there is just one crop; this enhances the chances of synchronised spraying which prevents the likelihood of re-infection of crops from other crops that have not been sprayed;
- pests and vectors of diseases cannot hide away in crops that have not been sprayed as alternative hosts of these insect pests are no longer in the vicinity of the sprayed crop(s);
- in the case of those pests that can be controlled by practising rotations, such as nematodes, the block system allows nematode-susceptible crops to be rotated with nematode-resistant crops.

The cited advantages are, however, valid only if the following assumptions apply:

- All farmers in a block behave 'responsibly' and spray when due[7]. This also implies that planting was done at the same time, otherwise co-ordination of spraying is not possible because different types of pests and diseases attack crops at different times of the crop growth stage e.g. American bollworms in tomatoes are fruit pests and are therefore important during fruiting, while early on in the life of the crop, early and late blight, which

[7] In some cases the timing of spraying is not easy to implement because the method of determining spraying levels is based on insect egg counts, which represents a formidable task for smallholder farmers to undertake. Linked to this problem is whether the timing should be based on pest levels on one farmer's field or over the entire block, and by whom?

are foliar diseases, are important;

- All farmers in a block (as many as 50 sometimes) can be co-ordinated to do everything together at the same time;
- The crops grown to control nematodes and other pests are of economic and social interest to farmers. If farmers are not interested to grow the crops in question they may simply ignore the advice or if they cannot do so, they may pay inadequate attention to the crop(s).

Just as in irrigation scheduling and bulk marketing, there are a number of unresolved conceptual and practical problems posed by block irrigation with regard to pest and disease control. First, on the practical side, as already stated, the assumption that farmers will plant at the same time, spray at the same time and somehow behave as if they are one, is optimistic. As one farmer in Fuve Panganai (where block irrigation is in place) put it:

> The problem is that if you tell your neighbour to spray when you spray so that your crops are not re-infected, he or she does not necessarily co-operate. You are normally told that they have no chemicals. They then ask you for the chemical. In the end you simply have to continuously spray because there is nothing you can do.

Co-operation among farmers with regards to effectively controlling pests, however, does not rest on the fact that there is block irrigation but on a willingness to co-operate.

Secondly, synchronised spraying against pests is only technically expedient when the pest regime is the same throughout the whole block i.e. when the 'economic thresholds' have been reached. If not, spraying on a block basis is 'non technical' in that some farmers will spray before the recommended pest levels have been reached. There are, however, no 'economic thresholds' worked out for crops such as tomato, cabbage and rape. Even on cotton, where economic thresholds have been established, spraying on the basis of egg counts is far too cumbersome to the smallholder farmer, who is unlikely to have the willpower or the time to do as recommended.

Thirdly, there are theoretical inconsistencies. Pests are known to thrive in monoculture environments. Mixed cropping or intercropping tends to reduce pest and disease incidence. This is due to the slower pest multiplication rate and the increased horizontal resistance that results from the greater ecological diversity (Page and Page 1991; Litsinger and Moody, 1976). Seen in this light a block system may enhance pests in the blocks.

7.3.4 Efficient Use of Water

Improving water use efficiency is considered the main advantage in block irrigation. This is supposed to be realized on the basis of the application of scientific principles of water distribution in particular, and to water management in general. The next section provides an examination of how the scientific approach is supposed to address the water management problematic.

7.4 THEORY AND PRACTICE IN IRRIGATION SCHEDULING

7.4.1 State-of-the Art Procedures

In agronomic terms irrigation scheduling incorporates soil, plant and meteorological data so as to ensure accuracy in the determination of water application. The 'one crop per block' scenario in block irrigation is seen as making it possible to factor the three basic elements in irrigation scheduling (see Doorenbos and Pruit 1977; Doorenbos and Kassam 1979; Allen, Pereira, Raes and Smith, 1998). The amount of water used up by the crop which has to be replaced to the soil, also known as the consumptive water use (ETcrop), is estimated by multiplying reference evapotranspiration (ETo) and crop factors (Kc). The quantity of water is estimated by the simplified formula:

$$ETcrop = Kc \times ETo$$

According to Savva *et al.* (1994: 774), in an FAO document meant for a Zimbabwean audience, this type of irrigation scheduling can be done in two ways. First it can be done by using estimated values of ETcrop based on climatic data of previous years. The authors find this method useful but considers it inadequate for 'accurate' scheduling:

> While for planning and designing purposes and where other means are not available, this is sufficient, for more **accurate scheduling**, the use of class 'A' pan and/ or tensiometer is recommended. .. the ETcrop values obtained from (the) calculations are the mean values of the past. However, in reality, the ETcrop within a 10 or 30 day period varies. This is why the use of evaporation pans and /or tensiometer provide better means of irrigation scheduling (emphasis added).

A number of conditions are necessary for 'accurate' scheduling to be realized. Relevant (for the different irrigation systems) efficiencies of delivery/conveyance to the field and application of the water in the field should be taken account of.

Apart from the amount of water to be applied, the timing of irrigation, or when irrigation water is to be applied, has also to be determined. The timing is a function of the evapotranspiration that is allowed to accumulate before the permanent *wilting point* (WP)[8] is reached. The objective of irrigation scheduling is to find the 'optimum' point to irrigate. This 'optimum' point also takes account of the allowable moisture depletion of the available soil moisture (amount of water between field capacity[9] and wilting point), which on the average in Zimbabwe is 50 per cent for most crops but is lower for vegetable crops.

Soil type also influences irrigation scheduling. Sandy soils lose water much faster than clay soils and hence reach WP faster, while in clay soils moisture is held more tightly than in sandy soils. The rate of moisture depletion to the permanent WP is also affected by the rate of evapotranspiration that is occurring; high evapotranspiration results in rapid acceleration towards WP. When evapotranspiration figures are accumulated and accordingly weighted with the appropriate crop factors and compared with soil moisture levels, the evaporation deficit is obtained. When a targeted deficit is reached the timing of the next irrigation is then arrived at. A typical 'accurate' irrigation schedule is shown in Table 7.1 (refer to Savva *et al*, 1994 for a stage by stage calculation)[10].

There have been numerous efforts in Zimbabwe to develop irrigation schedules, such as the one in Table 7.1, for various crops. Melterkamp (1968) gave a general state-of-the art treatise of irrigation scheduling based on the class 'A' evaporation pan method. He described this method as 'a reliable technique for use as an aid to irrigation scheduling'. There have also been a number of irrigation schedules developed for individual crops e.g. wheat (Watermeyer 1966, 1971, 1972; McGugan 1972), tomatoes and peas (Buchanan 1972), onions (Laver 1972), coffee (Morkel 1972) and deciduous fruits (Cormack 1972). After independence FAO-sponsored documents were produced tailor-made for Zimbabwe such as Savva *et al* (1991,

[8] Wilting point is the soil water content at which plants can no longer get enough water to meet transpiration. It is generally determined at a soil water potential of -1.5mPA.

[9] Field capacity is defined as the soil water content at which drainage becomes negligible.

[10] The last column is not in the original table; it was inserted as an illustration for a later point.

1994). All these schedules were developed for large-scale commercial farms. This is because of the colonial history of the country where that sector received priority in research while the smallholder sector was ignored. Paradoxically, however, Tembo and Senzanje (1988) reported that irrigation scheduling in large-scale commercial wheat production was not (properly) executed. (Burt (1996) commented that the majority of Californian farmers in the United States of America and in other parts of the world did not practise irrigation scheduling). According to Tembo and Senzanje (1988) 'improper scheduling' in the Zimbabwean context was surmised to persist because:

- water was too inexpensive for farmers to worry about conserving it;
- pumping and energy costs were low;
- farmers lacked the know-how to implement scientific scheduling;
- farmers did not want to be bothered with a management practice that appeared academic;
- there had been inadequate research carried out (in Zimbabwe) to show farmers the benefits of improved water management; and
- the marginal benefits from improved scheduling appeared minimal and were not comparable to the extra effort required.

Table 7.1 A Bean Crop Irrigation Schedule

Decade[a]	Etcrop (mm/day)	Rootzone (m)	RAM[b] (mm)	Interval GIR[c] (days)	Change[d] (mm)	(%)
01-10/04	2.00	0.15	7.5	4	10.7	-
11-20/04	1.92	0.21	10.5	5	12.8	+21
21-30/04	2.20	0.27	13.5	6	17.6	+38
01-10/05	2.80	0.33	16.5	6	22.4	+27
11-20/05	3.13	0.40	20.0	6	25.0	+12
21-30/05	3.17	0.40	20.0	6	25.4	+2
01-10/06	3.03	0.40	20.0	7	25.4	0
11-20/06	2.87	0.40	20.0	7	28.3	+11
21-30/06	2.90	0.40	20.0	7	26.8	-5
01-10/07	2.93	0.40	20.0	7	27.1	+1
11-20/07	2.95	0.40	20.0	7	27.5	+1
21-25/07	3.15	0.40	20.0	6	25.2	-8

a Decade is a period of ten days over which data are calculated. The period is a standard one in irrigation.

b RAM refers to the readily available soil moisture content that is determined by considering the water holding capacity of the soil, the rooting depth of the crop (root zone) and the allowable moisture depletion, which is usually 50 per cent as already pointed out.

c GIR refers to the gross amount of irrigation supplied to the crop that incorporates irrigation efficiencies.

d Change refers to the percentage increase or decrease of water applied compared to the previous irrigation.

Source: Adapted from Savva et al (1994)

The practical demands[11] of the computations of irrigation scheduling seem to be a common problem to all categories of farmers. In fact practical schedules that are utilised on

[11] One large scale commercial farmer who was not convinced about the need for 'scientific' irrigation scheduling told the author that he timed his irrigation when the dust began to rise behind his truck as he drove through his fields!

many commercial farms are akin to the (less accurate) first method described by Savva *et al.* (1994). On the same point it can be asked whether these farmer-crafted practical irrigation schedules are devoid of a 'theoretical' base, as every observation is theory laden (Feyerabend 1975, cited by Leeuwis 1993). Evidence provided in chapter 5 illustrate that farmers do not just irrigate haphazardly.

7.4.2 Assumptions of Irrigation Scheduling

The advantages of irrigation scheduling in block irrigation depend on a number of implicit operational and organizational assumptions. These are:

- All farmers who share the same irrigation turn plant their crops on the same day or close to that. This allows the irrigation water requirements to be 'accurately' determined, otherwise variations in crop factors, because of the different crop growth stages, can render 'accurate' determination of irrigation water requirements impossible;
- To be able to estimate evapotranspiration, there is in place a device for estimating evaporation such as a US class A pan or a similar device. There is then a need to have a skilled person on site who has to take the daily evaporation readings, compute them into evaporation deficits, and then inform the relevant farmers when to come and irrigate and how much to irrigate. A mechanism of monitoring the irrigation practice, so that farmers stick to their turns in the various blocks, is also necessary;
- The computed irrigation water requirements are successfully related to how the irrigation system is to be operated e.g. how the intake, the pump and water control structures such as gates are operated to take account of the variable water supply to cater for the different crop stages. There is also a need to link the computed irrigation water requirements to the number of siphons (if present) in surface schemes. In overhead systems where sprinklers are rotated, details like how long to keep the sprinklers operating in one place need to be worked out;
- Farmers' fields and the block served by a supply canal have uniform soils in terms of depth, texture, available water holding capacity so as to make the planned irrigation duration in practice worthwhile;
- Water is not limited in the scheme so that crop productivity per unit area is the ideal parameter, and farmers can irrigate whenever they want.

7.4.3 The Practical Reality

After dwelling on the mechanics of irrigation scheduling it is important to turn to the organizational/managerial requirements of irrigation scheduling. The main points are discussed in turn.

Equipment and human resources

Savva *et al.* (1994: 774) underline the importance of equipment and human resources in implementing irrigation scheduling:

> It requires proper recording and some management skills since the timing of the different irrigations will depend on the day to day variability of the climatic factors.

The opposite seems to be the case in practice. There are very few (less than one per cent) smallholder irrigation schemes in Zimbabwe where class A pans are in place. Secondly, the capacity of the personnel to manage the type of irrigation scheduling as required by block irrigation is next to non-existent e.g. Agritex personnel in the schemes have little idea of the

actual water flows in the primary, secondary and tertiary canals (see Makadho 1994).
Pump capacities are also not known, nor are siphon discharges[12]. Thus block irrigation, supposedly based on 'solid' figures, cannot claim to be based on any figures in reality[13].

On accuracy

Accurate irrigation scheduling is relative. According to some studies the pan method and the Penman formula, which are used in computation of CWR and irrigation schedules (in one form or another) in Zimbabwe, in some cases are not correlated (Koen and Watson 1987; Butlig and Makadho n.d). This is significant given that irrigation scheduling in the country is based on the class A pan method. Concern has also been raised about the lack of local (Zimbabwean) soil and crop data for inputting into irrigation scheduling calculations. When these 'accurate' data are used in smallholder schemes, where water use efficiencies in most cases are no higher than 50 per cent in surface schemes (Pearce and Armstrong 1990), the rigid adherence to that 'accurate' data is questionable. Furthermore, the mostly small differences in irrigation amounts to be applied for the greater part of the irrigation schedule (see Table 7.1) mean the differences are of no, or little, practical irrigation consequence. In such cases to strive for accurate irrigation scheduling is not only tedious but may be impossible to achieve because flows in existing irrigation systems cannot be matched to the small changes. If the schedule is extrapolated to Chibuwe (which is quite reasonable), it is obvious that this cannot be used as a useful management tool since in Chibuwe the irrigation turns are usually 7-10 days at a minimum and 28 days in some cases (see chapter 3).

There is yet another problem. Block irrigation is supposedly executed according to actual depletion of soil moisture while conventional irrigation can be thought of as based on average expected depletion. Savva *et al.* (1994: 772) conclude, after reviewing a number of studies, that the concept of depletion and estimation of root depth are areas of 'interesting controversies' and go on to recommend that one should not strive to irrigate according to actual depletion. A contrasting view is expressed by Nyamugafata (1993: 4) who believes that irrigation should be according to actual rooting depth and that farmers should occasionally do a random assessment of actual rooting depth to see whether it matches the one used in the design.

In conclusion, the desire for 'accurate' irrigation scheduling, which has been demonstrated to be full of conditionalities, has resulted in a water management approach that is inflexible and unsuitable to farmers. This is because it leaves very little room for negotiations over water, as irrigation is deemed to be based on what are taken to be almost infallible physical laws. Such uncritical use of engineering concepts, such as efficiency, that are applied without much notice of the circumstances (Vincent 1980), poses difficulties. In most cases, flexibility of operation, which is considered important in keeping harmony among irrigators, is totally neglected (Mahdi 1986; Vincent 1994).

Managerial requirements

The phenomenon of a variable water supply, which is a consequence of 'scientific' irrigation

[12] Two factors are responsible for this water flow `innumeracy' on the part of Agritex personnel. Firstly, their training does not include that aspect of irrigation. Both irrigation courses A and B concentrate on crop water requirements, irrigation scheduling and economics of irrigation. In the second instance, there has been a design rather than a management culture in the (Agritex) Irrigation Branch, i.e. the emphasis has been solely on designing. Shanan (1992: 171) underlines this fact by observing that in developing countries management staff do not generally know the flows in the network within 10 per cent; in many existing schemes irrigation projects are fortunate if flows are known within 25 per cent at any given time.

[13] The same picture (of lack of personnel to execute the irrigation scheduling tasks) was painted at an Agritex workshop for Manicaland extension workers and supervisors held at Manesa from 5 to 9 September 1994, where the presenter of the lecture was not clear on the very principles he was supposed to teach.

scheduling, poses practical problems. Frequent changes in the quantity of water to be delivered in the canals in the case of surface schemes, or pushed through pipes in the case of overhead systems, in relation to crop growth stages, are problematic. A continuously variable water supply over the growing season is a problem to both farmers and operators alike. The water bailiff has to deal with the variable flows which in practice means that he has to operate gates differently in surface schemes, for example. In the absence of any guideline on how to use these gates to deliver the desired irrigation quantity of water the task becomes difficult. The pump operator also has to contend with these changes. In the event of a single capacity pump being in place it is impossible to adjust the pump to the calculated variations in water demand. Other factors that nullify this 'metering' of water are, for example, differences in evenness, levelness and compaction of the soil in different fields.

A related problem is the changing intervals of irrigation. When accumulated evaporation deficits are used, the timing of irrigation depends, to a large extent, on the weather. From farmers' perspective, irrigation becomes less predictable. This means that when irrigation is due farmers have to be co-ordinated. This is not easy considering that farmers are involved in other activities, including non-farm ones. How a smallholder farmer can meaningfully plan for an irrigation, the basis of which depends on varying evaporation figures, remains to be answered.

On recognising the impractical nature of accurate irrigation scheduling in Zimbabwean smallholder irrigation schemes Savva *et al.* (1994: 784) advise that:

> Once the irrigation schedule is known, simplifications can be introduced in order to make the schedule practical and 'user friendly' for the farmers, e.g. irrigation intervals and irrigation duration can be made uniform throughout over a period of a 14-day cycle or a month. This is particularly important in-group irrigation schemes where a number of farmers are involved, living at some distance from the scheme. If they knew the irrigation schedule for the next month, they are in a better position to organize their work, household tasks and family life accordingly.

The issue of technology is one other relevant factor. Overhead systems may not have the problem of gate operation, for example. But the issue of calculated hours of irrigation may still not correspond to the different field conditions. For example in overhead systems where the draghose system is in place, which allows farmers to operate independent of other farmers, there is a likelihood that farmers may not want to be restricted to schedules and instead may prefer an *on demand* system of irrigation. This happened in Fuve Panganai Irrigation Scheme where farmers took advantage of the low pressure buried pipe technology to take water when they wanted, thereby rendering unattainable the advantage of using water 'efficiently' due to irrigation scheduling (see chapter 4).

7.4.4 Attempts at Block Irrigation

As a corollary to the preceding discussion on the problems of irrigation scheduling in block irrigation, an example is presented. The example is from Chibuwe Irrigation Scheme. Blocks C, D and E were earmarked for rehabilitation in 1994. This meant that the old earth furrows were to be replaced by concrete-lined canals. Instead of just diverting the flow to the plot by a shovel, siphons were to be introduced. Through the adoption of these measures water was going to be saved, and leakages, seepage and deep percolation were going to be reduced. The rehabilitation work was carried out in phases. The first phase was on an area of 20 ha in block C that was identified as C1. After the canals were put in place irrigation was then ready in the summer of 1994.

In the same season it was decided to implement block irrigation. The supervisor was of the opinion that it was easy to implement block irrigation in the rehabilitated blocks before its implementation in blocks A and B, where concrete canals were in place. It appeared that the irrigation supervisor, who was the manager of the scheme, had convinced the irrigation officer, his superior who was not involved in the day to day running of the scheme, that he needed block irrigation in his scheme[14]. Neither the supervisor nor the irrigation officer had any experience with block irrigation - what they had heard through colleagues had apparently convinced them of its merits. Block irrigation was embraced because of its ring of 'scientific' irrigation scheduling. As a result farmers were not necessarily re-issued with their original plots although this was possible.

The supervisor, as the implementor, did not want to tell the farmers before the actual date of hand-over as that would "embroil everything in controversy". Even the Irrigation Management Committee was not informed. When the matter was finally put before the farmers there was widespread opposition. Farmers complained that they were not prepared to swap their plots with some individuals who did not take good care of their plots. In a scheme where cultivation started in 1940, the complaints appeared genuine enough given the long time span that could have resulted in changes in soil conditions due to poor or good management. Appeals were made to the Irrigation Management Committee which supported the farmers but to no avail. The fact that only 20 farmers were involved made it possible for the irrigation supervisor to overrule them. Reluctantly farmers accepted the new arrangement.

There were a number of problems encountered in the attempt to establish block irrigation. The first was the number of crops to be grown and their spatial arrangement. Since the rehabilitated section was served by three supply canals, farmers were allocated two plots each along the supply canals as it was not practically possible to split the landholding further. Each area served by a supply canal was earmarked for a specific crop. Thus there was what could be called the maize, cotton and groundnuts supply canals. Since farmers wanted to grow three crops, a problem arose, as any one farmer could only grow a maximum of two. Under the conventional system, on the other hand, farmers used to sub-divide their plots and grow all three crops and even more!

There was also a problem relating to the actual water distribution. A number of deficiencies became apparent during the attempt to operationalize water distribution. The amount of water down the supply canals, and how it was to be released via operation of the gates, was not spelt out. Secondly, the supply canals had `on and off' gates which were not operated as such because in the full open position these would release too much water. Without the necessary guidelines a number of intermediate positions were tried by the water bailiff together with farmers so as to `meter' the right amount of water down the canal. This method involved placing a foot against the direction of flow of water. When the water level rose to the ankle that flow was deemed sufficient for one farmer whose field was near the gate. For farmers further on, the level of the water was allowed to rise a little above the ankle (Figure 7.2).

This was in contrast to block A, where there were sluice gates with notches/holes, and water was shared out on the basis of a number of holes or notches.

The siphon discharge was not known either. Together with the irrigation officer, the supervisor organized for that measurement to be made. Some preliminary calculations were

[14] The supervisor is entrusted officially with the day to day management of the scheme. In this he is assisted by three extension workers who manage one or more blocks depending on the size of the blocks in question. At the time of the reported episode there were three extension workers. One was responsible for block A (90 ha in size), the second for blocks B and D with a combined size of 95 ha, while the third had responsibility of blocks C and E which totalled 80 ha. The role of extension workers in advocating block irrigation was minimal. It appeared that they went along with it. This could have been because they did not know anything about it for none had any experience with it, or they could not bring themselves to contradict the supervisor.

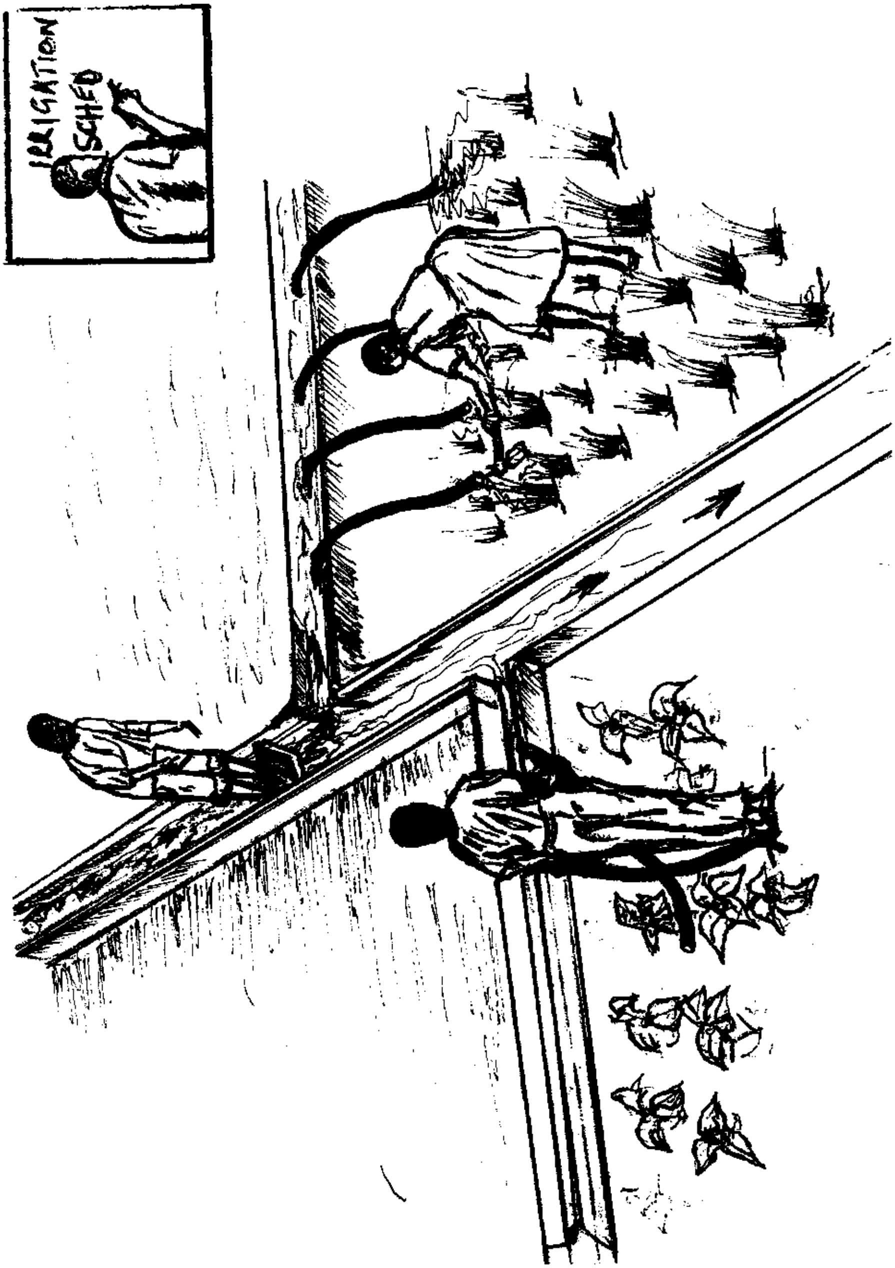


Figure 7.2 Water bailiff 'measuring' water by means of his foot (Inset: Depiction of a state official preoccupied with irrigation scheduling to the neglect of operational realities)

done and passed to the irrigation officer for guidance. That was the end of the matter.

The supervisor also realized he had to determine the time it took for the water to travel to the end of the field. An exercise was started but later abandoned because fields were not level to the same degree. Lastly, the absence of an evaporation pan in the scheme represented another hurdle. The supervisor and the irrigation officer discovered that block irrigation involved much more than delegating crops to some areas of the scheme. Block irrigation was consequently suspended. But the ideological urge of block irrigation remained strong as evidenced by the fact that it was introduced in the nearby Musikavanhu scheme that was commissioned in 1996.

7.5 CONCLUSIONS

Crop and water management in block irrigation, it has been demonstrated, was not the same for state officials and farmers, in terms of conceptualization and implementation. State officials insisted on block irrigation on ideological grounds. Before discussing this point further ideology needs to be defined. Ideology has two main definitions. In its basic form ideology refers to a body of ideas or ways of thinking (Bourdillon, 1990). Ideology has also been defined as a false consciousness where ideology, 'ducks the relevant practical issues' (Taras, 1984). Both meanings are relevant in the discussion in this chapter with the latter being more relevant. The main point being stressed here is that operational aspects of irrigation management were compromised because of 'scientific' ideology. State officials were attracted to block irrigation because of the science of irrigation scheduling, which was taken as proven knowledge. From the evidence it can be disputed whether there was adequate understanding of this science of irrigation scheduling. What cannot be disputed, however, is the fact that as it was conceptualized, it was inappropriate to the operation of smallholder irrigation schemes in Zimbabwe.

It can be said that the 'science' practised in block irrigation was a particular brand of science called inductivism. This brand of science claims that observations of certain isolated phenomena can be used to make generalizations about the world (see Chalmers, 1992, chapter 1). In our case this meant that observations from experiment stations, or gleaned from textbooks about irrigation scheduling, pest and disease control etc, were claimed to have wider validity as far as water and crop management in smallholder irrigation in Zimbabwe is concerned. This was, however, not the case. In more specific terms the agronomic concept of irrigation scheduling was inappropriate because:

- Reliability of water supply to make *on demand* scheduling a reality, in line with cropwater requirements, could not be guaranteed;
- Flexibility which allows farmers to irrigate according to the theoretically determined frequencies and quantity of water to be applied, was not present (for example the infrastructure was inappropriate for the calibre of the operators and did not meet farmers' needs);
- The crops that farmers grew or wanted to grow were at variance with the official requirements
- Volumetric water measurement, which can act as a deterrent to limit farmers' usage of the water, was not enforced in the schemes.

Part of the explanation of why these preconditions of irrigation scheduling were not met lies with history. Horst (1996) observes that the ascendancy of the agronomic concept of irrigation scheduling was a consequence of cropwater computations that arose in the latter half of the 20th century. This new knowledge seemed to have blinded many irrigation practitioners from the realities of practical irrigation management.

The major point coming from the above discussion is the one made by Taras (1984: 5). Ideologies are generally based upon some conceived objective truths about the real world. The fundamental weakness of many ideologies is their inability to consider these 'truths' in their social context. This explains why block irrigation was not well tuned to the technological, social and economic context of the farmers in smallholder irrigation schemes. For example, to succeed, the intensification of agricultural practices that block irrigation entailed also required the intensification of the human organization, which was not available.

On the other hand farmers showed a considerable degree of appreciation of their circumstances. Many farmers weighed out the options available to them and took appropriate action. However, extensionists or state officials in general tended to rely on models that were at variance with farmers' reality. In some instances these threatened farmers' livelihoods. The glut of maize in Fuve Panganai is a case in point. The lack of attention paid to the risk factor by state officials was a result of preferring unformity instead of diversity. In fact diversity was considered abnormal in need of (technical) regulation or standardization. The root of the problem lay in the assumptions that promoted standardization of all farming operations in the schemes. This attempt to simplify reality through the overarching technical frame, that simplified physical, technical and social diversity, was not fruitful.

One question that must be answered is why did the modernizing/scientific ideology prevail given its obvious limitations, as illustrated by the empirical material? The validation of the scientific position, it was illustrated, was through symbolic power play, by alluding to 'scientific' arguments which eroded the views of farmers. The fact that farmers' perspectives were largely ignored brings into picture power relations between farmers and the state. Any technology, such as block irrigation, has a political code (Mollinga and Mooij 1989). Thus the debate between state officials and farmers was not just a technical debate but a power struggle one as well in that the outcome of the debate did not depend on rational arguments. State officials could continue promoting block irrigation, not because they had won the argument, but because they had the power that their institution conferred upon them. In other words, the technical arguments that were propounded could not be separated from the socio-political realm. Expressed differently the socio-political dimension provided the undergird upon which the official ideology was constructed. It is important to note that it is not only the state that has ideological baggage. Donors sometimes rely on dollar power to propagate their ideologies (see chapter 6, for a more general discussion see Nijman, 1993). A practical point is that those who undertake interventions in irrigation should be wary not to confuse their ideological persuasions with the existing realities, especially with regard to operational aspects.

8 SUMMARY AND CONCLUSIONS

This chapter provides a synopsis of the study in relation to its major findings and conclusions. First, the research question that this study set out to investigate, which revolved around the subject of irrigation management in smallholder irrigation schemes in Zimbabwe, is revisited. Theoretical and methodological aspects of the research are discussed. Second, the chapter presents a summary of the major findings covering irrigation management as it was a) practised in the study schemes and b) ought to have been as defined by state officials and to some extent, donor agencies. The latter essentially deals with reasons as to the apparent differences between state and farmer-managed irrigation. Third, major conclusions of the study are presented. The main focus is on rethinking the concept of irrigation management by:

a) recasting the irrigation management debate from the field level rather than from a business management perspective,
b) distinguishing management from administration,
c) recognising management domains as emergent forms of irrigation management and
d) adopting a contingency/adhocracy perspective to irrigation management[1].

8.1 THE RESEARCH QUESTION REVISITED -THEORETICAL AND METHODOLOGICAL CHOICES

The main concern of the study was to investigate and analyse the implied (in literature) management problems in smallholder irrigation schemes in Zimbabwe, which were depicted by poor water utilization, falling agricultural production and heavy government subsidies. Schemes under farmer-management were said to be better managed than those managed by the state. The research question of the study was formulated thus:

> What are the existing management practices in different smallholder irrigation schemes in Zimbabwe, why are they different and how can the observed management practices be understood in terms of the strategies of the different actors in response to the immediate and the wider physical, technological and social environments?

Specifically the study aimed to understand the basis of management operations in different smallholder irrigation schemes, the extent to which the operations reflected users' interests, the extent to which the state influenced operations in the schemes and the underlying causes of the actions and strategies of the different actors (see chapter 1, section 1.2.2). This quest for understanding was because, while there were references to poor management in smallholder irrigation schemes in Zimbabwe, this was not matched by a clear understanding or elaboration of what management was, what it entailed and what aspects it covered. It was observed that there was thus no focus on operational aspects of irrigation management, which this study considered as key to, not only understanding what actually happened in the schemes, but also to informing how

[1] The approach emphasises that there is no one optimum way of managing irrigation schemes and hence advocates flexibility in irrigation management. On the basis of the empirical evidence presented in this book, this is seen as a useful philosophy with which to approach irrigation management (see below).

interventions meant to improve the situation could be shaped.

Both the local (Zimbabwean) and international literature was seen as limited in its concept of irrigation management, (see sections 1.2 and 1.3 chapter 1). The literature survey revealed that the majority of the studies on irrigation management was dominated by what could be called a business conception of management emphasising the setting up objectives and developing performance criteria to monitor progress (or the lack of it) towards the set objectives (see Lenton, 1988; Small and Svendsen, 1992; Rao, 1993; Murray-Rust and Snellen, 1993, Makadho, 1993, 1994). While some of the studies were useful e.g. those dealing with performance evaluation, the trend towards taking management out of the irrigated field, so to speak, into the domain of business management theories, it was observed, did not enhance our understanding of irrigation management. Another problem was that the term 'management' was used as a large portmanteau into which were put most things that were somehow different from technical factors (Wade and Seckler, 1990: 14). Yet another problem was that farmers were not accorded any management role- farmers were depicted as the 'managed'. This point will be expanded later.

In the light of the above, the study delineated management in terms of operation, and loosely defined management as day-to-day operational activities undertaken by different actors in relation to water delivery/distribution, field water application and crop management. (It was decided not to have a fastidious definition since the aim was not terminological exactitude but a conceptual framework within which management could be studied.) The focus on operational aspects was justified on the grounds that there was a need to distinguish management from other aspects such as administration, policy formulation and institutional reform. Such an approach was seen as allowing informed and targeted intervention, if desired. For example, on the basis of a good problem diagnosis, it could be decided to undertake some institutional changes so that certain management aspects can be improved, which is different from embarking on wholesale changing of the institutional environment in the hope that management would somehow be improved.

As the way forward the study drew rather heavily from a group of studies concerned with defining irrigation management at the field level. These in one way or another touched on operational aspects of irrigation management. Examples include Shanan (1992), Pradhan (1996), Horst (1998) Chambers (1988), van der Zaag (1992) and Mollinga (1998). [2] One important point made by this rather diverse group of studies, with varying degrees of emphasis, was that irrigation (management) had both technical and social aspects, hence the adoption of the socio-technical perspective as the general theory of the study.

It was observed, however, that the socio-technical approach needed to be clear on a number of points. To this end, firstly a definition was offered - irrigation systems were socio-technical in that they have social requirements for use, are socially constructed and have social effects (Mollinga, 1998: 14-15). Secondly some ground rules of the perspective in irrigation were outlined. In sum the perspective was based on a) a micro-sociological approach to research, emphasising everyday activities as the most appropriate way to understand what actually went on in the schemes, b) empirical findings but was not empiricist and c) recognised the critical influence of irrigation artefacts but did not ascribe agency to them. Thirdly, some concepts, as heuristic devices to operationalize the study, were given. These included practice, coping strategies, institutionalisation, ideology and management domains. These concepts were used to investigate irrigation management practices at three operational levels, namely water distribution, field irrigation (specifically field water application) and crop management as three distinguishable

[2]. For the respective focus of these see chapter 2.

'levels' of irrigation management.

Because smallholder irrigation schemes in Zimbabwe did not represent one homogenous group, a choice had to be made regarding to how best to structure the investigation. Since the study had management as the main focus of the study, variation in management was chosen as a useful entry point. By variation in management was meant whether a scheme was government-or farmer-managed, common labels in the Zimbabwean context. This comparison was all the more relevant because of claims in literature that farmer-managed schemes were better managed than government ones. This ironical situation was seen as warranting investigation since government-managed schemes, run by educated and scientifically-trained personnel which should actually be models for farmers to copy were poorly managed. It was therefore considered a legitimate point to find out why this was the case. From a practical angle, the investigation was also necessary - the majority of smallholder irrigation in Zimbabwe are under government management and will be handed over to farmers as a matter of policy.

To make the investigation fruitful, it was decided to study schemes of comparable size (all the selected schemes were over 100 ha in size) and method of irrigation (surface irrigation which is more widespread was chosen). Mutambara irrigation scheme was chosen as representing a farmer-managed scheme while Chibuwe was an example of a government-managed scheme. A third scheme, Fuve Panganai was added to capture the degree to which farmers were involved in management if the scheme was a result of participatory design (Agritex was claimed to have institutionalised the concept since 1985). The schemes had differences in relation to the water source and conveyance structures as discussed in chapter 3. Table 8.1 presents the main characteristics which have an important bearing on the summary comparison undertaken below.

Table 8.1 Characteristics of the study schemes

	CHIBUWE	FUVE PANGANAI	MUTAMBARA
a) Size (ha)	300	290	145
b) Water source			
From	River	Dam	River
Reliability	Poor	Good	Average to good
c) Water supply To field edge	pump, lined open canals	Gravity, lined open canal & underground pipe	Gravity, lined open canal
d) Infield works	lined open canals & earth furrows	Low pressure buried pipes	Earth furrows
e) Irrigation method	border strip	Furrow & border strip	Flooding
f) Administration	Government	Government	Traditional Chief

A case study methodology was opted for, so that an in-depth of understanding of what transpired in irrigation schemes could be obtained. This was made possible by the use of research methods originating in the social sciences such as situational analysis and participant observation (see section 1.5 chapter 1 for more details). The use of methods in the social sciences was based on the fact that management was essentially a social activity as it involved people-people interaction. This interaction, it is pertinent to say, had technological and physical dimensions, hence the research was complemented by technical measurements where deemed necessary.

8.2 MAJOR FINDINGS OF THE STUDY

The first two parts of this section present a characterisation of the presence and absence of operational irrigation management practices in smallholder irrigation schemes in Zimbabwe respectively. Section 8.2.1 discusses three operational levels/realities of irrigation management namely; water distribution, field irrigation and crop management (in terms of selection, production and disposal). The people most involved with these activities, it was noted, relied on a range of *coping strategies* to make a (relative) success of whatever they were involved in. Section 8.2.2 identifies *institutionalisation* and *ideology* as two virtual realities that militated against realisation of management practices. Virtual reality is a concept borrowed from computer-based games whereby the person involved in the game feels very much like he/she is experiencing the real thing while in fact the whole experience is a close imitation. In relation to the subject under discussion, it means that state officials may have felt that that whatever they were doing e.g. insisting on irrigation scheduling as a management tool was the real irrigation management practice while it was merely an ideological pursuit or a mere reproduction of official rules and regulations. This point has wider ramifications as discussed in subsequent paragraphs.

8.2.1 Three Operational levels/Realities

Water Distribution

Water sharing between and among farmers was shown to be an important aspect of irrigation management in the three study schemes. The main aim of the chapter was to understand the constituents of water distribution. The choice of the word 'constituent' was deliberate as these were regarded more as constituents rather than factors on the basis that these actually made up or constituted water distribution. In order to understand the intricacies of water distribution, defining water distribution as the movement of water to the field gate as implied by its technical definition, was seen as inadequate. It did not shed light on what was involved in water distribution. In pursuance of that understanding, the chapter focused on how water was distributed in at least two winter (dry) and summer seasons in each of the three schemes. By following the main actors in water distribution, and the analysing various situations, some general remarks about water distribution could be made. Water distribution was shown to be composed of:

- The *water source* (or physical environment in general terms) which determines availability of water for irrigation,
- The *irrigation technology* whose characteristics influence water sharing between and among the various users,
- *Social(political) relations*, due to the fact that irrigation resources and facilities are shared by more than one person and
- Commoditisation effects.

In general terms it could be said that the constituents of water distribution involved physical, technological and social aspects. The hydrology, the technical infrastructure and people-people interaction represented the physical, technological and social aspects in that order. Each of these constituents impacted on water distribution. The impact, however, varied from scheme to scheme. For example, because the water source was generally reliable in Fuve Panganai, in the form of a medium-sized dam, water distribution was not affected much by the water source. Technology was much more important in the sense that water shortages were encountered because of problems related to the infrastructure. On the other hand the water source was much more critical in Chibuwe and in Mutambara. Between these two, Chibuwe was affected much more because the Save River tended to dry up frequently. However, in severe water shortage years, all schemes were equally affected. Generally too little water resulted in little to no co-operation among farmers (as in the winter of 1995 in Mutambara) which jeopardised group efforts so critical to undertaking irrigation management. Out of the three schemes, socio-political relations played a much important role in Mutambara where these affected day to day water distribution. Mutambara was also unique in the sense that commoditization effects, notably the drama surrounding tomatoes and peas in winter, directly affected water distribution (as acquisition of the seed guaranteed access to water).

Apart from identifying the constituent elements of water distribution, the chapters also emphasised that these constituents did not operate in isolation to each other -they were interrelated. The inter-relationships, however, differed from scheme to scheme and from season to season. As such the inter-relationships could not be reduced to a mathematical relationship. That is to say, a full understanding of the dynamics of water distribution was best obtained by investigating water distribution and not treat water distribution as a passive sample. This justified the approach of looking at the *coping strategies* of the relevant actors particularly that of farmers and state frontline workers. The main conclusion of the chapter was that there was a need to move away from the concept of formal water allocation, which in many cases exists on paper, to actual water distribution dealing with the *where, when, how* and *why* of water sharing which is the trademark of an operational perspective of irrigation management.

Field irrigation

Another important operational 'level' in irrigation management that was discussed was field irrigation (see chapter 5). A number of observations were made.

Field irrigation was shown to be subject to a number of different factors such as water supply, the water delivery regime in place, irrigation technology, soil conditions and socio-economic factors. Thus field irrigation was not confined to the irrigated plot or just a matter of being 'below the field gate' -it was affected by a number of 'upstream' factors.

The effect of water supply on field irrigation related to the uncertainties in water distribution which in turn translated to uncertainties in field irrigation. The irrigation technology was also shown as affecting field irrigation. In Fuve Panganai the *on demand* system that was in place, thanks to the low pressure buried technology, allowed farmers to undertake frequent light irrigations. In this way farmers were able to keep their crops well watered without having to sacrifice too much of their time. They had their own irrigation schedules (frequency of water application as well as application depths) based on real life observations as opposed to scientific determination of when and how much to apply. In Chibuwe, the uncertain water supplies, and the poor physical infrastructure, at least in block D, resulted in farmers over-irrigating as a response to uncertain water supplies. This resulted in poor water management, in a technical sense. In general it could be argued that the unconstrained availability of water to farmers was critical to its efficient use, which challenges the economist's wisdom, that efficient use of water comes with scarcity (Van Steenbergen, 1996: 354). In other words adopting conventional efficiency approaches to water management does not always attain water use efficiency.

In relation to socio-economic factors, the two most important were draught power to prepare land for irrigation and labour availability to execute field irrigation. Events in Chibuwe were quite illustrative with respect to the former. Because of draught power problems, land could not be brought to the required technical level for field irrigation since this represented a significant cost of crop production This was more relevant because of border strip irrigation which requires good levelling. Labour limitations existed due to the fact that field irrigation was just one of the many tasks that irrigators had to undertake. As a result of labour limitations, field irrigation was sometimes rushed to accommodate these paying little regard to technical definitions of field irrigation.

There was another example of field irrigation being affected by non-technical issues. In Fuve Pangani there was a row among the irrigators because the field irrigation practices clashed with women 's domestic chores (e.g. fetching drinking water and laundry). While hydrants were regarded by men as technical irrigation infrastructure, this was not the case with women who saw them as sources of domestic water, never mind the fact that some hydrants were damaged in the process. The question that can be posed is how does irrigation management reconcile with such wider social needs? It is suggested here that irrigation management should take account of the wider issues. For example domestic water provision should have been seriously considered in the design stage together with farmers so that the women would not consider the designated watering point, in the form of a borehole, unsuitable. Another candidate for change is the current regulations in practically all smallholder irrigation in Zimbabwe that bar people from bathing in the canal or doing laundry. Without alternatives within the irrigation scheme setting, these regulations are not helpful at all.

Crop management

Activities around water distribution and field application are not entities in irrigation - they are meant to irrigate crops. The subject of which crops are grown is therefore critical. It was shown that in government-managed schemes there was a tendency to prescribe which crops could be grown. Block irrigation as discussed in chapter 7 illustrated this perfectly. It was also expected that farmers would plant at the same time and do other management aspects like spraying together. This was shown not to work. What was theoretically desirable e.g. monoculture to promote irrigation scheduling, clashed with what farmers not just preferred but could manage. For example planting at the same time was not possible because of limited access to draught power. The main point is that water management, in terms of water distribution and field irrigation, is sometimes affected by crop choice (in relation to food and cash needs of the farmers).

8.2.2 Two Virtual Realities in Irrigation Management

After having summarised the operational challenges concerning water distribution, field irrigation and crop management, this section attempts to show why these management challenges were not met by irrigation professionals/practitioners. It is suggested that this was because the state operated within certain virtual realities. The concepts of *institutionalisation* and *ideology* were used to explain the basis of the actions of many state officials in the irrigation management debate.

Institutionalisation

Both water distribution and field irrigation, to a large extent, assume that appropriate water control (to farmers) is in place, which is not always the case. This relates to putting in appropriate devices, which in public irrigation schemes in Zimbabwe is undertaken by Agritex and expatriate engineers from donor organisations. Through an inventory of hydraulic structures, and a 'biography' of a common hydraulic structure, the sluice gate, it was demonstrated that water control, from an operational perspective, was compromised. It was argued that hydraulic structures in state-managed irrigation schemes were largely a result of certain design protocols having been established rather than on purely technical grounds. This phenomenon was referred to as *institutionalisation*. In other words certain practices were institutionalised within organisations and were not necessarily technically rational. It was concluded that the socialisation processes engineers underwent in various organisations had significant effects on the choice of technical such as hydraulic structures. In other words lack of operational aspects of irrigation management should not only be blamed on individual engineers but also on the institutions they represent. At the same time national irrigation institutions are not islands -they are subject to much wider forces e.g. donors and national politics.

One major conclusion was that institutionalisation was not necessarily negative. What was being institutionalised was the issue in relation to how the institutionalised artefact or object or practice reflected the requirements of farmers, who at the end of the day, determine the success or failure of any irrigation management endeavour.

The value of these observations extend beyond their immediate practical relevance. They give credence to the socio-technical perspective, which doubts the artificial distinction that is often made between technical and social aspects of irrigation management.

Ideology

Chapter 7 in many ways provided a synopsis of the irrigation management problematic in smallholder irrigation in Zimbabwe. The problematic related to the apparent differences between the state and farmers *vis-à-vis* how irrigation management was conceptualised and executed. The differences, as was documented in the chapter, covered two critical aspects of irrigation management - water and crop management. Using block irrigation as an illustration, evidence was provided to the effect that state tended to rely on ideology and not on practical realities in its approach to management. With respect to the former there was emphasis on 'scientific irrigation scheduling' as a management tool. It must be said that this hailed from an agronomic outlook to the neglect of engineering and institutional aspects as discussed in chapter 7. Moreover, there were a number of incorrect assumptions at play which did not coincide with the realities on the ground *vis-à-vis* the needs of farmers and the conditions of the schemes in which farmers operated in relation to the hydrological, technical and social peculiarities. The result was largely inflexible standard recommendations, which sometimes jeopardised food security as well as farm viability (e.g. in Fuve Panganai scheme, chapter 7).

The observation that ideology 'fed off' the institutional power that the state wielded was made. However, this was not only state officials to which this applied; donors or financiers mustered influence through their finance. Thus ideology could not be subtracted from the issue of power relations between state officials and farmers. As such ideology could be used as a 'legitimating discourse' (Bourdieu, 1977: 188) and often relies on power formations within the society for its transmission. A general point is that it is not enough to talk of power issues in irrigation. It is more crucial that the modes of domination in irrigation are understood. According to Bourdieu (1977: 183-197), there are various modes of domination. Two examples were of interest to this study. First domination could be achieved through *objectified mechanisms* e.g. extolling the benefits of irrigation scheduling whereby objectivity is emphasised in the spirit of 'we have to be objective about water use'. Second there was evidence of what could be *cultural capital* where scientific knowledge, garnered through academic qualifications represented 'a higher culture' compared to farmers' knowledge. The point must be made that in irrigation, and in the general development field, these are essentially political strategies for maintaining certain social formations, couched in technical jargon of course. It must be added, however, that in many cases this is not apparent to the 'perpetrators' of this domination. An understanding of the modes of domination can lead us, not only into just understanding how power is wielded in irrigation schemes, but also how it be (re)channelled to good use.

In conclusion it can be said that without addressing the issues of power, authority and accountability, setting up objectives as advocated by performance assessment studies, may not amount to much. As noted by Freeman 'irrigation agency staff, however well meaning, are different from farmers, because unlike the main system managers farmers are directly rewarded and punished according to the productivity of water (Freeman, 1990: 118). Thus optimal quantity of water delivered could be useful as an objective provided farmers can hire and dismiss agency staff and when rewards for services are established by farmers (Freeman, 1990: 122). This situation does not obtain in any schemes in Zimbabwe and in many state-managed irrigation schemes throughout the world. This comment leads us to the wide debate of how society influences management aspects (see below).

8.2.3 State and farmer-managed irrigation management: an overview

In chapter 1, it was observed that there were claims in literature that farmer-managed irrigation schemes were better managed compared to those under government/state management. This was regarded as interesting because state officials represent an educated cadre of officials employed by the state to "train" farmers, oftentimes a euphemism for "teach" farmers about the ins and outs of irrigation management. What was then the reason for this reversal of roles whereby the "teacher" (state officials) had less knowledge of irrigation management than the "student"? This study sought to understand the reasons behind this irony, an understanding that was absent from the literature on smallholder irrigation schemes in Zimbabwe.

First a quick reference to Mutambara irrigation scheme, the flagship of farmer-managed schemes in the country, is made. Despite numerous problems (e.g. the political, social, physical and technical), the majority of farmers were preoccupied with operational aspects. Farmers showed remarkable ability to weave many conflicting elements into one, albeit, 'messy' management whole. The farmers negotiated their own tomato contracts to the satisfaction of a commercial company. They had suitable cropping programmes, which took account of food security requirements. Mutambara farmers also engaged in debate about water rights unlike their colleagues who were 'shielded' by state officials. (It needs to be stated, however, that farmers in state-managed irrigation schemes were not that passive. Within the constraints they faced they were still innovative). All these successes were against a very poor technical infrastructure and no financial support whatsoever from government. If conventional quantitative performance criteria were applied e.g. technical parameters such as water use efficiency or crop yields, Mutambara could have scored low in performance ranking. This would have been a poor depiction of the realities in Mutambara.

It is important to underline the fact that these successes were possible because the irrigation technology in place was cheap and easy to manage. As noted in chapter 4 if it were a pump-operated scheme the story would have been different. The physical aspects, as represented by the hydrological characteristics, also played a part as did the socio-historical circumstances. In other words Mutambara needs to be understood not just as a farmer-managed scheme, but as a scheme with certain distinct characteristics which influenced how management was undertaken therein. Another qualification is that the fact that farmers in Mutambara managed their own affairs does not mean there were no problems (see Manzungu, 1995). In fact it can also be argued that the prospects of the scheme were not good in the long term. The physical infrastructure was progressively deteriorating with no discernible/tangible strategies for correcting the situation. Inequality in water distribution was also rife. The other major problem was that the irrigation community did not and could not have any internal policing mechanisms. It would appear that there were reasons, as identified by farmers in the Maunzani block, for the state to play some role.

The evidence in this study suggested that farmer-managed irrigation was by and large successful. This, however, should be qualified by paying attention to the strengths and weaknesses, which can then be used to isolate conditions that promote effective farmer management of schemes. Without this caveat it is hasty to extol the virtues of farmer management. It can be recommended that the state needs to invest in understanding the situation first before intervening in the schemes. This is all the more relevant given that the state currently wields power in many smallholder irrigation systems. It would appear that joint irrigation management between the state and farmers could be the way forward in some schemes, for example where the technology may be beyond farmers' capacity. In such systems the state may provide the much need of technical backup so as to facilitate farmer management at the local level.

One important point emanating from the above discussion is that irrigation management is not and should not be isolated from the wider socio-political environment. This all the more relevant in Zimbabwe where government involvement in smallholder irrigation schemes is so pronounced. As such studies on irrigation management should analyse and understand the relationship between the state and farmers since irrigation intervention is mediated by relations between the state on one hand and farmers on the other (Manzungu and van der Zaag, 1996).

The above remark is borne out by the fact that current administrative arrangements in government-managed irrigation schemes in Zimbabwe were found to militate against promoting a culture of operational irrigation management. The government department responsible for irrigation, Agritex, did not have any personnel responsible for irrigation management. The Irrigation Branch was thus a design rather than management outfit. Management fell under the Field branch and was undertaken by junior personnel (the highest was a certificate holder in general agriculture). Management was therefore no man 's land in as far as state institutions were involved. In the end farmers and frontline state workers were increasingly filling this void. Unfortunately the frontline workers were not equipped enough with the necessary knowledge and skills. Farmers were also disadvantaged in the sense that they did not legally have a management status. Irrigation Management Committees were not recognised in law and were mostly seen as assisting Agritex to manage schemes (Makadho, 1994). These observations, dealing with state-farmer relationships in smallholder irrigation schemes, need also to be placed in their proper historical context.

Events in today 's schemes in Zimbabwe are a product of a long history of an intrusive state into the sub-sector (see chapter 2). State involvement in smallholder irrigation in Zimbabwe dates back to the mid 1930s when the state took over farmer-initiated schemes (Mutambara irrigation scheme being the most famous) and constructed others for political reasons (see chapter 2). Strict control of farming activities over the schemes followed. This strict regime was bequeathed to the post-colonial era. To some extent, as already said, the differences between the state and farmers has throughout history represented the irrigation management problematic. It appears that both the colonial and post-colonial state was overly concerned with the *governability* of the schemes. That is to say, the actions and activities of state officials were 'naturally' aimed at making the schemes easy to run or govern. The primacy given to this issue by state officials, knowingly and unknowingly, minimised farmers ' own contribution. This of course is not unique to Zimbabwe. Freeman generalises it this way:

> The problem (in irrigation schemes) is that the generalisations of irrigation managers in large bureaucracies are not legitimate where farmers' individual and unique settings are concerned. The lack of mutual understanding is rooted in differences in types of knowledge and experience. There need be no hypothesis of irrationality or ill will on the part of any party to account for fundamental differences in orientation (Freeman, 1990: 114).

8.2.4 Conclusion: juxtaposing the research question and the findings

If a short answer were to be given to the research question it would be this: irrigation management practices in smallholder irrigation schemes in Zimbabwe differ depending upon whether a scheme is government-or farmer-managed. In government-managed schemes there was a tendency towards invoking the ideology of 'science' which more often that not was at a tangent to real management issues. This ideology was well supported by an intricate set of rules which contributed to the institutionalisation of the said ideological behaviour on the part of state officials. The reliance on official rules and regulations pointed to the need to go beyond the mere observation of power issues in irrigation -it was important to understand the modes of domination.

As will be expanded below government-managed irrigation schemes tended to be administered than managed. On the other hand farmer-managed schemes were managed in the sense that strategic actions were taken to solve management issues. The coping strategies of farmers embodied what happened in the schemes -farmers were preoccupied with securing their livelihoods and not with ideological debates. Moreover, it will be pointed out in the subsequent paragraphs that the labels of government-and farmer-managed irrigation schemes can be misleading since farmers do not relinquish all management duties to the state. This study does corroborate other works on African irrigation such as those discussed in chapter 2 (e.g. Diemer and Vincent, 1990, Adams, 1992, Makadho, 1994 among others). However, this study tried to go a step further and sought to explain why farmer-managed schemes tended to be better managed compared to schemes managed by 'experts'.

8.3 MAJOR CONCLUSIONS: RECONCEPTUALIZATING IRRIGATION MANAGEMENT

At the beginning of this thesis it was noted that the subject of irrigation management, locally and internationally (especially at the operational level), was deficient. There was thus a compelling reason, as demonstrated in this book, to justify a revisit of the concept of management. This last section of the chapter tries to show along which dimensions the concept of management needs to be revisited, dealing in turn with ideas about 'going back to the field' in the conceptualisation of irrigation management, distinguishing administration from management and the need to understand management domains. This leads to a discussion of a contingency management approach to irrigation management.[3]

At the base of this argument is that management should not be conceived as a hierarchical expression of power and authority structures in the schemes as implied by the organograms of

[3]. This should not been conceived as something "extra" to real management: it is rather a philosophy to irrigation management which advocates that management should be in sympathy with changing physical, technological and social environments.

organisations. Rather management involves negotiations (which may be shaped by power and authority) between the actors. These bring about management domains as distinct fields of action where different actors wield influence over what happens therein more than the other actors. On this basis it is noted that the best approach for effective management in smallholder irrigation schemes is what may be called contingency management (also known as adhocracy). This espouses the basic principle that there is no one way or blueprint of managing irrigation. The specifics, or peculiarities, of different situations and circumstances of irrigation schemes determine the relevant management regime. The strategic actions of the actors, in response to a given set of circumstances, constitute an important aspect of contingency management, hence the need to find out what actually happens at the ground. The practical implication is that such an understanding of irrigation management will inform better management practices. The concept has also relevance to design issues -the design should facilitate and not frustrate strategic action.

At various points in this book the importance of looking at the day-to-day operations in irrigation was emphasised on the grounds that, at the end of the day, the success of any policy, technological or institutional interventions, depended on how water was actually shared in the schemes. It was suggested that management needed to be taken back to the field so as to understand what actually was going on in the schemes upon which informed interventions could be based. This observation was based on the fact that irrigation management had been, perhaps, too much affected by a business management theory. Below is a discussion of how that returning to the field can be undertaken.

8.3.1 Distinguishing administration from management

Evidence presented in the empirical chapters showed that the state tended to administer rather than manage irrigation schemes. This refers to the fact that formal rules and regulations were relied on and invoked irrespective of the demands of the specific situation (see Uphoff, 1991). The procedures often did not have much to do with actual operations in the schemes. For example 'management' for the 'managers' meant the application of irrigation schedules, standard crop production packages and strict regimes of enforcing these (see chapters 7). Uphoff (1991: 26-28) distinguishes managed and administered systems. In managed systems irrigation agencies or farmer organisations are *oriented towards flexibility and adaptation, towards learning new methods and strategies, varying activities in accord with differentiated or changing conditions and objectives.* Administered systems, on the other hand, *follow predetermined schedules, criteria, and instructions and guide lines.*

As noted by Uphoff, administration has its advantage -it allows reliability and predictability. However, Uphoff suggests an *either or* approach to management, arguing that a scheme can either be an *administered* or a *managed* one. This characterisation is disputed here on the grounds that each irrigation system essentially has elements of both administration and management. As such it is undesirable for system to be only administered or managed; there cannot be any replacement of strategic action by any administrative act or vice versa.

All in all farmers demonstrated an awareness of operational aspects of many irrigation-related activities. For example Fuve Panganai farmers successfully irrigated their fields despite steep slopes and variable soils with little to no official advisory input. Further they had a working idea of irrigation schedules based on their experiences. The same can be said for water distribution in Chibuwe where novel water measurements were used by the water bailiff and farmers (see Figure 7.2). Even in Mutambara where the political situation was not conducive, coupled to uncertain water supplies, farmers devised effective coping strategies.

The above remarks make a case for exercising caution when discussing irrigation management. For example, in the context of public-managed schemes, management is invariably defined as something farmers do not do. In the light of the evidence presented here calling state officials 'managers', is misleading since state officials administered rather than managed the schemes. By the same token 'state-managed' irrigation schemes are a misnomer since it is implied that in these farmers do not have any management functions. These terms tell us very little about the dynamics of irrigation management, certainly not at the operating level. The concept of management domains does offer some help.

8.3.2 Management domains

In his attempt to present 'some useful conceptual frameworks for thinking and communicating about the management of irrigation systems and the schemes they serve' Keller (1990: 31) defined an irrigation scheme as incorporating three primary *domains;* namely the watershed, the water supply and the agricultural domain. According to Keller irrigation scheme management referred to the management of the watershed and the irrigation systems as a whole, plus the management of information and people, and of the necessary production, financial and institutional inputs. This study, on the other hand, narrowed down the definition of irrigation management to activities within the field but acknowledged that the wider physical, social and technological environment could influence these activities.

The concept of domains, it is suggested here, can be used to analyse irrigation management so as to obtain a comprehensive understanding of how irrigation management is executed. But is important to note that, as discussed in chapter 1, domains in this study were used differently from that of Chambers (1988), Keller (1990) and Small and Svendsen (1992). This study used the concept as it was used by Van der Zaag (1992) and Mollinga (1998).

The concept of domain was seen as conveying the idea of spatial territory defined by the practices and social interactions in particular settings or circumstances (van der Zaag p.212) cf. (Mollinga, 1998). This means that domains are of an emergent nature in that they come into being, not because they are planned for or gazetted, but are a result of the need to find solutions to pressing management challenges. They usually come about through negotiations by different actors. The concept of the existence of management domains in irrigation fits well with the presence of multiple actors in the schemes. This removes the burden of looking for specific groups of people to give the honour of being the 'managers' or 'the management'. The evidence in this study showed that management was not done by one individual or a group of people but by many different actors. Some examples will suffice. In Chibuwe it was shown that, as far as water distribution was concerned, this was largely the domain of the water bailiff and farmers. The field irrigation domain belonged to farmers while the Irrigation Management Committee acted as the broker in conflict resolution. The 'manager' of the scheme, in this case, the supervisor had also a role to play - he could use his institutional powers to apprehend bye-law breakers, something which the irrigation Management Committee, because of social pressure, could not do. Even in Mutambara domains existed. This explains why the traditional leadership failed to impose their will upon every aspect of irrigation management.

A practical agenda *vis-à-vis* management domains is to identify them, acknowledge them for what they are, and use them as basis for understanding and crafting better management practices. The notion of management domains is also flexible: it is not averse to different forms of management that may emerge as better alternatives to blueprint management approaches based on *a priori* decisions on what is the best form of management. The concept of management domains can also be placed within a large framework of what has been called contingency management (Dessler, 1986) as described below.

8.3.3 Contingency management

Contingency management (or adhocracy view of management) is a philosophical view of looking at management. In this case the usual meanings of the 'contingency' and 'adhocracy' do not apply - rather the two words are used in the context of organisation theory (see Dessler, 1986).

Adhocracy, in the context of management, is primarily a response to an environment that is both dynamic and complex. This can be contrasted to a professional bureaucracy where management is ordered according to an organogram. To illustrate the fundamental difference between the two Mintzerg cited in Dessler (1986: 226) puts it this way

> Faced with a.... problem, the operating adhocracy engages in creative effort to find the novel solution; the professional bureaucracy pigeonholes into a known contingency to which is it can apply a standard program. One engages in diverse thinking aimed at innovation, the other in convergent thinking aimed at perfection.

The above quote assumes practical relevance to our discussion here when the evidence in chapter 7 is recalled. We saw that irrigation scheduling, as an answer to poor water utilisation, became standardised across different situations. This compromised its usefulness. It was shown that the environment of the schemes, in terms of the physical and social characteristics, was dynamic and complex and was not appreciated as such. In this situation an adhoracy approach to management would have been ideal.

The adhocracy approach also does not depend on a management hierarchy (Dessler, 1986: 223). Instead management and operational components merge into one entity dedicated to solving both the administrative and operational (management) activities. In many ways this has begun to happen in the irrigation sector. Turnover of irrigation systems often results in a disappearance of the 'management hierarchy' leaving farmers to fend for themselves.

The ethos of a contingency approach to management is that management is seen as depending on the specific set of conditions of the scheme. In other words there cannot be the one way of organising and managing irrigation. What works in one scheme may not work in the other. The activities in the three study schemes showed that in many ways as documented in chapters 4, 5, 6 and 7. In sum, contingency management emphasises that the beginning of management wisdom is the awareness that there is no one optimum management system.

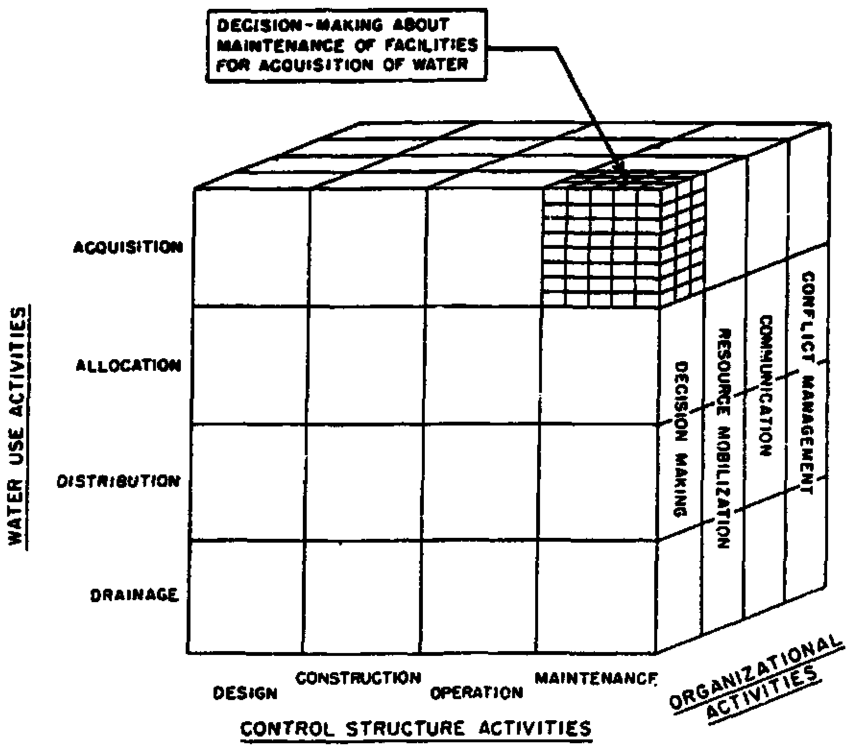
A contingency approach to management has also design implications. The design should facilitate rather than hinder the possibility of farmers engaging in strategic irrigation management. The challenge facing designers should no be underestimated since by tradition designers usually put in place systems that are meant to operate within a narrow operational range. Having said that it should be noted there are efforts towards making irrigation designs operationally friendly (see Shanan, 1992; Pradham, 1996; Horst, 1998).

8.4 EPILOGUE

This study has attempted to provide an alternative way of looking at irrigation management. The alternative was very much shaped by the empirical findings that related to smallholder irrigation schemes in Zimbabwe. To this extent the applicability of the suggested approach may be different in different circumstances. That remains a subject of research. However, the argument for a more flexible but field-based concept of irrigation management still holds water on the grounds that it is in the farmers' fields where any interventions, at whatever level or from whatever angle, will ultimately be tried and tested. The point that was emphasized throughout the book, and which is worthy repeating, is that it is crucial to separate operational aspects of irrigation management from such general issues dealing with administrative, policy, institutional aspects, for example. Without this separation irrigation management will remain shrouded in generalisations.

APPENDIX 1

Uphoff 's cube of irrigation activities in three dimensions



Source: Uphoff (1991)

APPENDIX 2

Major Features of Zimbabwe's Farming Sectors

			Small-Scale	Large-Scale	
	Communal farms	**Resettlement area farms**	**Small-scale commercial farms**	**Large-scale commercial farms (private**	**Parastatal government farms**
Number of farms	1,000,000	56,794	8,500	4,832	55
Total land area (million ha)	16.34	3.29	1.38	10.74	0.42
Share of tatal agricultural land (%)	50.8	10.2	4.3	33.4	1.3
Average farm size (ha)	18	58	162	2,223	7,644
Of which is arable (ha)	3-5	3-5	10-40	Highly varied	Highly varied
% of land in Natural Regions (NR):					
I and II	9	19	19	35	4
III	17	35	35	22	32
IV and V	74	43	46	43	64
Irrigated area (000)		72	3.6	126.0	13.5
Share of National Woodland area (%)			21	44	3.5
Estimated population (000)	5,327	421	166	1,160	38
N density (persons/sq km)	32.6	12.8	12.0	10.8	9.0
Cropping intensity (planted area/total area) (%)	14.0	5.8	4.3	4.2	2.3
Livestock stocking rates (ha/ISU)	5.5	8.2	6.4		9.3

Source: After GOZ (n.d.)

APPENDIX 3

Policy objectives in smallholder irrigation development in Zimbabwe: 1912 to the present

Period	Policy objectives
1912-27	Farmer-initiated furrow irrigation with help from missionaries. Government watches from a distance
1928-34	Government provides services and helps farmers develop irrigation schemes. Farmers retain control of the schemes
1935-45	Government takes over management of communal irrigation schemes
1946-56	Racial segregationist laws are reinforced. Black people are moved to native reserves. New irrigation created to resettle black people
1957-65	Government curtails development of irrigation schemes because of cost ineffectiveness
1966-80	Government policy of separate development for blacks and whites revived. Irrigation schemes conceived as 'population concentration camps' around rural growth points based on irrigation
1981-90	Government policy emphasizes reduction of irrigation subsidies and greater farmer participation in the design, financing and management of schemes
1991-	Discourse on farmer participation strengthens with no concrete action plans. De facto turnover of some schemes to farmers

Source: Rukuni and Makadho (1994) and Manzungu (1996b)

APPENDIX 4:

Government insitutions responsible for smallholder irrigation in Zimbabwe: 1932 to the present

Period	Responsible government institution
1932-1944	Ministry of African Affairs
1945-1963	Internal Affairs African Administration
1961-1963	Department of Native Agriculture (Ministry of Agriculture)
1964-1968	Department of Conservation and Extension (Ministry of Agriculture)
1969-1978	Ministry of Internal Affairs
1979-1981	Devag (Ministry of Lands, Resettlement and Rural Development)
1981-1985	Department of Rural Development (Derude)
1985-	Agritex

Source: Rukuni (1986)

APPENDIX 5

Present institutions in smallholder irrigation in Zimbabwe

Smallholder irrigation schemes fall under a number of institutions that are located in a number of ministries. In this regard the improvement from the colonial past has been slight. It is important to note that the Ministries of Agriculture and Water have been shuffled a number of times during the course of the study. This brief description limits itself to the current situation.

Ministry of Lands and Agriculture
The Ministry is charged with formulating and implementing policy on agriculture. In relation to irrigation, it is supposed to formulate appropriate policies, strategies and plans to guide both planners and users of irrigation infrastructure. The Ministry is supported by other ministries, departments and non-governmental organizations.

Department of Agricultural, Technical and Extension Services (Agritex)
This is the government department which is charged with irrigation development in addition to its other responsibilities such as planning agricultural projects as well as offering extension services. Most of Agritex's activities are in communal areas while in commercial areas Agritex is involved by invitation. In irrigation, Agritex 's responsibilities include identification of potential irrigable land and assessing feasibility of projects. It is also directly involved in planning, design, implementation and operation of smallholder irrigation schemes as well as coordinating the donor community in the sub-sector.

Department of Research and Specialist Services (DR&SS)
DR&SS undertakes soil surveys to establish the suitability of soils for irrigation.

Regional Water Authority (RWA)
This parastatal was tasked with the management of water resources to irrigated lands in the south-eastern lowveld region of the country. RWA has now been replaced by the Zimbabwe National Water Authority (ZINWA) by act of parliament that was passed in 1998. ZINWA will have jurisdiction over all the country 's water resources.

Agricultural and Rural Development Authority (ARDA)
ARDA is a parastatal charged with agricultural and rural development on behalf of the government. Under it are 13,500 ha of irrigation, which qualifies it as the largest single irrigator in the country. Attached to ARDA 's estates are settler irrigators, also known as outgrowers.

Agricultural Finance Corporation
This is a parastatal which administers finance for lending to farmers. Under it is a revolving fund, the National Farmers Irrigation Fund (NFIF), with a concessionary interest rate of 9 per cent. In its original set up this fund was tied up to growing wheat. The wheat requirement was, however, restricted to commercial farmers. In communal areas the restriction was that farmers had to be in groups to access the funds in addition to the proviso that the money would be used for in-field works. On the other hand, commercial farmers could use the fund for dam development. Because of these strictures, only 2 per cent of the money was accessed by communal farmers.

Ministry of Rural Resources and and Water Development (MRRWD)
This Ministry has overall responsibility for water development in the country. Under it are a number of departments.

Department of Water Resources (DWR)
DWR under MRRWD holds the mandate for water resources management in the country. It plans, implements and operates water projects or undertakes supervision of projects where non-in house service is sought. In addition it supposed to keep an inventory of both surface and underground water and is also supposed to safeguard water quality. Part of DWR will be absorbed in ZINWA.

District Development Fund (DDF)
Falling under the MLGNH undertakes development of rather smallholder irrigation schemes.

National Economic Planning Commission (NEPC)
Under the Office of the President the NEPC vets, approves and prioritizes all public-funded projects including irrigation projects.

Ministry of Finance (MOF)
As the Ministry responsible for administration of public funds in the country, it also administers project funds which may be government or donor funds. The Ministry is responsible for negotiating project funds with donors.

Ministry of Local Government and National Housing (MLGNH)
The Ministry is responsible for local affairs. It is involved in mobilising communities for irrigation projects, farmer selection and plot allocation, tasks which it shares with Agritex.

Non-Governmental and Donor Organizations
Local and international donors are also involved. Some of them concentrate on small irrigation schemes (under 10 ha) e.g. Christian Care, Lutheran World Federation and Coopibo. International organizations include, FAO, Danida, GTZ, Japanese Embassay etc.

Irrigation Management Committees
These were set up by the government in every scheme so that they would act as farmer representative bodies. The lack of a legal status has compromised them greatly.

LEGAL INSTRUMENTS

The Water Act (1976) was repealed in 1998. It was replaced by the Water Act (1998) which among other things did away with the priority date system which espoused the principle of 'first in time first in right' principle. This was regarded as discriminating against the black population. Another new act, the Zimbabwe National Water Authority (ZINWA) Act (1999) gives power to catchment councils to issue water permits in consultation with ZINWA, a function which was centrally being done by the Water Court.

APPENDIX 6

Job description of the water bailliff as designed by the irrigation supervisor

POSITION CHARTER. WATER CONTROLLER/WATER BAILIFFS. AGRITEX CHIBUWE IRRIGATION SCHEME. NOVEMBER 1994"

NAME..POSITION CHARTER: WATER CONTROLLER

REPORTS TO

NAME..POSITION: AEW

KEY OBJECTIVE
Purpose: To assist farmers to be self sufficient and produce surpluses for sale through systematic agricultural management skills.

SERVICES
To provide the following services:
1. Water management skills
2. Crop cultural practices
3. Efficient routine maintenance work
4. Administration

TARGET GROUP: To satisfy the identified needs of Chibuwe Irrigation Scheme farmers
GEOGRAPHIC: To provide these services throughout the Chibuwe Irrigation Scheme

1. WATER MANAGEMENT SKILLS
To maintain an efficient water management system which meets Agritex standards
STANDARDS
Water measurement
- Record time pump starts and stops
- Record canal and gauge amount of water per tertiary canal
- Advice the correct use and number of syphons/border strips
- Record time taken to irrigate 1.0 ha
- Record depth of irrigation after 24 to 48 hours
- Assess amount of water spilling into drains
- Recommend flow cut off two-thirds run of border strip

WATER DISTRIBUTION TO FARMERS
- Keep an update routine programme of who gets water and when
- Record crop and area irrigated
- Adjust routine to prevailing circumstances
- Withhold water from farmers who do not comply with rules and regulations of the scheme
- Water is allocated only to adults who may not be assisted by their own children

LAND MANAGEMENT
- Inspect plot boundaries that they are properly demarcated.
- Ascertain border strips are of the recommended measurement
- Bunds are of the recommended height i.e. + 23 cm

- Ploughing is done at a depth of 23 cm.
- Harrowing is done before planting in order to achieve a fine xseedbed.
- No subletting is practised by farmers.
- Report veld fires
- Discourage indiscriminate cutting of trees in the scheme
- Report any stray animals.

CROP MANAGEMENT
To develop an efficient and effective crop management system.
STANDARDS
- To ensure that crops (are) planted at recommended time.
- That only recommended types of crops and varieties are planted.
- That farmers do apply the recommended fertiliser types and amounts
- That farmers apply well-rotted and recommended amounts of manure
- Ensure that pests are effectively controlled.
- That farmers achieve recommended plant population for the type of crop
- Record area planted to each crop
- Crops are harvested in time and yields recorded.
- Crop residues are made into compost or made available to livestock as supplementary feeds or bedding.
- No stover is burnt

ADMINISTRATION
Develop and maintain an efficient administrative system which operates within Agritex rules and regulations.
STANDARDS
- Cropping programmes are submitted.
- Winter = 15th September
- Summer = 15th March
- Seasonal report is submitted by 31st August
- Facts and figures report is submitted by 30/09
- Water level, ZESA metric readings, area irrigated and pumping hours report forms are submitted once a month
- Area planted for winter and summer crops are submitted weekly during relevant periods
- Call for farmer meetings
- Attend farmer and staff meetings
- Settle farmer disputes with AEW and IMC member

MAINTENANCE WORK
To ensure that plotholders comply with scheme maintenance rules and regulations.
STANDARDS

Canals
- Maintenance of one metre canal bank
- That silt in canal is kept to a minimum
- Report any canal damages for immediate action
- Earth furrows must be kept free of grass
- Grass on canal edges must be kept short
- Report very low spots in earth furrows
- No washing of clothes and/bathing in the canals and furrows.

ROADS

- Ensure bridges and grids are in good working order
- That mitre drains are in working order
- That road has no potholes, corrugates, tall grass or major damages
- No implements (ploughs, harrows, sledges, cultivators etc) are drawn on roads
- Road has a good clearance from tree branches

FENCE

- Report any broken fences
- Report any stolen fences
- Ensure gates are in good condition
- Ensure gates are closed most of the time
- Ensure worn out droppers and standards are replaced in time.
- Good maintenance of fire guards where applicable.

APPENDIX 7

Hydraulic properties of structures (After Horst, 1998)

From the hydraulic point of view irrigation structures can be divided into two types:

- overflow type (wiers and flumes)
- undershot type (orifices).

These structures can be used under two hydraulic conditions:

- non-module - discharge affected by upstream and downstream water level
- semi-module - discharge only affected by upstream water level.

In order to determine the discharge, in the first case two (upstream and downstream) and in the second case one (upstream) water level readings are required.

Sensitivity and Hydraulic Flexibility

Two important hydraulic concepts explain the operational implications of selecting a certain type of structure: the *Sensitivity* S and *Hydraulic Flexibility* F.

Sensitivity S

The discharge through a structure is directly related to the upstream head in case of semi-modular flor conditions and with the head loss in case of non-modular conditions. This can generally be expressed as:

$$Q = c.h^u$$

The Sensitivity S of a structure depends on the power u and the head h. It is commonly expressed as the fractional change of discharge caused by the unit rise of the upstream head:[1]

$$S = \frac{\Delta Q}{Q} = \frac{\frac{dQ}{dh}.\Delta h}{Q}$$

or with $Q = c.h^u$:

$$S = \frac{c.u.h^{u-1}.\Delta h}{c.h^u} = \frac{u}{h}\Delta h$$

This formula can also be used for canals. The rating curve (stage-discharge relationship for a canal may be expressed as $Q = c.h^u$, where the power u is dependent on the shape of the canal. In practice, u can be taken between 1.6 and 1.8.

Summarizing, the most common values for u are:

Overflow structures	u=1.5
Undershot structures	u=0.5
Canals	u=1.6 - 1.8

[1] Sensitivity can also be related to other indicators (such as flow area, conveyance, gate setting, etc.)

The water-level fluctuation Δh caused by a change of flowΔQ, can also be expressed as:

$$\Delta h = \frac{h}{u} \cdot \frac{\Delta Q}{Q}$$

From this formula the implications of the choice of structure become clear. Take for example an undershot (u=0.5) and an overflow structure (u=1.5). When Q, ΔQ, and h are the same value for each structure, Δh is three times larger for an undershoot than for an overflow structure.

Sensitivity requirements depend on the purpose of the structure:

- To minimise upstream head fluctuations, the Sensitivity should be high. In other words, the structure should have the highest possible factor u/h.
  u large: weir or flume (u = 1.5)
  h small: weir with long crest (e.g. duck bill weir)

- To minimize fluctuations of discharge through the structure, caused by varying upstream water levels. In this case, the factor u/h should be as small as possible (undershot type: u = 0.5 and h as large as possible, entrance as narrow as possible).

- To measure discharges. Here also the Sensitivity should be small (small variation in Q should result in a relatively large variation in h to enable accurate reading).

From the above it becomes clear that the combination for more than one purpose in one structure cannot always be reconciled.
In the above, the requirements for Sensitivities for different purposes are indicated from a hydraulic point of view. In practice, other requirements (e.g. operation or head losses) could lead to the selection of a different type of structure.

***Hydraulic Flexibility* F**[2]

The flow at a bifurcation will be divided by a certain ratio. Changes in oncoming flows will result in changes in the water level at the bifurcation. The relative change in distribution will depend on the hydraulic properties of the structures. This can be defined by the Hydraulic Flexibility F:
The Hydraulic Flexibility is an important tool to visualize generations of flow changes through a system. It is expressed as the ratio between the relative change of offtake flow and the relative change of the ongoing flow (or the ratio between the Sensistivities of offtaking and ongoing structures S_O/S_S).

[2]Often the term *flexibility* is used. Here *Hydraulic Flexibility* is used as different from *operational flexibility*. See Section 7.3

The Hydraulic Flexibility can be expressed as:

$$F = \frac{S_o}{S_s} = \frac{\frac{U_o}{h_o}.\Delta h}{\frac{U_s}{h_s}.\Delta h} = \frac{U_o\, h_s}{U_o\, h_o}$$

where:

u = power u of Q = c.h^u
h = head
o = offtake
s = supply (ongoing) flow
S = Sensitivity
(cf. Bos ed. 1978)

REFERENCES

ADAMS, W.M. (1992)
Wasting the rain: rivers, people and planning in Africa. Earthscan, London.

ALLEN, G.A., L.S. PEREIRA, D. RAES AND M. SMITH (1998)
Crop evapotranspiration: guidelines for computing crop water requirements. FAO Irrigation and Drainage paper No 56.

ALVORD, E.D. (N.D)
The gospel of the plough or a guided destiny. Autobiography of E.D. Alvord, O.B.E. MSc, Unpublished manuscript.

ANDREINI, M.S., T.S. STEENHUIS AND G. MAKOMBE (1995)
"Water management and dambo irrigation systems in Zimbabwe". In: Owen, Richard, Katherine Verbeek, John Jackson and Tammo Steenhuis (eds), *Dambo farming in Zimbabwe: water management, cropping and soil potentials for smallholder farming in wetlands.* University of Zimbabwe Publications, Harare. pp.9-21.

ANDREWS D.J AND A.H. KASSAM (1976)
The importance of multiple cropping in increasing world food supplies. In: *Multiple Cropping.*ASA Special Publication No. 27; pp 1-10.

ANKUM, P. (1992)
Classification of flow control systems for irrigation. In: Mwendera Emmanuel and Moussa Badji (eds.), *Advances in planning, design and management of irrigation systems as related to sustainable land use* .CIE and Ecowarm; pp.651-661.

BALL, J.S. (1973)
Design and construction of screeded concrete furrows. Department of Conservation and Extension.

BALL, J.S. 1983.
Design and construction of screeded concrete furrows. Department of Conservation and Extension.

BEACH, D.N. (1995)
Archaelogy and history in Nyanga, Zimbabwe. Paper for presentation to the Tenth Pan African Archaelogical congress. History Seminar Paper No. 97. Department of History . University of Zimbabwe, Harare.

BERNARD, H. RUSSEL (1988)
Research methods in cultural anthropology. Sage Publications, Newsbury Park.

BERGER, PETER, L. AND THOMAS LACKMANN (1966)
The social construction of reality: a treatise in the sociology of knowledge. Penguin Books. London.

BLACKIE M.J. (ED.) (1984)
African regional symposium on smallholder irrigation, 5-7 September 1984. Hydraulics Research, Wallingford/University of Zimbabwe, Harare.

BOLDING, A., P.P. MOLLINGA AND K. VAN STRAATEN (1995)
Modules for modernization; colonial irrigation in India and the technological dimension of agrarian change. *Journal of Development Studies* 31(6): pp. 805-844.

BOLDING, A. (1996)
Caught in the catchment: past, present and future of Nyanyadzi water management. Paper presented at University of Zimbabwe /ZIMWESI `Water for agriculture' workshop, Harare, 11-13 March 1996.

BOLTON, P.J. (1989)
Model test on free draining offtake and drop structures for small irrigation canals. HR Wallingford OD/TN 25.
BOS, M.G. AND J. NUGTEREN (1974)
On irrigation efficiencies. Publication 19. International Institute for Land Reclamation and Improvement. Wageningen.
BOITEN, W. (1993)
Flow measuring structures. Wageningen Agricultural University.
BOTTRALL, ATHONY (1981)
Comparative study of the management and organization of irrigation projects. World Bank Staff Working Paper: 458, Washington, 181b.
BOURDIEU, PIERRE (1977)
Outline of a theory of practice. Cambridge University Press, Cambridge.
BOURDILLON. M. (1990)
Religion and Society: A text for Africa. Mambo Press. Gweru.
BOURDILLON M.F.C. AND E. MADZUDZO (1994)
Small-scale irrigation schemes in Zimbabwe. Unpublished manuscript. Danida, Harare.
BUCHANAN, G (1972)
Water in agriculture. *Rhodesia Journal of Agriculture* Technical Bulletin No. 15; pp.77-81.
BULLOCK, A. (1995)
Hydrological studies for policy formulation in Zimbabwe's communal lands. In: Owen *et al. op.cit.* pp.69-81.
BUTLIG, F. AND J. MAKADHO (N.D)
Estimating crop water requirements: comparative analysis between the modified Penman method and the pan evaporation method used in Zimbabwe. In: *Irrigation handbook.* Agritex, Harare.
BURT, C.M (1996)
Essential water delivery policies for modern on-farm irrigation management□. In: *Irrigation scheduling; from theory to practice,* Proceedings of ICID/FAO workshop, Sept. 1995, Rome. Water Report No. 8, FAO, Rome. pp. 273-278.
CHABAYANZIRA, EPHRAIM (1994)
Smallholder irrigation development: impact on productivity, food production, income and employment. In: S.A. Breth (ed.) *Issues in African development* 2. Winrock International; pp.185-198.
CHALMERS, A.F. (1992)
What is this thing called science? Open University Press, Milton Keynes.
CHAMBERS, R. (1988)
Managing canal irrigation: practical analysis from South Asia. Oxford and IBH Publishing CO., New Delhi.
CHATORA, C (1995)
The resource water. Paper presented at the University of Zimbabwe/ZIMWESI workshop 'Extension intervention and local strategies in resource management; new perspectives on agricultural innovation in Zimbabwe'. Harare, 10-12 January 1995.
CHITSIKO, R.J (1995)
Irrigation development in Zimbabwe-constraints and opportunities. Paper presented at ZFU workshop '*Water development for diversification within the smallholder farming sector*',Harare.
CLEMMENS, J. ALBERT (1987)
'Delivery system and required capacities'. In: Zimbelman, D. Darell (ed.), *Planning,*

operation, rehabilitation and automation of irrigation water delivery systems. Proceedings of a symposium sponsored by the irrigation and drainage Division. American Society of Civil Engineers, New York; pp 18-34.

CERNEA. M.M. (1986)
Irrigation projects. editors' note. In: Cernea, M.M. *Putting people first, sociological variables in rural development,* Oxford University Press, Published for the World Bank

CORMACK, D.B. (1972)
Physiological aspects of irrigation of deciduous fruit trees. *Rhodesia Journal of Agriculture* Technical Bulletin No. 15. pp. 68-76.

COWARD, WALTER, E. (1980)
Irrigation and development: institutional and organizational. Issues. In: Walter E. Coward (ed) *Irrigation and agricultural development in Asia: perspectives from the social sciences.* Cornell University Press, Ithaca and London. pp. 15-27.

COWARD, WALTER. E. (1986)
Direct or indirect alternatives for designing for irrigation investment and the creation of property. In W.W. Easter (ed.) *Irrigation investment, technology and management strategies for development.* Studies in Water

DERUDE (1983)
Policy paper on small scale irrigation schemes. Ministry of Lands , Resettlement and Rural Development, Harare.

DIEMER, GEERT AND JACQUES SLABBERS (1992)
Irrigation and engineers in developing countries. In: Geert Diemer and Jacques Slabbers (eds), *Irrigators and engineers.* Essays in honour of Lucas Horst. Thesis Publishers. Amsterdam.

DIEMER, GEERT AND FRANS. P. HUIBERS (1996)
Crops, people and irrigation: water allocation practices of farmers and engineers. (eds.) pp. 1-10.

DE GRAAF, MARTIN AND WILLEM VAN DEN TOORN (1995)
Institutional context of irrigation management transfer. In: S.H. Johnson, D.L. Vermillion and J.A. Sargadoy (eds.) *Irrigation management transfer.* FAO Water Reports 5. FAO. Rome. pp.69-86.

DONKOR, STEPHEN MAXWELL KWAME (1991)
A project management model based on observation- response practices for small scale irrigation scheme. PhD thesis. Colorado State University, Fort Collins.

DOORENBOS, J AND A.H. KASSAM (1979)
Yield response to water. FAO Irrigation and Drainage Paper no. 33. FAO, Rome.

DOORENBOS, J AND W.O. PRUITT (1977)
Guidelines for predicting crop water requirements. Irrigation and Drainage Paper No. 24. FAO, Rome.

EGGINK, J.W, AND UBELS, J. (1984)
Irrigation, peasants and development: an attempt to analyse the role of irrigation in social change in Third World Societies. MSc thesis, Wageningen Agricultural University.

FAO (1996)
Irrigation scheduling; from theory to practice, Proceedings of ICID/FAO workshop, Sept. 1995, Rome. Water Report No. 8, FAO, Rome.

FEYERABEND, P. (1975)
Against method: outline of an anarchistic theory of knowledge. Bristol.

FLEURET, P (1985)
The social organization of water control in the Taita hills, Kenya. *American Ethnologist* 12(1985)1: pp. 103-118.

FIGTREE CONSULTANTS (1998)
Impact of removing the priority date system and options for future water management in Zimbabwe. Paper prepared for the Water Resources Management Strategy Technical Secretariat, Ministry of Rural Resources and Water Development.

FREEMAN, D.M. AND M.L. LOWDERMILK (1985).
Middle level organizational linkages in irrigation projects. In: Cernea, M.M. *Putting people first, sociological variables in rural development,* Oxford University Press, Published for the World Bank.

FREEMAN, DAVID M. (1990)
Designing local irrigation organizations for linking water demand with supply. In: Sampath, T.K. and Robert A. Young (eds.) Social, economic and institutional issues in third world irrigation management. Studies in Water Polic and Management. No. 15. Pp. 111-140.

GIDDENS, ATHONY. (1976)
New rules of sociological method. a positive critique of interpretatve sociologies. Cited in Mollinga (1998) *op.cit.*

GIDDENS, A (1981)
Agency, institution and time-space analysis. In: K. Knorr-Certina and A.V. Cicourel (eds.), *Advances in social theory and methodology: towards an integration of micro- and macro- sociologies.* Routledge and Kegan Paul Ltd. Boston. pp. 161-174.

GOWING, J.,A. TARIMO AND O. EL-AWAD (1996)
A rational method for assessing irrigation performance at farm level with the aid of fuzzy set theory. *Irrigation and Drainage Systems.* Volume 10 No.4. pp. 319-330.

GOZ (1985)
Rehabilitation and development of small scale irrigation schemes in communal land. Volume II: sector review. Final report April 1985. Mutambara. GKW Consult, Mannheim, Hunting Technical Services Ltd, London, and Brian Colquhoun, Hugh O'Donnel and Partners, Harare.

GUIJT, IRENE AND J.THOMPSON (1994)
Landscapes and livelihoods: environmental and socio-economic dimensions of small-scale irrigation. *Land use policy,* Vol. 11 No. 4. pp. 294-308.

HAMMERSLEY, H. (1992)
What's wrong with ethnography? Routledge, London and New York.

HARVEY, J., D.H. POTTEN AND B. SCHOPPMANN (1987)
Rapid rural appraisal of small irrigation schemes in Zimbabwe. *Agric. Admin. & Extension* 27(1987): 141-155.

HILLEL, DANIEL (1988)
Historical concepts of irrigation management. *Efficient irrigation management in arid zones,* World Bank Technical Paper No. 15. World Bank. Washington DC.

HERBST , J. (1990)
State politics in Zimbabwe. University of Zimbabwe Publications, Harare.

HOECHT, ANDREAS (1990)
Management Information System (MIS) for scheme and sector management in irrigation a modular approach. OD/TN52. Hydraulics Research, Wallingford.

HORST, L (1996)
The discrepancy between irrigation scheduling and actual water distribution: an analysis and suggestions for possible solutions. In: *Irrigation scheduling; from theory to practice,* Proceedings of ICID/FAO workshop, Sept. 1995, Rome. Water Report No. 8, FAO, Rome. pp. 297-304.

HORST, LUCAS (1998)
The dilemmas of water control: considerations and criteria for irrigation system design. International Water Management Institute/Wageningen Agricultural University.

HUGHES, A.J.B (1974)
Development in Rhodesian tribal areas, an overview. Tribal Areas of Rhodesia Research Foundation, Salisbury.

HUNT, A.F (1958)
Manicaland irrigation schemes, economic investigations. Dept. of Native Economics and Marketing, Salisbury.

HUNT, ROBERT AND EVA HUNT (1976)
Canal irrigation and social organization. *Current anthropology* 3(17). pp. 389-411.

HUNT (1982)
Determinants of management from in canal irrigation. In Diemer Geert and Jacques Slabbers (eds) *op. cit.*

HURST, PAUL (1987)
The methodology of qualitative research. *International Journal of Educational Development.* Vol 7 No. 1. pp. 69-72.

IAP-WASAD, N.D.,
National Action Programme Zimbabwe (1993).

IFAD (1994)
Review of irrigation sub-sector: Annex VII in: *Zimbabwe strategy cum general identification report.* Draft. IFAD, Rome.

IFAD (1997)
Smallholder irrigation support programme: formulation report.

JANSEN, DORIS WITH D. MFOTE AND K. KASERARAH (1993)
Economics of irrigation; a modular approach for comparing the benefits with the costs. Final report. Ministry of Lands, Agriculture etc., Harare.

JOHNSON, HAZEL (1992)
Rural livelihoods: action from below. In: Henry Bernstein, Ben Crow and Hazel Johnson (eds.) *Rural livelihoods: crises andd responses.* Oxford University Press/ The Open University, Milton Keynes. pp. 274-307.

JURRIENS, R AND DE JONG, K. (1989)
Irrigation Water Management: A Literature Survey, Working Party "Irrigation and Development" Publication nr. 0 11 89

KELLER, J. (1986)
Irrigation system management. In: K.C. Nobe and R.K. Sampath (eds.) *Irrigation management in developing countries.* pp 329-352.

KELLER, J. (1990)
On wholistic approach to irrigation scheme water management. In: Sampath, R.K. and Robert A. Young (eds.) *op. cit.*

KOEN, C AND J.P. WATSON (1987)
The relationship between Penman estimates and potential evaporation and pan evaporation. *Zimbabwe Journal of Agricultural Research* 25(1): 101-106.

KORTEN, FRANCES F. AND ROBERY Y. SIY. JR. (ED) (1988)
Transforming a bureacracy: the experience of the Philippine National Irrigation Administration. Kumarian Press Connecticut

KNORR-CERTINA. K. (1981)
Introduction. The micro-sociological challenge of macro-sociology: Towards a reconstruction of social theory and methodology. In: K. Knorr-Certina and A.V. Cicourel (eds.) *Advances in social theory and methodology: Towards an integration of micro- and macro-sociologies.* Routledge and Kegan Paul Ltd. Boston. pp. 1-47.

LAMBERT, ROBERT A. AND PATRICIA F. HOTCHKISS (1990)
Shallow ground water for micro-sale irrigation. In: Ruigu and Rukuni; pp.252-264.

LAMBERT, ROBERT A., PATRICIA F. HOTCHKISS, NEIL ROBERTS, RICHARD D. FAULKNER, MORAG BELL AND ALAN WINDRAM (1990)
The use of wetlands (dambos) for micro-scale irrigation in Zimbabwe. *Irrigation and Drainage systems* 4(1990): 17-28.

LATOUR, BRUNO (1987)
Science in action: how to follow scientists and engineers through society. Harvard University Press, Cambridge and Massachusetts.

LAVER, G (1972)
Irrigation of onions. *Rhodesia Journal of Agriculture* Technical Bulletin No. 15; pp. 82-84.

LEEUWIS, CEES (1993)
Towards a sociological conceptualization of communication in extension science: on Giddens, Habermas and computer-based communications technologies in Dutch agriculture. *Sociologia Ruralis* 33(1993)2: 281-305.

LENTON , R. (1988),
Strategy development in IIMI: the International Irrigation Management Institute: four years of development. ODI/IIMI Network paper No 88/1e. Odi. London.

LEWIS, N.S. (1984)
Flow measurement structures, Nyanyadzi, Zimbabwe. Report OD/TN 8. Hydraulics Research Limited. Wallingford. Oxfordshire.

LITSINGER, J.A., AND K. MOODY, 1976,
Integrated pest management in multiple cropping systems. In: *Multiple Cropping,* ASA Special Publication Number 27. pp.293-316.

LONG, N (ED). (1989)
Encounters at the Interface. A perspective on social discontinuities in rural development. Wageningen Studies in Sociology 27. Agricultural University Wageningen.

MAGADZIRE, G.S.T (1994)
Water is life. Address on the occasion of World Food Day. The Netherlands FAO Committee, The Hague, 14-16 October 1994.

MAHDI, M. (1986)
Private rights and collective water management of water in a Hill Atlas tribe. In: *BOSTID Proceedings of the conference on common property resource and management.* National Academy Press, Washington DC.; pp. 181-198.

MAKADHO, J.M (1990A)
Policy considerations on the role of farmers, governments and donor agencies in small holder irrigation development in Zimbabwe. In: Ruigu and Rukuni (eds.) Irrigation policy in Kenya and Zimbabwe. Proceedings of the second intermediate seminar on irrigation farming in Kenya and Zimbabwe held at Juliasdale, Harare, 26-30 may 1987. Institute of Development Studies, University of Nairobi, Nairobi; pp.138-152.

MAKADHO, J.M (1990B)
The design of farmer managed irrigation systems: experiences from Zimbabwe. *ODI/IIMI Irrigation Management Network Paper* 90/1d.
MAKADHO (1993)
An approach to quantifying irrigation water delivery performance. A paper preseneted at a workshop Irrigation Performance in Zimbabwe , Juliasdale, 4 - 6 August 1993
MAKADHO, J.M (1994)
An analysis of water management performance in smallholder irrigation schemes in Zimbabwe. PhD thesis.University of Zimbabwe, Harare.
MAKADHO, JOHANNES (1996)
Water delivery performance. In: Rukuni et al (1996) (eds.)
MAKARAU, AMOS (1996)
Zimbabwe's climate: past, present and future. Paper presented at the University of Zimbabwe/ZIMWESI workshop 'Water for agriculture'. Harare, 11-13 March 1996.
MANZUNGU, EMMANUEL (1995)
Engineering or domineering? The politics of water control in Mutambara irrigation scheme. *Zambezia* 22(1995) 2.
MANZUNGU, EMMMANUEL (1996A)
Constraints facing institutional and legal reform for effective farmer participation in smallholder irrigation: a case study from Zimbabwe. *Sixteenth Congress on Irrigation and Drainage,* Cairo, Egypt. International Commission on Irrigation and Drainage. Cairo. pp. 329-346.
MANZUNGU EMMANUEL (1996B)
Contradictions in standardization: the case of block irrigation in smallholder schemes in Zimbabwe. In: Manzungu, Emmanuel and Pieter can der Zaag (eds.) *op cit.*
MANZUNGU, EMMANUEL AND PIETER VAN DER ZAAG (1996)
The practice of smallholder irrigation: case studies from Zimbabwe. University of Zimbabwe Publications. Harare.
MANZUNGU, EMMANUEL (1998)
The development of farmer participatory methodologies for the transfer of authority and responsibility to farmers at government-run smallholder irrigation projects in Zimbabwe. Main report. Unpublished paper.
MARTIN, D.L., E.C. STEGMAN AND E. FERES (1990)
Irrigation scheduling principles. In: G.J. Hoffman, T.A. Howell and K.H. Solomon (eds.), *Management of farm irrigation systems.* American Society of Agricultural Engineers Number 9. American Society of Agricultural Engineers, St. Joseph; pp. 155-203.
MATSIKA, NYASHA (1996)
Challenges of independence: managing technical and social worlds in a farmer-managed irrigation scheme. In: Emmanuel Manzungu and Pieter van der Zaag (eds) *op cit.*
MCFARLANE, M.J (1995)
Dambo gullying in parts of Zimbabwe and Malawi: a reassessment of the causes. In: Owen *et al (eds.) op ci.t* pp. 105-116
MCGUGAN, P (1972)
Irrigation studies. In: K.E. Cackett (ed.), Lowveld irrigated wheat. *Rhodesia Journal of Agriculture* Technical bulletin No. 14. pp. 31-38.
MEINZEN-DICK, RUTH (1993)
Objectives of irrigation development in Zimbabwe. Paper presented at the University of Zimbabwe/AGRITEX/IFPRI workshop 'Irrigation performance in Zimbabwe'. Juliasdale.

MEINZEN-DICK, RUTH, AND MARTHA SULLINS AND GODSWILL MAKOMBE (1996)
Agroeconomic performance of smallholder irrigation in Zimbabwe. Paper presented at the University of Zimbabwe/AGRITEX/IFPRI workshop *`Irrigation performance in Zimbabwe'*. Juliasdale.

MEHRETU, ASSEFA (1994)
Social poverty profile of communal areas. In: Mandivamba Rukuni and Carl K. Eicher (eds)

METERLEKAMP, H.R.P (1968)
Irrigation scheduling by means of class "A" pan evaporation. *Rhodesia Journal of Agriculture* Technical Bulletin No. 16.

MHARAPARA, I.M (1995)
A fundamental approach to dambo utilisation. In: Owen *et al.*;pp. 1-7.

MINAE, SUSAN AND UBELS (1993)
Tuning irrigation systems to their social environment: towards an improved design method. In: Jan Ubels and Lucas Horst (eds).

MALDM (1996)
Regional workshop on smallholder irrigation in Eastern and Southern Afica. Nairobi, Kenya. 24-3- November 1996.

MOLLINGA, PETER P AND ALEX BOLDING (1996)
Signposts of struggle: pipe outlets as the material interface between water users and the state in a large-scale irrigation system in South India. In: Geert Diemer and Frans P. Huibers (eds) *op. cit.*

MOLLINGA, P AND J. MOOIJ (1989)
Cracking the code; towards a conceptualization of the social content of technical artefacts. Technology Policy Group Occasional Paper No. 18. Open University, Milton Keynes.

MOLLINGA, PETER, P (1998)
On the waterfront: water distribution, technology and agrarian change in a South Indian canal irrigation system. Ph.D thesis. Wageningen Agricultural University.

MOORE, MICK (1989)
The fruits and fallacies of neoliberalism: the case of irrigation policy. *World Development,* Vol 17, No.11. pp. 1733-1750.

MORIS, J. (1987)
Irrigation as a privileged solution in African development. *Development policy review* Vol 5.

MORIS, JON R AND DERRICK J. THOM (1990)
Irrigation development in Africa; lessons of experience. Studies in water policy management, no.4. Westview, Boulder.

MORKEL BYL, W. VAN DER (1972)
Irrigation of coffee. *Rhodesia Journal of Agriculture* Technical Bulletin No. 15. Water in Agriculture; pp.66-67.

MOYO, SAM (1987),
The land question. In: Ibbo Mandaza (ed.), *Zimbabwe, the political economy of transition 1980-1986.* Dakar; pp. 165-201.

MURRAY-RUST, HAMMOND,D. AND W. BART SNELLEN (1993)
Irrigation system performance; assessment and diagnosis. International Irrigation Management Institute/International Insitute for Land Reclamation and Improvement/International Institute for Hydraulic and Environmental Engineering.

MUIR, KAY (1994)
Agriculture in Zimbabwe. In: Rukuni and Eicher; pp. 40-55.
MUPAWOSE, ROBBIE MATONGO (1984)
Irrigation in Zimbabwe , a broad overview. In: Blackie, M.J. (ed) *op. cit.*
NIJMAN, CHARLES (1993)
A management perspective on the performance of the irrigation subsector. Ph.D. thesis. Wageningen Agricultural University.
NYAKUDYA I.W. (1995)
Field irrigation performance, Chibuwe irrigation scheme, Zimbabwe. MSc thesis. Wageningen Agricultural University.
NYAMUGAFATA, P (1993)
Study on the impact of irrigation development on the environment in Zimbabwe. Ministry of lands, Agriculture and Water Development. Harare. Unpublised paper.
NZIMA, M.D.S (1990)
A cropping systems research approach to cropping programmes in small scale irrigation schemes. In: Ruigu and Rukuni; pp. 375-384.
OUTHWAITE, WILLIAM (1983)
Towards a realist perspective: the realist 's view of science. In: Gareth Morgan (ed.) *Beyond method: Strategies for social research.* Sage Publications Inc. Newsbury Park. pp. 321-330.
OWEN, RICHARD, KATHERINE VERBEEK, JOHN JACKSON AND TAMMO STEENHUIS
(EDS.), 1995,
Dambo farming in Zimbabwe: water management, cropping and soil potentials for smallholder farming in the wetlands. University of Zimbabwe Publications, Harare.
OSTROM, ELINOR AND ROY GARDNER (1993)
Coping with asymmetrics in the commons: self-governing irrigation systems can work. *Journal of Economic Perspectives*. Vol. 7. Number 4, pp. 93-112.
PAGE, SAM.J AND HELAN E. PAGE (1991)
Western hegemony over African agriculture in Southern Rhodesia and its continuing threat to food security in independent Zimbabwe. *Agriculture and Human Values* Fall 1991;pp.3-18.
PAZVAKAVAMBWA, S. (1984).
Relationship between Design of Smallholder Irrigation Systems and their Subsequent Operation Criteria: The Zimbabwe Experience. In: Blackie, M.J.(ed), pp. 95 - 98.
PAZVAKAVAMBWA, S. (1984A)
Management of Smallholder Irrigation Schemes in Zimbabwe: The Committees Approach. In: Blackie, M.J. (ed), *op cit.* pp. 95-98
PAZVAKAVAMBWA, S. (1984B)
Management of smallholder irrigation schemes in Zimbabwe: the committees approach. In: Blackie; pp.421-426.
PAZVAKAVAMBAWA, S. (1987)
The impact of irrigation development on the environment a policy perspective. Paper presented at the second intermediate seminar on irrigation farming in Kenya and Zimbabwe. Juliasdale.
PEARCE, G.P.R. AND ARMSTRONG, A.S.B. (1990).
Small Irrigation Design, Nyanyadzi, Zimbabwe; *Summary Report of Studies on Field - water use and Water Distribution. Report* OD 98, Hydraulics Research, Wallingford

PEACOCK, TONY (1995)
Financial and economic aspects of smallholder irrigation in Zimbabwe and prospects for further development. Paper presented at ZFU workshop `*Water development for diversification within the smallholder farming sector*'. Harare.

PEREIRA, L.S (1996)
Inter-relationships between irrigation scheduling methods and on-farm irrigation systems. In: *Irrigation scheduling; from theory to practice,* Proceedings of ICID/FAO workshop, Sept. 1995, Rome. Water Report No. 8, FAO, Rome. pp. 91-104.

PLUSQUELLEC, HERVE, CHARLES BURT AND HANS W. WOLTER (1994)
Modern water control in irrigation: Concepts, issues and application. World Bank Technical Paper 246. World Bank. Washington DC..

PRADHAM, T.M.S (1996)
Gated or ungated water control in government-built irrigation systems: comparative research in Nepal. Wageningen Agricultural University.

RAO. P.S. (1993)
Review of irrigation performance. International Irrigation Management Institute. Colombo.

REPLOGLE, JOHN A. (1986)
Some tools and concepts for better irrigation water use. In: K.C. Nobe and R.K. Sampath (eds.) *Irrigation management in developing countries: current issues and approaches.* Proceedings of an invited seminar series sponsored by the International School for Agricultural and Resource Development. Studies in Water Policy and Management No. 8. Westview Press, Boulder and London. pp. 118-148.

REYNOLDS, NORMAN (1969)
A socio-economic study of an African development scheme. PhD thesis. University of Cape Town, Cape Town.

RODER, WOLF (1965)
The Sabi Valley irrigation projects. Dept. of Geography Research Paper No. 99. University of Chicago Press, Chicago.

ROUSSOS, PETER (1988)
Zimbabwe: An Introduction to the Economics of Transformation. Baobab Books, Harare.

RUIGU, GEORGE M. AND MANDIVAMBA. RUKUNI (1990)
Irrigation policy in Kenya and Zimbabwe. Proceedings of the second intermediate seminar on irrigation in Kenya and Zimbabwe held at Juliasdale, Harare, 26-30 May 1987. Institute of Development Studies. University of Nairobi.

RUKUNI, M. (1984A)
Cropping patterns and productivity on smallholder irrigation schemes. In: Blackie, M.J. (ed) *op cit.*

RUKUNI. M. (1984B)
Organization and Management of Smallholder Irrigation in Zimbabwe: An Overview. Working Paper 2/84 of Agricultural Economics Department.

RUKUNI, M., M. SVENDSEN, R. MEINZEN-DICK WITH G. MAKOMBE. (1996)
Irrigation Performance in Zimbabwe. Irrigation Performance in Zimbabwe Project, University ofZimbabwe, Harare.

RUKUNI. M. (1988A)
The evolution of smallholder policy in Zimbabwe: 1928-1986. *Irrigation and Drainage systems* 2(1988): 199-210.

RUKUNI. M. (1988B)
Economic and financial aspects of smallholder irrigation in Zimbabwe. Paper presented at the workshop on irrigated agriculture in Africa. Harare.

RUKUNI, M. (1993A)
Irrigation issues in Zimbabwe. Paper presented at the University of Zimbabwe/AGRITEX/IFPRI workshop `Irrigation performance in Zimbabwe'. Juliasdale.

RUKUNI, M.(1993B)
Impact of smallholder irrigation in Zimbabwe: a framework and data needs. Paper presented at the University of Zimbabwe/AGRITEX/IFPRI workshop `Irrigation performance in Zimbabwe'. Juliasdale.

RUKUNI, M. (ED.) (1994)
Report of the Commission of inquiry into appropriate agricultural land tenure systems. Volume one: main report; volume two: technical reports. Government Printer, Harare.

RUKUNI, M. (1995)
From participation to farmer-management in irrigation systems. Keynote paper presented at the Regional Workshop on Farmer Participation in Irrigation Management: Experiences from Eastern and Southern Africa. Harare, 11-13 December 1995.

RUKUNI, M. AND CARL K. EICHER (EDS.), 1994,
Zimbabwe's Agricultural Revolution. University of Zimbabwe Publications, Harare.

RUKUNI, M. (1996)
Impact of smallholder irrigation in Zimbabwe. In: Rukuni et al (1996) (eds.)

RUKUNI, M. (1997)
Creating an enabling environment for the uptake of low-cost irrigation equipment by small-scale farmers. Proceedings of a subregional workshop on *Irrigation Technology Transfer in support of food security* held in Harare, Zimbabwe. 14-17 April 1997. FAO Water Report No. 14.

RUKUNI, M. (1994)
Managing the food economy in the 1990s. In: Rukuni and Eicher; pp. 374-390.

RUKUNI,, M AND T.S. JAYNE (1995)
Alleviating hunger in Zimbabwe: towards a national food security strategy. supplement to Zambezia. University of Zimbabwe Publications, Harare.

RUSSEL, B.H. (1988).
Research Methods in cultural anthropology. Sage Publications, Newbury Park, California.

RYDZEWSKI, J.R. (ED.) (1987)
Irigation development planning: an introduction fir engineers. Wiley, Southamptpn.

SAVVA, A.P., J.A. STOUTJESDILK, P.M.A.REINIER AND S.V. HINDKJAER (1991)
Irrigation manual. UNDP/FAO/AGRITEX, Harare.

SAVVA, A.P., J.A. STOUTJESDILK, P.M.A. REINIER AND S.V. HINDKJAER (1994)
Irrigation manual. Second edition.Agritex, Harare.

SMALL, LESLIE E AND MARK SVENDSEN (1992)
A framework for assessing irrigation performance. Woking papers on Irrigation Performance 1. International Food Policy Research Institute, Washington.

SAGARDOY, J.A., A. BOTTRAL AND G.O. UITTENBOGAARD (1982)
Organization, operation and maintenance of irrigation schemes. FAO. Rome.

SCHEER, STEVEN (1996)
Communication between irrigation engineers and farmers: The case of project design in North Senegal. Ph.D thesis. Wageningen Agricultural University.

SCHWAB, GLENN, O., DELMAR D. FANGMEIER AND WILLIAM J. ELLIOT. (1993)
Soil and Water Management Systems. John Wiley & Sons, Inc. New York.

SECKLER, D. (1985)
The management of paddy irrigation systems debate. Irrigation Management Network Paper 11b. Overseas Development Institute. London.

SHANAN, LESLIE (1992)
Planning and management of irrigation systems in developing countries. *Agricultural Water Management* 22 (October 1992) 1+2.

TARAS, RAY (1984)
Ideology in a Socialist State: Poland 1956-1983. Cambridge University Press. London.

TEMBO, S AND A. SENZANJE (1988)
Water use efficiency on commercial wheat farms in Zimbabwe. In: Mandivamba Rukuni and Richard H. Bernsten (eds.), *Southern Africa: Food Policy Options.* Proceedings of the Third Annual Conference on Food Security Research in Southern Africa. 1-5 November 1987. University of Zimbabwe Publications, Harare; pp.389-406.

TIFFEN, MARY AND CHARLOTTE HARLAND (1990),
Socio-economic parameters in designing small irrigation schemes for small scale farmers; Nyanyadzi case study report 3: Managing water and group activities; implications for scheme design and organisation. Report OD116. Hydraulics Research Wallingford.

TREACY, JOHN M. (1994)
Teaching water: hydraulic management and terracing in Coporaque, the Colcal valley, Peru. In: Mitchell, William P. and David Guillet (eds.) Irrigation at high altitudes: the social organization of water control systems in the Andes. Society for Latin American Anthropology Publications Series. Volume 12. Pp. 99-114.

UBELS, JAN (1990)
The physical system and regional-national social environment. In: Wageningen Agricultural University (1990) *op. cit.*

UBELS, JAN, AND LUCAS HORST (EDS.) (1993)
Irrigation design in Africa; towards an interactive method. Wageningen Agricultural University/CTA, Ede.

UNDERHILL, H. (1990)
Small scale irrigation Cranfield Press, Silsoe.

UNDERHILL, H.W. (1984)
The Roles of Governmental and Non-Governmental Organizations and International Agencies in Smallholder Irrigation Development. In: Blackie, M.J.(ed) *op.cit.* pp. 9-22.

UPHOFF, N. (1986).
Getting the process right: improving irrigation water management with farmer organization and participation, Working Paper, Cornell University, 1986.

UPHOFF, NORMAN WITH PRITI RAMAMURTHY AND ROY STEINER (1991)
Managing irrigation: analyzing and improving the performance of bureacracies. Sage Publications. New Delhi/ Newbury Park/London.

VAN HOFWEGEN, P (1996)
Social, cultural, institutional and policy constraints. In: *Irrigation scheduling; from theory to practice,* Proceedings of ICID/FAO workshop, Sept. 1995, Rome. Water Report No. 8, FAO, Rome. pp. 323-334.

VAN STEENBERGEN, F (1996)
System captives: change and stagnation in farmer-managed water delivery schedules. In: *Irrigation scheduling; from theory to practice,* Proceedings of ICID/FAO workshop, Sept. 1995, Rome. Water Report No. 8, FAO, Rome. pp. 353-360.

VIJFHUIZEN, CARIN (1995)
Not through man or market . ZIMWESI in-house seminar paper. Mutare.
VINCENT, L.F (1980)
Efficiency as a concept in irrigation design. Development Studies Discussion Paper no. 68.
VINCENT. L.F. (1994)
Lost chances and new futures :interventions and institutions in small-scale irrigation. *Land Use Policy* 11(1994)4: 309-322.
WADE, ROBERT AND ROBERT CHAMBERS (1980)
Managing the main system: canal irrigations blindspot. *Economic and Political Weekly,* 15(39), pp.A107-112.
WADE, ROBERT (1982)
The system of administrative and political corruption: canal irrigation in South India. *Journal of Development Studies 3(18) pp. 287-327.*
WADE, ROBERT (1990)
On technical causes of irrigation hoarding behaviour, or why irrigators keep interfering in the main system. In: R.K. Sampath and Robert A. Young (eds.) *Social, economic and institutional issues in Third World irrigation management.* Studies in Water Policy and Management No. 15 Westview Press, Boulder, pp. 175-193.
WADE, ROBERT AND DAVID SECKLER (1990)
Prority issues in the management of irrigation systems. In: Sampath, R.K. and Robert A. Young (eds.) *Social economic and institutional issues in third world irrigation management.* Studies in water policy and management No. 15.
WAGENINGEN AGRICULTURAL UNIVERSITY (1990)
Design of Sustainable farmer managed schemes in sub-saharan Africa, Wageningen Agricultural University, 5-8 February, 1990.
WITHERS, BRUCE AND STANLEY VIPOND (1974).
Irrigation: design and practice. B.T. Batsford Ltd. London.
WRC (1993)
Community participation and sustainable development. *Proceedings of the international workshop on smallholder irrigation.*
ZAAG, PIETER VAN DER (1992)
Chicanery at the Canal: Changing Practice in Irrigation Management in Western Mexico. Cedla. Amsterdam.
ZAAG, PIETER VAN DER (1993)
Factors influencing the operational flexibility of three farmer-managed irrigation systems in Mexico. Proceedings of the 15th International Commission on irrigation and Drainage. The Hague. Vol 1-B; pp.651-661.
ZIMBABWE, 1994,
Irrigation policy and strategy. Ministry of Lands, Agriculture and Water Development, Harare.

ENGLISH SUMMARY

Strategies of smallholder irrigation management in Zimbabwe

The smallholder irrigation sub-sector in Zimbabwe is considered mainly to be of socio-political significance since its economic contribution, valued at below 1% of total national agriculture output, is small. It is estimated that the 10,000 ha of irrigated land in some 300 formal smallholder irrigation schemes directly and indirectly support a total of 200,000 people, a small but significant proportion of the country's 12 million people. Literature sources claim that the benefits accruing from the smallholder irrigation sub-sector are under threat due to what can be called management problems. Poor water management and low crop yields have been cited, as has also been poor financial and economic viability, resulting in heavy government subsidies. Schemes run by farmers are said to be better managed than those under government management. This is quite a significant claim given that the majority of smallholder irrigation schemes are under government management. This study therefore sought to understand the implied management problem in both government and farmer-managed smallholder irrigation schemes in Zimbabwe. This problem is explored in the introductory chapter of the thesis.

Despite its high profile in the public domain in Zimbabwe, and this is true for the international situation, management, as it is discussed in literature, is generally undefined and poorly conceptualised. The management debate is dominated by a 'container' conception of management –management is often conceptualised as something to do with a series of problems without a clear central idea of what management is, and how it may be different from administration, government or policy formulation. This study had its focus operational irrigation management, dealing with what irrigation management actually was, what it involved and did not involve, and how it was executed in practice. For the purpose of this study a working definition of management was adopted: management was defined as day to day operational actions/activities undertaken by a variety of actors in the scheme and its precincts in relation to water delivery/distribution, field irrigation and crop production and disposal as three distinguishable operational 'levels' in irrigation management. This definition informed the research question which was formulated thus:

> *What are the existing management practices in different smallholder irrigation schemes in Zimbabwe, why are they different and how can the observed management practices be understood in terms of the strategies of the different actors?*

Specifically the study aimed to find answers to the basis of management operations in different schemes, the extent to which the operations and activities reflected users' interests, the extent to which the state influenced operations in the schemes as well as the role played by the wider physical and social environment. Such an understanding may lead to the much-sought-after improvement in irrigation: operational aspects are critical to whatever interventions are instituted, be they policy, institutional, legal, or technological.

Such a focus requires an appropriate theoretical framework. The chapter traces the shift in emphasis from physical-technical aspects to social aspects which brought into being studies with the right intentions but with inappropriate tools. This was because these were characterised by a wide coverage of topics and themes and few accompanying concepts. The socio-technical approach to irrigation is chosen as the general theoretical framework of the study since it is able to handle both social and technical aspects –irrigation management is essentially a human activity with social and technical dimensions. Three rules of operationalising the approach in irrigation are given. The perspective should a) focus on micro-processes/events/interactions as a step towards an understanding of the bigger picture, b) be empirically based, but not empiricist and c) accept that material objects, such as technical devices, play a crucial role in irrigation management but deny that they have the same agency as social actors. A number of concepts that can be applied in the study of different aspects of irrigation management are identified. These include practice, coping strategies, institutionalisation and ideology.

The case study methodology was used on the basis that it facilitates insights into the subject under investigation. Empirical evidence was mainly gathered with respect to Mutambara, Chibuwe and Fuve Panganai irrigation schemes. The study was conducted between 1994 and 1996 and included at least two wet and dry seasons. Research methods and techniques used included formal and informal interviews, participant observation, situational analysis and document review.

The book consists of eight chapters. Chapter 1, whose contents have already been outlined, serves as the introduction. This is followed by two background chapters, chapter 2 and 3. The empirical material is contained in chapters 4-7. Lastly chapter 8 presents the conclusions and recommendations.

The objective of chapter 2 is contextualise the smallholder irrigation sub-sector within the national Zimbabwean context. The role of smallholder farming in general and smallholder irrigation in particular in agriculture is described as are the characteristics of the schemes in general. An overview of issues that have militated against a focus on operational aspects of irrigation management is given. Chapter 3 presents the history and contemporary characteristics of the three study schemes, namely Mutambara, Chibuwe and Fuve Panganai. This sets the scene for the empirical chapters, which follow thereafter.

Chapter 4 examines operational aspects of water distribution. It is suggested that the constituents of water distribution should be identified as a first step towards understanding the reality of water distribution. The empirical material demonstrates that water distribution is affected by the water source, the technology, social relations and commoditization of certain crops. The chapter observes that the various factors, however, combine and recombine differently in each scheme and are not mathematically related. A major conclusion of the chapter is that focus on formal water allocation should not be emphasized ahead of how actually water is distributed in practice.

Chapter 5 is concerned with field irrigation, as another important operational 'level' in irrigation management. The chapter provides evidence to show that farmers are at the very centre of field irrigation as shown by farmers' ability to cope with the demands of timing of irrigation, the amount of water to be applied and the actual application of water in the fields. A number of factors influence field irrigation. Apart from the biophysical conditions of the fields, farmers face challenges in the social realm, particularly socio-economic factors such as lack of draught power and related financial resources to adequately prepare lands for irrigation. Field irrigation is also shown to incorporate other aspects rather than just water. (In this regard the evidence in Fuve Panganai was illustrative; there was, for example, a relationship between field irrigation practice and women's domestic chores (e. g.) fetching drinking water). When water is reliable, in terms of frequency and amount, farmers tend to undertake frequent light irrigations as a way of balancing the time they spend in the field. However, 'over-irrigation' is observed when water is scarce. Then farmers, because of uncertainities, exhibit hoarding behaviour by soaking their fields to hold as much water as possible in their fields.

Chapters 6 and 7 discuss the causes of the discrepancy between farmers and government officials in relation to operational aspects of irrigation management. Chapter 6 focuses on water control whose success is said to occur when water sharing between farmers is facilitated by the technical infrastructure and farmers can easily handle water during irrigation. Hydraulic structures play a crucial role. Through an inventory of hydraulic structures and a 'biography' of a common hydraulic structure, the sluice gate, it is demonstrated that water control does not receive much consideration from design engineers, be they nationals or expatriates. It is also shown that the choice of hydraulic structures is largely a result of a routine having been established, a consequence of departmental/institutional protocol. This is referred to as institutionalization which explains that hydraulic structures may be a consequence of factors that are not necessarily technical. That is to say the socialization processes that engineers undergo tend to have a significant effect on the choice of technical artefacts, such as hydraulic structures. This evidence vindicates the adoption of the socio-technical perspective, which doubts the artificial distinction that is often made between technical and social aspects of irrigation management. From a practical point of view, it is observed that on its own institutionalization is not necessarily negative. What is being institutionalized is the issue in relation to how the institutionalized artefact or object or practice reflects the requirements of farmers, who at the end of the day, determine the success or failure of any irrigation management intervention.

Chapter 7 in many ways provides a synopsis of the irrigation management problematic in Zimbabwe. The problematic is the apparent differences between the state and farmers *vis-à-vis* how irrigation management is conceptualized and executed. These differences have to do with different reference points. Using block irrigation as an example, evidence is provided to show that the state tends to rely on 'scientific' irrigation scheduling although it is hardly suited to the circumstances. This is an example of ideology at play, referring to the fact that interventions tend to be based on ideas about what ought to be done ideally, and not on practical realities on the ground *vis-à-vis* the needs of farmers and the poor physical condition of the schemes. It is also shown that the ideology tends to be bankrolled by the institutional power that the state wields. This underlines the need to understand the modes of domination in irrigation or in simple terms, how power is constructed in irrigation.

Chapter 8 summaries the important findings of the study as well as characterizing the findings with a view to make some theoretical points regarding irrigation management. The state is characterized as administering rather than managing irrigation schemes. This means that formal rules and regulations tend to be invoked irrespective of the demands of a specific situation. In contrast farmers in all the schemes easily engaged with operational aspects of irrigation management. For example Fuve Panganai farmers successfully irrigated difficult fields with little or no official input. They depended on their own experience and devised locally determined schedules which took into account not just physical aspects but social issues as well. The same observation holds for Chibuwe. Even in Mutambara where the situation was not conducive, coupled to uncertain water supplies, farmers devised effective coping strategies. It is observed, however, that farmers had their shortcomings particularly, in relation to factoring extra-local factors. The findings caution against hasty conclusion that farmer management is superior to government management without understanding the coefficients of the actual management in place. However, the study found out that on balance, farmers were more aware of operational aspects of management than state officials, an observation that is corroborated by Makadho (1994).

As a round up to the empirical chapters, it is observed that operational aspects of management are subject to the wider environment, such as the national institutional and policy environment and there was no culture of operational irrigation management on the part of state officials. Farmers tended to consider operational aspects of irrigation management as this directly affected their livelihoods however the state tended to interfere. This situation was not unrelated to the governance of these schemes. It appeared that the governability of schemes was considered more important.

The last section of the chapter is devoted to revisiting the concept of management. Citing Wade and Seckler (1990), it is observed that in literature management is not clearly spelt out: it is treated as a large, portmanteau term into which are put most things that are somehow different from technical factors. In the Zimbabwean context this observation is true especially in the context of public-managed schemes. It is invariably associated with state officials and as something farmers do not do. The empirical evidence shows otherwise. From this perspective the word 'managers', could be misleading given that the managers were inclined towards administering. By the same token 'state-managed' irrigation scheme is a misnomer as the implication is that in those schemes farmers do not have any management functions. These labels of 'managers' and 'state- or government- managed' irrigation tell little about the dynamics of irrigation management, certainly not at the operating level. It is also argued that rationalistic models of management, such as objective analysis, or concepts derived from business management, are not really applicable to irrigation management for the simple reason that operational aspects of irrigation management a) cannot always be reduced to rational action and b) irrigation systems are radically different from the shopfloor of a business enterprise.

The book provides ample evidence to conclude that water-related operations in smallholder irrigation schemes in Zimbabwe, and in similar places, incorporates both social and technical aspects, and that a socio-technical approach is well placed to shed light on the subject of irrigation management. Whether social or technical aspects are relevant depends on the local situation. The nature of the management practices find expression in the interactions of the various actors which in turn are mediated by local factors as well as the wider environment. The relevance of any individuals or groups is not determined by clarifying the roles of the different actors, and the rules which should govern the interactions, as is commonly thought – management is about negotiating. It is therefore suggested that irrigation management should be seen as composed of management domains where some actors are more active in one area than others for a variety of reasons. That is to say management should be seen as being about strategic actions undertaken by various actors at various levels. This observation justifies what in this book was called a contingency approach to management originating from organizational theory. The sum of all this is: the beginning of management wisdom is the awareness that there is no one optimum management system.

NEDERLANDSE SAMENVATTING

Dutch Summary

Strategieën in het beheer van kleinschalige irrigatie in Zimbabwe

Het belang van de kleinschalige irrigatie sub-sector in Zimbabwe ligt in haar sociaal-politieke betekenis, aangezien haar economische bijdrage, met minder dan 1% van de totale landbouw productie op nationaal niveau, gering is. De 10.000 hectares land onder irrigatie in 300 officiële kleinschalige irrigatie systemen voorzien direct of indirect in de levensbehoeften van circa 200.000 mensen, een klein maar significant deel van de 12 miljoen inwoners van Zimbabwe. Volgens literatuurbronnen staan de inkomsten uit de kleinschalige irrigatie onder druk als gevolg van beheersproblemen ('management' problemen). Gewezen wordt op een gebrekkige waterverdeling en lage gewasopbrengsten, evenals een geringe financiële en economische levensvatbaarheid, die heeft geleid tot een hoge mate van overheidssubsidiering. Er wordt beweerd dat door boeren bestuurde systemen beter worden beheerd dan systemen onder overheidsbestuur. Deze bewering is opmerkelijk gezien het feit dat het merendeel van de kleinschalige irrigatie systemen in Zimbabwe bestuurd wordt door de overheid. Vandaar dat deze studie een poging doet de veronderstelde problemen in beheer te onderzoeken voor zowel de door de overheid bestuurde als de door de boeren bestuurde systemen. In het introducerende hoofdstuk van dit proefschrift wordt de problematiek verder verkend.

Ondanks de niet geringe hoeveelheid aandacht voor irrigatiebeheer binnen het publieke domein van zowel Zimbabwe als in internationaal verband, wordt de term beheer ('management'), zoals besproken in de literatuur, vaak slecht begrepen en niet gedefinieerd. Het debat over beheer wordt gedomineerd door een 'container' begrip van management. Management wordt vaak geconceptualiseerd als hebbende iets van doen met een reeks van problemen, zonder een duidelijk idee van wat management inhoudt, en in welke opzichten het verschilt van bestuur, beheer of beleidsformulering. Deze studie concentreert zich op het operationele beheer van irrigatie. Besproken wordt wat irrigatiebeheer is, wat het inhoudt en wat het niet inhoudt, en hoe het wordt uitgevoerd in de praktijk. Voor deze studie is een werkbare definitie van beheer gebruikt: beheer wordt gedefinieerd als de dagelijkse operationele activiteiten die worden ondernomen door een verscheidenheid aan actoren in het systeem en haar directe omgeving op het gebied van drie duidelijk onderscheidbare operationele 'niveaus' in irrigatiebeheer. Deze operationele niveaus zijn wateraanvoer en –verdeling, irrigatie op veld niveau, en gewasproductie en –verwerking. Op basis van deze definitie kom ik tot de volgende onderzoeksvraag:

Wat zijn de bestaande beheerspraktijken in de verschillende kleinschalige irrigatie systemen in Zimbabwe, waarom verschillen ze van elkaar en hoe kunnen de waargenomen beheerspraktijken worden begrepen als het resultaat van de strategieën die de verschillende actoren hanteren.

Meer in het bijzonder richt deze studie zich op het begrijpen van de grondslag van beheersactiviteiten in de verschillende systemen, de mate waarin handelingen en activiteiten gevoed worden door gebruikersbelangen, de mate waarin de staat invloed uitoefent op beheersactiviteiten in de systemen als ook de rol van het fysieke en sociale milieu hierop. Een dergelijk begrip kan leiden tot de door zo velen gezochte verbetering van het resultaat van irrigatie: operationele aspecten zijn van kritiek belang in wat voor een maatregelen ook ter remedie worden genomen, of het nu beleidsmatige, institutionele, wettelijke of technologische maatregelen betreft.

De hierboven geschetste invalshoek vereist een passend theoretisch begrippenkader. Het theoretische hoofdstuk beschrijft hoe een verschuiving heeft plaatsgevonden van het belang dat wordt gehecht aan fysieke en technische aspecten naar sociale aspecten. Deze verandering heeft geleid tot studies met de juiste intenties maar het verkeerde begrippenkader. Deze studies leggen een brede belangstelling aan de dag voor verschillende onderwerpen en thema's, maar ontberen daarbij passende begrippen. De sociaal-technische benadering in de irrigatie is gekozen als het algemene kader van deze studie aangezien deze benadering bestudering van zowel sociale als technische aspecten mogelijk maakt – irrigatiebeheer is in essentie een menselijke activiteit met sociale en technische dimensies. Drie algemene richtlijnen voor het operationaliseren van de benadering in de irrigatie worden beschreven. De benadering moet a) zich richten op micro processen, gebeurtenissen en interacties als basis voor begrip van het grote geheel, b) empirisch onderbouwd zijn, maar niet empiristisch, c) er vanuit gaan dat materiele objecten, zoals kunstwerken, een cruciale rol spelen in irrigatiebeheer maar niet hetzelfde vermogen tot handelen hebben als sociale actoren. Een aantal begrippen die kunnen worden gebruikt bij de bestudering van de verschillende aspecten van irrigatie beheer worden gedefinieerd in het theoretische hoofdstuk. Het betreft de begrippen praktijk, aanpassingsstrategieën ('coping strategies'), institutionalisering en ideologie.

De studie is verricht aan de hand van verschillende casus aangezien dit een beter inzicht oplevert ten aanzien van het object onder studie. Het empirische materiaal is hoofdzakelijk verzameld in de irrigatiestelsels van Mutambara, Chibuwe en Fuve Panganai. Het veldwerk is verricht tussen 1994 en 1996 en beslaat tenminste twee natte en droge seizoenen. De gebruikte onderzoeksmethoden en –technieken betreffen formele en informele interviews, participatieve observatie, situationele analyse en literatuur verwerking.

Het boek bestaat uit acht hoofdstukken. Hoofdstuk 1, waarvan de inhoud reeds is beschreven, beslaat de introductie. Dit wordt gevolgd door twee achtergrond stukken, hoofdstuk 2 en 3. Het empirisch materiaal wordt gepresenteerd in de hoofdstukken 4 tot 7. Tenslotte worden in hoofdstuk 8 de conclusies, aanbevelingen en epiloog behandeld.

Het doel van hoofdstuk 2 is de kleinschalige irrigatie sub-sector te plaatsen binnen de nationale Zimbabwaanse context. De rol van kleinschalige landbouw in het algemeen en die van kleinschalige irrigatie in de landbouw in het bijzonder wordt beschreven evenals de karakteristieken van de stelsels in het algemeen. Tevens wordt een overzicht gegeven van factoren die hebben geleid tot het verwaarlozen van de operationele aspecten van irrigatie beheer. Hoofdstuk 3 behandelt de geschiedenis en huidige kenmerken van de drie stelsels onder studie, zijnde Mutambara, Chibuwe en Fuve Panganai. Dit schetst het kader voor de empirische hoofdstukken die volgen.

Hoofdstuk 4 behandelt de operationele aspecten van waterverdeling. Het wordt aanbevolen om de samenstellende delen van waterverdeling te identificeren als een eerste stap naar begrip van de realiteit van waterverdeling. Het gepresenteerde empirisch materiaal toont aan dat de waterverdeling wordt beïnvloed door de waterbron, de technologie, sociale verhoudingen en de 'commoditization' (verwaarding) van sommige marktgewassen. Het hoofdstuk concludeert echter dat de verschillende factoren op verschillende wijzen op elkaar inwerken en zich aldus in ieder stelsel manifesteren op een wijze die zich niet rekenkundig laat vastleggen. Een andere conclusie is dat indien men geïnteresseerd is in het achterhalen van de daadwerkelijke waterverdeling in de praktijk, men zich beter niet blind kan staren op de officiële water allocatie.

Hoofdstuk 5 heeft betrekking op irrigatie op veld niveau, opnieuw een belangrijk operationeel niveau in irrigatiebeheer. Het hoofdstuk toont aan dat boeren centraal staan op veld niveau, zoals kan worden afgeleid uit de capaciteit van boeren om te gaan met de behoefte tijdig te irrigeren, met de hoeveelheid water die nodig is en de middelen die benodigd zijn om het water daadwerkelijk op het land te krijgen. Een aantal factoren beïnvloeden de uitvoering van irrigatie op veldniveau. Naast de juiste fysieke gesteldheid van het areaal, moeten boeren een aantal zaken op het sociale vlak bewerkstelligen, waarbij in het bijzonder een aantal sociaal-economische factoren als gebrek aan trekkracht ('draught power') en daaraan gerelateerd gebrek aan financiële middelen het moeilijk maken het areaal tijdig bouwrijp te krijgen. Irrigatie op veld niveau heeft betrekking op meerdere aspecten dan water alleen. (In dat verband levert Fuve Panganai een interessant voorbeeld: er bleek een relatie te bestaan tussen irrigatie giften op veld niveau en het verrichten van huishoudelijke taken door vrouwen i.c. het halen van drinkwater). Wanneer water beschikbaar is, in de juiste hoeveelheid en frequentie, blijken boeren veelvuldige lichte watergiften te nemen als een manier om hun tijd op het veld efficiënt te besteden. Echter, wanneer water schaars is wordt er over-geirrigeerd. Bij onzekerheid over toekomstige water beschikbaarheid, hebben boeren de neiging te hamsteren door hun velden te inunderen en aldus zoveel mogelijk water vast te houden op het veld.

In de hoofdstukken 6 en 7 staan de oorzaken van de discrepantie tussen boeren en overheidsdienaren ten aanzien van de operationele aspecten van irrigatiebeheer centraal. Hoofdstuk 6 behandelt water 'control' (stroombeheersing), waarvan het succes afhankelijk is van de aanwezigheid van een technische infrastructuur die het mogelijk maakt het water te verdelen tussen boeren onderling en daarnaast het boeren in staat stelt de waterstroom gedurende irrigatie te beheersen. Hydraulische kunstwerken spelen hierbij een cruciale rol. Met behulp van een inventarisatie van de aanwezige hydraulische kunstwerken, en een 'biografie' van het meest voorkomende verdeelwerk, de afsluitbare sluis ('sluice gate'), wordt aangetoond dat waterbeheersing niet veel aandacht geniet van ontwerpers, of het nu Zimbabwaanse of buitenlandse ontwerpers betreft. Ook wordt aangetoond dat de keuze voor de aanleg van hydraulische kunstwerken grotendeels voortvloeit uit de ontwerptraditie, die als gevolg van bepaalde departementale protocollen, is ontstaan. Dit verschijnsel wordt aangeduid met het begrip institutionalisering. Dit verklaart dat de keuze voor een hydraulisch kunstwerk meestal voortvloeit uit overwegingen die niet noodzakelijkerwijs technisch zijn. Dit betekent dat socialisatie processen die ingenieurs ondergaan een grote invloed uitoefenen op het keuzeproces ten aanzien van technische artefacten, zoals kunstwerken. Deze bevinding onderschrijft het belang van een sociaal-technisch perspectief, dat het kunstmatige onderscheid tussen technische en sociale aspecten van irrigatiebeheer overstijgt. In praktische zin is het verschijnsel institutionalisering op zichzelf niet noodzakelijkerwijze negatief. Wat wordt geïnstitutionaliseerd is de vraag, zeker in relatie tot de vraag in hoeverre een geïnstitutionaliseerd artefact of object aansluit bij de behoeften van boeren, hetgeen uiteindelijk het succes of de mislukking van een irrigatiebeheer maatregel bepalen.

Hoofdstuk 7 presenteert de irrigatiebeheer problematiek van Zimbabwe in een notendop. De problematiek speelt rond de bestaande verschillen tussen de staat en boeren ten aanzien van hoe irrigatiebeheer wordt opgevat en uitgevoerd. Deze verschillen hebben te maken met een verschil in uitgangspositie. Gebruikmakend van het voorbeeld van blok irrigatie, wordt aangetoond dat de staat een voorkeur heeft voor 'wetenschappelijke' irrigatie rota's hoewel de situatie zich hiervoor amper leent. Dit is een duidelijk voorbeeld van hoe een ideologie werkt. Veel maatregelen die genomen worden door de staat zijn gebaseerd op een ideaal model en niet op de realiteit in het veld ten aanzien van de behoeften van de gebruikers en de slechte fysieke staat waarin de meeste stelsels zich bevinden. Gebruikmakend van de institutionele macht van de staat worden veel maatregelen die voortvloeien uit de heersende ideologie erdoor gedrukt. Dit benadrukt de noodzaak om de heersende macht in irrigatie te onderzoeken. Simpel gezegd dient men zich af te vragen wie de baas is in irrigatie.

In hoofdstuk 8 worden de belangrijkste bevindingen van deze studie gepresenteerd. Ook wordt een theoretische bijdrage geleverd aan het debat rond irrigatiebeheer. Een bevinding is dat de staat voornamelijk bezig is met het bestuur van irrigatiestelsels en niet met het beheer ('management'). Dientengevolge worden officiële regels en procedures vaak toegepast in situaties die zich hier niet voor lenen. Het zijn voornamelijk de boeren die zich bezighouden met de operationele aspecten van irrigatiebeheer in de stelsels zelf. In Fuve Panganai, bijvoorbeeld, irrigeren boeren hun lastig gelegen plotjes zonder enige hulp van overheidsdienaren. Ze vertrouwen op hun eigen ervaring en ontwerpen lokaal bepaalde rota's die zowel fysieke als sociale aspecten verenigen. Hetzelfde geldt voor Chibuwe. Zelfs in Mutambara, waar het politieke spanningsveld zich niet leent voor gemakkelijke waterverdeling, en bovendien een vrijwel continue water schaarste aanwezig is, hebben boeren effectieve manieren van irrigatiebeheer gevonden. Toch schieten boeren hier wel eens tekort, hetgeen voornamelijk te maken heeft met externe factoren. Men moet echter oppassen boerenbeheer op te hemelen en overheidsbeheer te verdonkeremanen zonder de feitelijke beheerspraktijken te bestuderen. Toch wijst deze studie op het feit dat boeren zich meer bewust zijn van operationele aspecten van irrigatiebeheer dan overheidsdienaren, een bevinding die al eerder naar voren is gebracht door Makadho (1994).

Als algemene bevinding uit de empirische hoofstukken moet men concluderen dat operationele aspecten van beheer afhankelijk zijn van de wijdere omgeving die wordt gevormd door nationale institutionele en beleidsmatige kaders. Er is geen cultuur van operationeel irrigatiebeheer binnen het staatsapparaat. Boeren zijn wel gedwongen zich bezig te houden met operationele aspecten van irrigatiebeheer, aangezien hun levensomstandigheden ervan afhankelijk zijn. Deze situatie kan men niet los zien van het bestuur ('governance') van de irrigatiestelsels. Het is gebleken dat bestuursaspecten een belangrijke rol spelen in het handelen van overheidsdienaren.

Het laatste deel van het hoofdstuk wordt besteed aan een herziening van het beheer begrip. Citerend uit Wade and Seckler (1990), wordt geconstateerd dat beheer over het algemeen slecht gedefinieerd is in de literatuur: het wordt gepresenteerd als een container begrip dat alle aspecten omvat die niet technisch zijn. In de Zimbabwaanse context draagt dit begrip portee waar het publiek beheerde stelsels betreft. Beheer wordt geassocieerd met staatsdienaren en gezien als iets wat boeren niet kunnen. Empirisch bewijs toont aan dat dit onzin is. Zo bezien is het woord beheerder ('manager') uiterst misleidend, aangezien beheerders geneigd zijn te handelen als bestuurders ('administrators'). Vanuit dezelfde optiek kan men zeggen dat het misleidend is te spreken van door de 'overheid beheerde' irrigatiestelsels, aangezien de term suggereert dat het stelsels betreft waar boeren niks van doen hebben met het beheer. Stempels als 'beheerders' en door de 'staat of overheid beheerde' irrigatiestelsels zeggen niets over de dynamiek van irrigatiebeheer, zeker niet op het operationele niveau. Ook wordt beargumenteerd dat rationele beheersmodellen, zoals objectieve analyse, of andere concepten uit de bedrijfskunde, niet van toepassing zijn op het vlak van irrigatiebeheer, simpelweg omdat operationele aspecten van irrigatiebeheer a) niet altijd kunnen worden bevat als vormen van rationeel handelen en b) irrigatiestelsels radicaal verschillen van de werkvloer van een bedrijf.

Deze studie levert voldoende bewijs om te concluderen dat waterbeheer in kleinschalige irrigatiestelsels in Zimbabwe, en in andere locaties, betrekking heeft op zowel sociale als technische aspecten. De sociaal-technische benadering kan goed gebruikt worden om en licht te werpen op het onderwerp van irrigatiebeheer. Of sociale dan wel technische aspecten relevant zijn hangt af van de lokale situatie. De aard van de beheerspraktijken komt tot uiting in de interacties van de verscheidenheid aan actoren, die op hun beurt weer gedreven worden door lokale factoren en de externe omgeving. Of de acties van individuen of groepen relevant blijken te zijn hangt niet af van hun formele rol of de regelgeving ten aanzien van hun handelen, zoals vaak wordt gedacht - beheer gaat over onderhandelen. Daarom wordt het aanbevolen irrigatiebeheer te zien als een scala van beheersdomeinen waarin sommige mensen actief zijn op één vlak en anderen op een ander vlak voor uiteenlopende redenen. Dat wil zeggen dat beheer gaat over strategisch gedrag dat wordt ondernomen door verscheidene actoren op verscheidene niveaus. Deze bevinding doet recht aan wat in dit boek de 'contingency' (toevals) benadering wordt genoemd. Deze beheersbenadering komt uit de organisatietheorie. De crux van dit alles is dat een goed begrip van beheer begint met de realisatie dat er niet maar een optimaal beheerssysteem bestaat.

Curriculum vitae

Emmanuel Manzungu was born on 5 October 1958 in Chibi district. .He completed a Diploma in Agriculture from Chibero College of Agriculture in August 1984. He joined the Department of Research and Specialist Services as a research technician stationed at Chiredzi Research Station. Between 1985 and 1987 he studied for a BSc Agriculture Hons degree programme. He re-joined Chiredzi Research Station as a research officer in 1988. From 1990-91 he followed the MSc Tropical and Sub-tropical Horticulture and Crop Science course at Wye College, University of London, United Kingdom. Currently he is research co-ordinator with the ZIMWESI project.