Economic performance of smallholder irrigation schemes: A case study in Zanyokwe, Eastern Cape, South Africa

By

Njokweni Elliot Ntsonto

Submitted in Partial Fulfilment of the Requirements for the Degree

M. INST. AGRAR (AGRICULTURAL ECONOMICS)

In the

Department of Agricultural Economics, Extension and Rural Development

Faculty of Natural and Agricultural Sciences

University of Pretoria

Promoter:

Prof. Sylvain R. Perret

Pretoria

South Africa

ACKNOWLEDGEMENT

I wish to express my sincere gratitude to the following persons and institutions: that made this study a success. My gratitude first goes to my supervisor Prof. S.R. Perret, who encouraged me and read the script. Thank you for your guidance, support assistance and the opportunity to study under you. On many occasions you had to go out of your way to ensure that the study remained focussed and that all ingredients necessary for success were available.

This study would not have been possible without generous financial assistance from the Water Research Commission (WRC) for financing through K5/1353//4 project and appointing a vibrant steering committee to see the project through successfully and the National Research Foundation (NRF). The contribution by the entire steering committee is gratefully acknowledged.

I am indebted to my parents, Manayi (my father) and Nothusile (my mother), who provided me with the spiritual and intellectual inspiration to persevere under difficult circumstances. My studies would not have been possible without the loving backing and help I received from my three sisters and two brothers, Bongiwe, Lindiwe, Nontsikelelo and Zingisile and Ntando, respectively.

To my fellow students I say thank you for being there, for me when the going was getting tough and all hopes seemed to be lost. Without your encouragement to persevere, the fight might have been given up. To all those who in diverse ways made contribution to this study but were omitted, I say thanks.

Finally, I wish to acknowledge the help, protection and guidance I received from God. May His Name be praised, Amen.

Njokweni Elliot Ntsonto

Pretoria, South Africa

July 2004

Economic performance of smallholder irrigation schemes: A case study in Zanyokwe, Eastern Cape, South Africa

By

Njokweni Elliot Ntsonto

Degree: M. Inst. Agrar (Agricultural Economics)

Department: Agricultural Economics, Extension and Rural Development

Promoter: Professor Sylvain R. Perret

Abstract

This study has been carried out in one irrigation scheme of the Eastern Cape Province, South Africa. The study assessed the economic performance of a smallholder irrigation scheme (Zanyokwe Irrigation Scheme). The study took place in a former homeland area (Ciskei). This region is submitted to a semi-arid and relatively mild climate. The infrastructures were built during the apartheid era, in order to provide employment and food to the local black population. Currently, the farmers crop from 1 to 10 hectares, producing vegetables and maize with low productivity. The government has engaged in a revitalization process, aimed at upgrading infrastructures and establishing new local organisations. Its objectives are to curtail the financial burden of operation and maintenance costs and withdraw from any direct farming activitie s and management of the schemes. The process includes the rehabilitation of infrastructure and establishment of Water User's Associations, which are to take over ownership and collective management of the scheme. In such context the aims of the research were:

(i) To evaluate the diversity of livelihoods and the contribution of farming;

(ii) To estimate productivity of land and water;

(iii) To identify factors influencing production at farm level;

(iv) To examine the role of land tenure onto productivity.

The conceptual framework for operation of an irrigation scheme, the Smile (sustainable management of irrigated land and environment) approach, the sustainable livelihood framework and descriptive statistics were used for analysis of the data. Primary data were obtained from 55 randomly selected households from the Zanyokwe Irrigation Scheme. Verbal description, interpretation and appreciation of facts were used for the qualitative data analysis. Descriptive statistics and typologies were employed to analyse the quantitative da ta.

Findings indicate that irrigation households pursue heterogeneous livelihood strategies due to different access to livelihood assets and heterogeneous constraints and incentives. A socio-economic comparison on the land size indicates that land size in the scheme is not uniform, it varies from one person to another. Land tenure in Zanyokwe is very diverse. It is highlighted that land tenure does not seem to have impact onto the farming style adopted by farmers, with the exception of leasing which is not practised by non-farming holders and dry-land farmers. It is demonstrated that there is no direct or clear relationship between land tenure system and farming styles, farmer's types, or cropping systems adopted.

It is indicated that farmers under leasing arrangement are having small size, few years of settlement and youngest household head. Leasing arrangement is relatively new tenure in the scheme. The level of education in the scheme is very low. It is observed that more educated farmers have larger siz e of land in the scheme.

The diversity of the farmer's situation has been highlighted through the use of typological techniques. Five household types have been identified within the scheme, and thorough economic analyses have been carried out. Particularly, some vulnerable types of farmers have been identified. The results on irrigation performance indicate that productivity of water varies among crop management styles. For example, potato and butternut (high-yield) showed R2.55 and R1.75 as gross margin per cubic meter used respectively, and potato and butternut (low yield) showed R0.09 and R0.14 as gross margin per cubic meter used respectively, is measured in terms of gross margin per volume of irrigation water consumed as an estimate for return to irrigation water. Contingent analysis of willingness to pay indicated that farmers with limited demand, hence limited income from irrigation farming are not willing to pay, and it also suggests that farmers with high consumption of water are willing to pay for water related activities. Findings indicate that land productivity (yield/ha) is higher for specialised subsistence farmers than others types, per unit of land used

The following recommendation arises on the basis of the findings of this study and evidence from other studies on smallholder irrigation in South Africa. Agriculture is likely to be a necessary feature of rural development in the Eastern Cape Province for years to come. It is highly recommended that intensification should be promoted along wit h training, and improved access to inputs at reasonable cost since high yielding crops are more profitable and more conducive to water valuation, and high yields come with intensification, since one given crop can perform very differently depending on the way it is grown.

TABLE OF CONTENTS

CONTENTS **PAGE**

CHAPTER THREE: METHODS AND PROCEDURES

CHAPTER FOUR: RESULTS AND DISCUSSIONS

CHAPTER FIVE: SUMMARY AND CONCLUSIONS

LIST OF FIGURES

LIST OF TABLES

LIST OF BOXES

ACRONYMS

Ulimocor:	**Agricultural parastatal of the former Ciskei**
IMT :	**Irrigation Management Transfer**
SIS :	**Smallholder Irrigation Scheme**
PGEC :	**Provincial Government of the Eastern Cape**
NDA :	**National Department of Agriculture**
WUA :	**Water Users Association**
HH :	**Households**

CHAPTER ONE: INTRODUCTION

1.1. Background

South Africa is currently undergoing a significant transformation in its political, social and economic structure. The political dimension of the transformation process has been remarkably and successfully completed as marked by the first all-race election in April 1994 and the subsequent elections in 1999 and 2004. The government has made considerable progress in peeling away the legacy of racial segregation through legal and regulatory reform and redistribute public investment programmes (Ngqangweni, 2000). This process of change has called attention to the issue of reintegration of the previously marginalized black rural inhabitants into the mainstream economy. Of particular interest is the role that black smallholder agriculture and especially irrigation agriculture could play in such a process, and specifically its role in providing needed rural livelihoods in such a dynamic environment (Ngqangweni, 2000).

There is a perception that irrigation is a first step in promoting development in impoverished rural areas (Crosby et al., 2000). In South Africa, like in many other African countries, smallholder irrigation farming has a long tradition. Farmers primarily used rivers and streams as a source of water to irrigate small plots for cultivation of grain crops and vegetables for home consumption (Rukuni et al., 1994). This is applied in the context not only of large schemes but also in the establishment of landless people as emergent farmers and the creation of plots and community gardens to promote food security both in deep rural areas and adjacent to major population centres (van Averbeke et al., 1998).

However, smallholder irrigation schemes in South Africa are facing new challenges and changing driving forces in the world's irrigation sector. These are competing demands for water, emerging environmental issues, persistent food insecurity, poverty and financial difficulties (Perret, 2002a).

In South Africa, irrigation farming became more co-ordinated during the early part of the 20th century, and several large-scale irrigation projects were established, to serve white farmers (Bruwer et al., 1995). Though in most cases, irrigation projects focussed on the production of staple food with the objective to achieve national food self-sufficiency (Kirsten, Van Zyl, and Van Rooyen, 1990). Because of a perceived lack of entrepreneurial and managerial abilities amongst black farmers and a philosophy of "optimal resource use", an approach was taken which resulted in the establishment of estate schemes, by parastatals (e.g. Ulimocor in former homeland of Ciskei), with little or no community participation (Mphahlele et al., 2000). In a later adaptation process, projects were adjusted to settle selected l people (nominee farmer) as project farmers under central management (van Averbeke et al., 1998). One of these centrally managed schemes was the Zanyokwe Irrigation Scheme, my case study. Like many other similar projects, the scheme faces tremendous problems. Since the government support in terms of funding and service provision, lastly supplied by Ulimocor, has been stopped, most farmers dropped out of production. Significant changes have also been taking place in the South African agricultural sector since the beginning of the political reforms of the early 1990's, in line with the general climate of reform. The institutional arrangements of the old order, which favoured large-scale commercial, mainly white farms above small-scale, mostly subsistence and mainly black farms, have been changed (Ngqangweni, 2000).

The key outcomes of the Earth Summit held in Rio in 1992 were recommendations that water should be treated as an economic good, that water management should be decentralised, and that farmers and other stakeholders should play a more important role in water management (Keating, 1993, cited by Perret, 2002a). South Africa has just cautiously initiated Irrigation Management Transfer (IMT) in smallholding irrigation schemes located in former homeland areas. Vermillion and Sagardoy (1999) defined the concept irrigation management transfer as follows, "the relocation of responsibility and authority for irrigation management from government agencies to non-governmental organisations, such as water user's associations. It may include all or partial transfer of management functions and may also include full or partial authority". The impoverishment of the African rural areas demands from this sector to provide livelihoods for the inhabitants. Some research on South African agriculture is sceptical regarding the ability of smallholder farming to create additional rural livelihoods in any significant way (Kirsten, 1996).

This study aims to provide insight into contemporary smallholder irrigation farming, based on information from the Zanyokwe Irrigation Scheme. It also investigates whether there are prospects and potential for viable, long term, autonomous management and operation of smallholder irrigation schemes by farmers.

1.1.1. The situation of smallholder irrigation schemes in South Africa

In 2000, Provincial Government of the Eastern Cape (PGEC), assisted by the Department of Agriculture (DoA) and Land Affairs, started to develop a new policy for irrig ation schemes. At policy making level there was a general agreement that schemes need to be transferred to land holders and the farmers, and that the State should withdraw from active farming, limiting its responsibilities to well defined functions, mainly related to information supply through research and extension, and capital development.

At present, South Africa has an estimated 1.3 million ha of land under irrigation for both commercial and subsistence agriculture (Perret, 2002a). These schemes consume about 60% of the currently available water resources of the country (NWRS, 2002), and contribute almost 30% of the total agricultural production (Backeberg and Groenewald, 1995). Smallholder irrigation schemes account for about 4% of the irrigated area in South Africa (Bembridge, 2000). In spite of such a relatively small contribution, it is believed that those schemes could play an important role in rural development, since they can potentially provide food security, income and employment opportunities (Perret, 2002b). Moreover, their location in remote, poor, semi-arid areas represents a potential for poverty alleviation and food security in such areas, even though they represent a small percentage of irrigated land at country level.

In the Eastern Cape, it is acknowledged that most smallholder irrigation schemes (SIS) are moribund and have been inactive for many years (Bembridge, 2000). Several causes for this have been mentioned, i.e. infrastructure deficiencies emanating from inappropriate planning and design or poor operational and management structures, both beneficiaries and government assigned extension officers lack technical know-how and ability, absence of people involvement and participation, inadequate institutional structures, inappropriate land tenure arrangements (Bembridge, 1986). Also these schemes have been characterised by local political power struggles that hinder effective problem solving (Perret, 2002c).

Now the government aim is to revitalise smallholder irrigation and curtail the financial burden of their maintenance and operation costs. Most schemes are earmarked for rehabilitation and transfer to water user's association (WUAs) in South Africa. Water Users Associations form the third tier of water management and operate at local level. These WUAs are in effect co-operative associations of individual water users wishing to undertake water-related activities for their mutual benefit. By law, (NWA, 1998), farmers have to form water users association, and farmers should pay for water use and water-related services and for the resource. Since the late 1990s', government have set up rehabilitation and management transfer programs throughout the country but it is taking place in Limpopo Province and still in the planning phase in the Eastern Cape province (Perret, 2002a).

1.1.2. Development issues

"Ensuring that we manage our inheritance of natural resources with care, so that it provides livelihoods for present and future generations, is the responsibility of all. Those who use land and water must have the incentives, resources and knowledge to use them wisely**"** (Ministry for Agriculture and Land Affairs, 1998).

Many governments have found it increasingly difficult to finance the costs of irrigation operation and management and to be effective providers of water services to large numbers of small farmers (IWMI, 2002). Government is attempting to transfer management responsibility for irrigation systems from government agencies to farmers organised into Water Users Associations (WUAs). Government is seeking technical and economic options for the smallholders and rural community members to improve their standards of living, especially in smallholder irrigation schemes in which the authorities are urging the emergence of commercial farming systems, in a context of rehabilitation and ownership transfer (Perret, 2002b). Backeberg & Groenewald (1995) argued that irrigation development in South Africa shows success or failure in the past as related to marketing potential of agricultural products and the level of profitability of farming. In South Africa, smallholder black farmers are subsistence, and lack organisation, which is not favourable to sustainable self-management and cost recovery (Perret, 2002a). Without proper support measures, smallholder farmers are not likely to take over immediately the management that governments and parastatals used to carry out for them, to shift directly from subsistence farming to commercial farming and lastly to take direct charge of operating and maintenance costs within the schemes. Conversely to most situations elsewhere in the world, black farmers are not used to paying for irrigation water related services (DWAF, 1997).

IMT is a new solution in this regard, whereby farmers should manage their own scheme and activities, and contribute to cover water fees and resource fees. The reliance of farmers on irrigation schemes may be weak in many instances, on-farm and off-farm diversification livelihood system is widely spread in SIS (Perret, 2003a). Shah et al. (2001) emphasises that viability after irrigation management transfer depends on the cost of sustainable self-management and reliance of the farmers on irrigation. The authors stressed that for the process of IMT to succeed the following requirements should be satisfied:

- Hold out a promise of improvement in the life situations of significant proportion of farmers involved in the process.
- Irrigation must be central to creating such improvements (large proportion of income of the farmers must come from irrigation).
- The cost of sustainable self-management must be acceptably a small proportion of the improved income.

1.2. Problem statement

The general problem is the low performance of smallholder irrigation schemes, and the subsistence basis that prevents farmers from increasing their cash income, whereas cash cost are generally high (e.g. mechanization and farm inputs). Two specific problem are the low productivity of land and water, and the low contribution of irrigated farming to people's livelihood.

1.3. Research Design

1.3.1. General research objective(s)

The general objective of the study is to investigate the economic and production features of smallholder irrigation schemes, with a sustainability perspective, in the context of IMT, on a case study basis:

1.3.2. The specific objectives are:

1. To evaluate the diversity of livelihoods and the contribution of farming
2. To estimate productivity of land and water

3. To identify factors influencing production at farm level
4. To examine the role of land tenure on productivity

It is important to understand the issues that have culminated into this seeming abandonment of the schemes, and to assess whether there is any potential for the farmers to operate the schemes on their own, with minimal initial support in terms of capacity building, organisation and facilitation (Kamara et al., 2001).

1.3.3. Conceptual framework

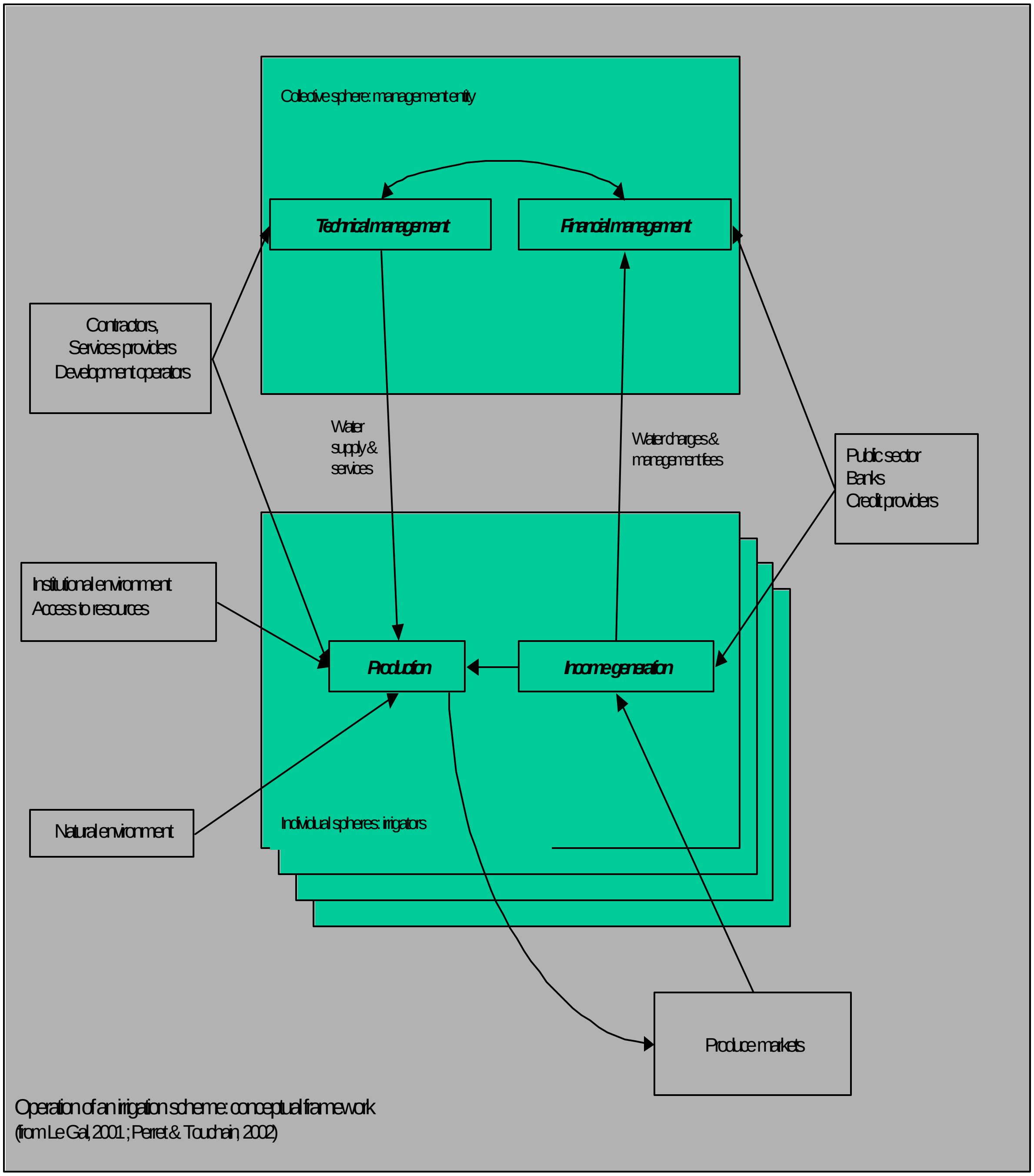
The concept of viability can be defined at different levels and in various contexts. In the context of the study, it includes the ability of the scheme to generate sufficient income to satisfy the household income expectations of the irrigators, and cover basic operational and maintenance costs of the irrigation infrastructure, while not mining the natural resources (Kamara et al., 2001). Income expectations may differ widely across crops and among the individuals (Shah et al., 2001). Furthermore, it includes the ability of the scheme to maintain cash flow and consistency of income generation over time, and management of risks and shocks associated with smallholder irrigation scheme.

An effective reform involves changing simultaneously the roles and responsibilities of the users. In order to support this transformation, a conceptual framework is needed (see figure 1). This framework specifies co-ordination among the users and the links between the spheres of management: the farm and the scheme. In terms of users participation there is a widespread support in policy but implementation of schemes where effective participation takes place is slow.

At this stage more focus for the study will be at production and income generation. The cost factors related to production and different types of crops planted will be considered. Income generation at farm level will be also considered looking the ways of marketing products. Since the market can determine the farm income of the individual farmer to be able to repay back the water charges in future and production loans. At farm level water is consumed individually without being measured or charged for. Individual farmers should transform this water in products through their productive systems, and then convert it to money if they market these products.

The production process at farm level starts at land use by incurring some costs of preparing the land for production purposes. Positively, the gross margin will be generated and all the production costs including (labour, production inputs) will be deducted to farm profit. From the farm profit, to determine the ability or willingness to pay, the productivity of water will be deducted from the water use. From operation and maintenance cost subtract cost recovery in order to evaluate the economic viability at scheme level.

Figure 1. Operation of an irrigation scheme: a framework (from Perret et al., 2003; Perret & Touchain, 2002; Le Gal, 2001)



Box 1. Operation of an irrigation scheme: a framework (Perret et al., 2003a)

Figure 1 represents the framework for irrigation scheme's operation. This framework attempts to integrate the different dimensions, stakeholders and functions that take place in a scheme's operation. It is a conceptual framework and an analytical framework as well, as it provides guidelines for multidisciplinary and comparative analysis and stimulates participation among different stakeholders.

The management of a scheme involves 3 types of stakeholders: the individual farmers, the management entity and external role -players. These can be the public sector (government, provincial authorities), contractors and service providers, banks, and the marketing or food-processing sector. All provide financial or technical support to the management entity and/or to the farmers.

Farmers manage production at farm level; possibly market the products, which in turn generates income. The natural environment influences the production process (e.g. climate and soils, weeds, pests, hail). The institutional context also impacts onto production, especially the rules on accessing resources (e.g. land tenure, inner water-sharing features, water rights). Farm income influences production, since it defines the level of intensification and diversification. Finally, contractors and service providers, the public sector (extension) also influence the production process.

The management entity (a corporation or an irrigation board in the past, a water users' association nowadays) provides irrigation water and related-services to the farmers, for them to produce. It technically manages, operates and maintains the scheme as a whole. There are costs incurred by such management. This supposes a financial management. Funds are collected from the farmers, and managed at scheme level.

Four major functions may be identified within a scheme: production (farmers), water supply / O&M (WUA), finance (WUA) and commercialisation / input supply (farmers and possibly WUA). These functions generate a number of flows and transfers: water (between WUA and farmers), money (between farmers and WUA, between markets and farmers), products (between farmers and markets), services (between providers and the scheme, between WUA and farmers), etc. Such transfers are conditioned by proper information circulation between all parties. The whole process is illustrated in figure 2 from land use to economic viability at farm and scheme level.

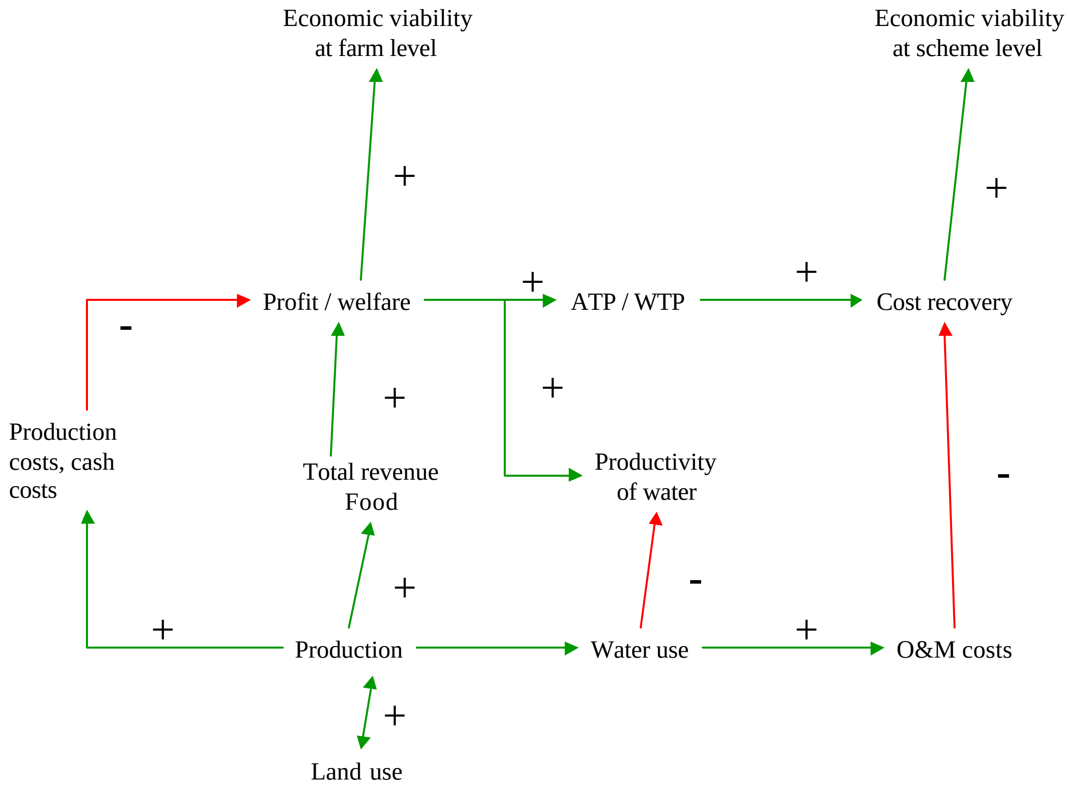


Figure 2: The Smile approach (Perret, 2004)

1.3.4. The hypotheses

The hypotheses for this research are as follows:

- The low productivity of land and water limits farming income and the high cash costs, therefore hinder cost recovery at scheme level, and ultimately its viability
- The lack of co-ordination and social capital impairs production, marketing and cost recovery, and consequently the viability of the scheme
- In the current situation, farmers are not ready to take over the technical and financial management of the irrigation scheme.

1.4. Outline of the study

This study is made up of five chapters. **Chapter two** of this report reviews international experience in irrigation management transfer and global changes, cost recovery and land tenure on smallholder irrigation schemes. **Chapter three** presents the method used for the study and seeks to describe the Zanyokwe Irrigation Scheme, natural resources and history, climate, water and soil) and the social circumstances of the plot holders. **Chapter four** synthesises the results and discussion of surveyed data, the farmer's and crop typologies are also highlighted in the chapter. Statistic analytical method was used to discuss the findings. Finally, **chapter five** presents the summary of the findings, recommendations and conclusions on the performance and viability of the scheme.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

Irrigation agriculture plays a key role in both water resources management and conservation, and food supply. Historically, the irrigation sector was managed by governments, which has proved to be inefficient in most cases. Part of the "Blue Revolution," that seeks to make the use of water more efficient, can be seen in irrigation management transfer (IMT) in giving rights and responsibilities to farmers and organisation (Postel, 1999, cited by Karkkainen, 2002).

2.2. Irrigation Management Transfer

2.2.1. From Green Revolution to Blue Revolution

Water, food, poverty, and urbanisation have strong impacts on food security. Urbanisation leads to tightening competition over scarce water resources. Growing cities and industries demand more water, and as they can also pay more for water, agriculture is losing its share of water resources in the competition. In order to secure water and food for the future's population, agriculture must use water more efficiently; make more crops per drop (Karkkainen, 2002). The challenge of making irrigation more efficient cannot be answered on the basis of the Green Revolution (Postel, 1999, cited by Karkkainen, 2002).

Now, after the Green Revolution decades, some 50-70% of the world's irrigation schemes are in need of repair (Postel, 1999; World Bank, 1993 cited by Karkkainen, 2002). The large-scale schemes are often also badly maintained and managed (World Bank, 1993 cited by Karkkainen, 2002). Population grows, water resources do not. The Green Revolution development was not sustainable (Postel, 1999 cited by Karkkainen, 2002), because principle of the green revolution was to increase the production per unit area whilst regarding water as a public good. A new concept of "Blue Revolution" has emerged. Postel (1999) cited by Karkkainen, (2002) argues that: "the Blue Revolution will be more difficult than the Green Revolution of the past because, there is no obvious, off-the-shelf package available to raise water productivity. This new challenge will require a more diverse and creative mixes of strategies that makes agriculture more information-intensive and less resource-intensive in, by substituting technology and better management for water. It will require thinking systemically because water performs many different functions as it flows through the landscape toward the sea."

2.2.2. Global changes in irrigation schemes management

Over the past three decades, governments in both developed and less developed countries have transferred public companies and other state enterprises to the private sector (Johnson, 2002). While originally concentrated in the manufacturing and transportation sectors, privatisation has now extended to almost all sectors of the economy, including the provision of water services such as potable water and irrigation (Johnson, 2002).

Increasingly, countries are embarked on a process of transferring the management of irrigation systems from government agencies to water users associations (Perret, 2002a). However, some countries are still unsure about whether or not to adopt reforms and how to design and implement them (Perret, 2002b). This process, the so-called irrigation management transfer (IMT), includes state withdrawal, promotion of the participation of water users, development of local management institutions, transfer of ownership and management (Perret, 2002c). It has a broad objective of increasing irrigation performance and reducing demands on the public budget (Perry, 2001).

IMT seems to improve economic conditions by reducing the role of the state agents through privatisation and empowerment of local communities (Kamara et al., 2001). Zanyokwe irrigation scheme used to be managed by government. The scheme proved to be inefficient and farmers took over and manage their plots individually. The underlying principle of the reorientation is to encourage farmers and local communities to take responsibility for the management of local resources, and thereby limit external interventions to the provision of information and institutional support services that enhance efficient resource allocation.

Water is a major constraint to continued and sustainable agricultural development both in the developed and developing countries (Chakravorty and Zilberman, 2000). With growing population and increased competition for water from different users, the world will face a severe shortage of good quality of water for irrigation (Smith and Maheshwari, 2002). The shortage is not confined to particular group of countries, but it is a global issue with some serious repercussions for the future irrigation water supplies also, there are some concerns about the sustainability of irrigation projects (Smith and Maheshwari, 2002). Farmers have to pay for water.

The economic and social output from irrigation projects is often lower than estimated at the planning stage (da Silva et al., 2001). In a recent report which evaluated more than 200 irrigation projects subsidized by the World Bank, for example, 23% were rated unsatisfactory (Jones, 1995 as cited by da Silva et al., 2001). Freeman and Lowdermilk (1991) argued that many accounts of irrigation projects report failure to meet estimated agricultural production targets, poor maintenance, and disappointing economic returns on investments.

The future alternative water supplies for irrigation will have to be carefully developed and managed (Smith and Maheshwari, 2002). Another related issue is that the way farmers manage water affects the long-term sustainability of their farms. There is now greater demand to share water resources with the environment. As a result landholders need to consider the options available to them to meet their irrigation water needs (Smith and Maheshwari, 2002).

Currently, significant changes in water policies are being implemented in South Africa, (Perret, 2002a). These changes will lead to increased contribution by farmers to costs and reduced availability of water for irrigation (Smith and Moheshwari, 2002). In general, the changes will require irrigators to improve water use efficiency and look for alternative water supplies. In the case of South Africa water reform (Act 36 of 1998) will play a large role in driving this.

Among the key outcomes of the Earth Summit, were the recommendations that water should be treated as an economic good (with a property right attached to it), that water management should be decentralised, and that farmers and stakeholders should play an important role in the management of natural resources, including water (Vermillion, 1997). Early efforts to IMT from the government to farmer's organisation occurred in the USA, France, Colombia and Taiwan from the 1950s through the 1970s (Vermillion, 1997). IMT became a national strategy in most developing countries only in the 1980s and 1990s.

It remains to be seen whether IMT can simultaneously save money for the government, bring about more cost-efficient management for the farmers, and achieve financial and infrastructure sustainability

(Vermillion, 1997). In developing countries, most post-transfer organisations tend to be water users' associations that take over O&M responsibility directly, at relatively small scales. But policy encourages farmers to defer maintenance. Also, particularly in Africa, neither post-transfer management entities nor individual farmers have clear or measurable water rights. This uncertainty may inhibit farmers from investing more fully in the long-term maintenance and improvement of their irrigation systems (Vermillion, 1997).

There are some clear common trends in most of the countries. In those countries where IMT has not been initiated, it is one of the main objectives of development policies for the coming years, along with modernisation or rehabilitation of the schemes (FAO, 1994). Besides, there is a tendency to consolidate the existing users associations through institutional strengthening programmes, aiming at financial sustainability, technical assistance, training and extension for users and technicians. Additionally, work is being done to determine irrigation water charges and collection. In most arid and semi-arid zones, increase in irrigated land will require efficiency improvement in conveyance, distribution and application, as well as more efficient use of water by plants (Byerlee and Murgai, 2001).

Despite the success of irrigation in supporting the green revolution, irrigation schemes have often under-performed in economic terms, and field research has highlighted substantial shortcomings in management (operation and maintenance), equity, cost-recovery and agricultural production (Johnson et al., 2002). Public investment in irrigation development tailed off during 1980s as fiscal constraints set in and external funders become disillusioned with the economic performance of previous investments. Further, growing environmental concern over the impacts and costs of large water development projects have stimulated more interest in the careful use of water than in simply increasing its supply. Rosegrant and Binswanger (1994) summarise policy options in response to poor economic performance:

-Technological solutions, including rehabilitation, modernisation and water conservation technologies;

-Reform of public management through improved farmer participation;

-Communal water management through improved farmer participation;

-Establishment of trade able property rights in water and the development of markets in water rights.

For improving management, Vermillion (1994) identified some essential elements underwriting effective irrigation management:

- Clear and sustainable water rights are accorded to users, at individual or group level;
- The irrigation infrastructure should be compatible with the water rights allocated and with local management capacity;
- Clear and recognised responsibility and authority are vested in the managing organisations;
- Adequate financial and human resources exist to operate and maintain the infrastructure and managing organisations.

Disappointing performances of state-owned and operated irrigation systems have compelled a number of countries to transfer rights and responsibilities for management of irrigation systems from government agencies to private or local persons or organisations (Wijayaratna and Vermillion, 1994; Svendsen, 1992). Transferring responsibilities has come to be seen as a way to reduce pressures on thinly stretched government finances, while at the same time improving irrigated agricultural production and ensuring the long term sustainability of irrigation systems (Lipper, 2001). The intention is to encourage efforts by individuals to take responsibility for the management of resources in the belief that individuals have greater stake and better information for making efficient resource allocations (Brewer et al., 1997). Irrigation officials insist that the primary concern behind encouraging irrigation management transfer is to improve water use efficiency. Irrigation must provide a wide range of users with on-time, adequate and equitable supply of water at least cost. To achieve this goal, irrigation institutions need to adopt a service orientation and improve their performance in different areas. At global level there is a need to produce more food with the same amount of water, improve water resources management and contribute to the well being of rural inhabitants that constitute most of the poor people in developing countries.

2.2.3. Cost recovery and charging system.

In the past, water has been plentiful in most countries and the role of water pricing, a means to ensure efficient allocation and productive use has attracted little attention in a context of government management and funding. But, now water is manifestly scarce in many countries. Perry (2001) argued that water should be treated as an "economic good". Rosegrant and Binswanger (1994) stressed that the maintenance of water related facilities are often observed to be inadequate. These two issues have provided an impetus for the introduction of pricing for water and water services. A primary target for this intervention is irrigation, because it is the largest consumer of water, in most countries where water shortage is a problem. It is clear from this brief introduction that there are a number of reasons for recommending water charges (Perry, 2001). The two most commons are:

- To recover the cost of providing the services (e.g. capital expenses, ongoing O&M cost);
- To provide an incentive for the efficient use of scarce water resources.

Cost recovery requires a political sensitive choice as to the extent of cost recovery, which may range between full recovery of capital and O&M costs at realistic interest rates, and partial recovery at subsidised rates.

The apparent misuse and waste of irrigation water, especially in the context of low and subsidised prices for water and deterioration of irrigation systems, suggests that charges should be increased to cover the costs of system operation, and the pricing mechanisms should have a prominent role in encouraging more efficient resource use. The developing countries suggest that the likely charge needed to cover O&M costs would be $0.003-0.005 per cubic meter, while the charge required to substantially affect demand would be much higher (Perry, 2001). This indicates that a charge designed to meet cost recovery will have minimal efficiency impact and that a charge that meets the efficiency will recover far more than the costs of O&M, which seems attractive (Perry, 2001).

One of the factors that needs to be considered in this study is that smallholder irrigation in South Africa in general and Eastern Cape in particular has a history of dependency. This resulted from lobbying popularity by homeland leaders by providing free services to people. This means that for a long time farmers have depended on government support for their farming activities. The role of the government was to make and finance all decisions about farming practices for smallholders. This proved to be very costly, since on the government side there was no way to recover the costs incurred through mechanisation and other costly practices. Currently, farmers are expected to form water user association, which will undertake water management activities (Perret, 2002c). The question remains as to how subsistence farmers with low productivity and low cash income can pay for water supply?

2.3. Institutional Arrangements

2.3.1. Recent development on irrigation schemes: Water Users Association

Water Users Associations are co-operative associations of individual water users who wish to undertake water related activities for their mutual benefit (Perret, 2002c). Smallholder irrigation schemes were built and operated by the government and parastatals agencies. Operating costs if any were charged to farmers at a subsidised rate. According to the new policy trends, membership of these schemes would be transferred to Water Users Association (WUA). Particularly, the new National Water Act (Act 36 of 1998) enables any group of people with the need to jointly manage their water matters to become WUA. A WUA is a legal body with the primary objective of managing water on behalf of its members (Perret, 2001). After a couple of documents officially published, the White Paper on National Water Policy for South Africa was launched in 1997. This resulted in the new legislation:

The National Water Act (Act 36 of 1998), which deals with the management of water resources of South Africa, replaces the previous Water Act (Act 56 of 1956). Under the National Water Act (Act 36 of 1998), only WUAs may apply for a licence and may be granted the right to use water under specific conditions. The NWA urges rural communities and smallholding irrigation farmers to form WUAs, which will be registered, licensed and charged (water fees).
The Water Service Act (Act 108 of 1998) regulates water supply and sanitation service provision.

Water User Associations play a pivotal role in IMT. These are the organisations through which farmers manage their irrigation system and the institution to which water rights, infrastructure use rights and obligations are transferred. It is the responsibility of the WUA to further manage and develop these assets in order to maximise the irrigation benefits for its members. Similar to water rights legislation, legislation for WUA should contain a number of minimum elements in order to be successful. Water users associations, are self-governing entities, and mobilise membership fees or labour contribution to fulfil their collective needs. WUA are smallest and simplest organisations that manage irrigation efficiently. Payment is collected by user organisation. The term water user's association as used in the conceptual framework (figure 1) refers to the grouping of farmers, usually in one hydraulic unit for the purpose of managing parts of an irrigation system, including collection of water charges, water sharing issues, operation and maintenance organisation.

One of the objectives of WUA is to operate and maintain the transferred irrigation system efficiently and economically, and with the full and active participation of all the members. It includes the criteria for assessing water charges and operation and maintenance charges from members. WUAs will be authorised to enforce discipline in water use among the users, and resolve any dispute in sharing of water by individual farmers.

The main responsibilities of the WUA include:

- Collecting water charges from water users (for organising operation, maintenance and Repairs;
- Registering as one water use and being granted one licence (water use right);
- In addition it can be responsible for approving the cropping pattern and area to be irrigated for each crop within the area of operation of the WUA;
- It has also a power to inspect the irrigation systems under its operation, to establish a water distribution process to ensure equity and prevention of wastage and to deal with allocation of water during shortage and crisis.

2.3.2 Conditions for IMT to be successful

Shah et al. (2000) argued that from an African perspective, policymakers have to help create the necessary conditions for profitable smallholder agriculture by implementing policies that encourage improved farming practices, strengthen access to both credit and output markets and reform irrigation management agencies so that they can effectively respond to the full range of smallholder needs. As suggested, under the right conditions smallholder irrigation systems should serve as an engine of agricultural growth.

Specific policies that lead to improved farming practices include promotion of high-value crops, expansion of systems for extension and technical support, investment in smallholder technologies and clarification of land tenure arrangements. These need to be fully addressed by policy makers in order for IMT to be successful (Shah et al., 2000).

Strengthening smallholder access to markets through collaboration with agri-business may provide a window of opportunity for smallholder irrigators. To help foster healthy collaboration between agribusiness and smallholders that benefits both sectors. Government needs to explore ways to make contract farming sustainable by reducing incentives for default on commitments by both farmers and companies (Shah et al., 2000).

Shah et al. (2000) argue that policy thinking needs to shift reform of smallholder irrigation management to the development of interventions that significantly enhance smallholder productivity and incomes. They argue that appropriate institutions are probably not pure WUAs, but either farmer-controlled organisations with a much broader mandate and capacity or specialised marketing associations with strong institutional links with agri-businesses.

2.4. Land tenure in former Ciskei

The debate around tenure reform in South Africa is not a new one (Lahiff, 1999). Indeed, it has long been a central feature of the wider debates on access to land by African people under colonialism, segregation, apartheid and of late, democracy. According to Madikizela (1997), cited by Ngqangweni (2000) land seems to be viewed as having four main functions in the homelands, namely:

• A security system for its occupants and an essential component of their physical and mental well-being;

• A political resource used to gain political power through the granting of favours;

• An agricultural resource, but only after satisfying the first three roles.

The policies and actions of the South African State in pursuit of racial segregation and the promotion of an oppressive migrant labour system have directly influenced the pattern and forms of landholding and land use in the homelands. State policy on land in the reserves/homelands since 1948 has been based on a number of key elements, described by Hendricks (1990) and Lahiff (1991).

For historical reasons, land tenure in the Eastern Cape in general and Zanyokwe Irrigation Scheme in particular is very diverse. This diversity was added to by new legislation that provided for a new form of tenure and modifications to existing tenure (Scogings and van Averbeke, 1999). Mills & Wilson (1952) and Scogings & Averbeke (1999) argued that in Keiskammahoek District, the chiefs were responsible for choosing the form of tenure that would apply to their people. Three forms of tenure that were granted, namely un-surveyed communal tenure; surveyed quitrent and freehold tenure. A fourth tenure system, Trust Tenure, was established on freehold land that was once allocated to whites settlers in the Cape Colony. Since the Land Acts of 1913 and 1936 restricted whites from owning land in the Native Reserves, such land was acquired by South African Native Trust who then leased it to landless Africans (Ngqangweni, 2000). The four types of land tenure are discussed below.

2.3.2. Freehold Tenure

Under this system the owner is accorded full ownership and freedom to alienate and use the land at will, but subject to statutory restrictions. Africans freeholders are not allowed to sell their land without state approval. They are also prevented from accommodating any other person on the land outside their immediate families (Kruger, 1995; Scogings and van Averbeke, 1999).

2.3.3. Quitrent Tenure

A grantee of a quitrent title is allocated a surveyed residential site, a surveyed arable plot of about 4 to 6 hectares, and rights to commonage. One of the main differences between freehold and quitrent systems is that in the latter an annual rent is payable. The Upgrading of Land Tenure Rights Act of 1993 makes provision for the holders of quitrent land to convert their tenure to freehold free of charge.

2.3.4. Communal Tenure

This system of tenure, often referred to as "traditional land tenure system", is formally rooted in the system of betterment planning. Under this system, a headman empowered to allocate land belonging to a "Tribal Authority", replaced the village chief. Under communal tenure, members of a settlement share certain rights in the land attached to their settlement. They hold the land under conditions of usufruct, as opposed to private ownership. Access to a residential plot is acquired through a "certificate of occupation". In addition to an arable land allocation, the bearer household is entitled to raise livestock on the commonage and to harvest wood and water from it. The ownership of the crop harvest rests with the individual grower household, but the crop residue becomes communal property.

Since the advent of the national political changes of the early 1990s, a village chairman has now replaced the headman in the handling of matters of common interest to the community, including land matters. Through the Communal Property Association Act of 1993 communities or groups can hold a registered title to land (as in freehold tenure), while allowing them to make their own decisions on the allocation of ownership and user rights to the land. Beneficiaries of the land redistribution programme of the national government have thus far used this new system.

2.3.5. Trust Tenure

Land under trust tenure consisted of formerly white-owned land situated in proclaimed native areas, which was eventually made available to the South African Native Trust through the Native Trust and Land Act of 1936. This land was subsequently allocated to Africans on a system of leasehold tenure.

2.5. Conclusion

As discussed, irrigation agriculture can play a key role in water management and conserving water since water is considered as economic good. Nowhere in Africa is there a significant body of positive experience to suggest that straightforward IMT will work in smallholder irrigation as it has in the US, Mexico, Turkey, New Zealand and Columbia (IWMI, 2002).
However, a policy proposal prepared by a group of South Africa's most experienced scholars, led by Backeberg, states clearly that "irrigation farming can be very remunerative provided the following are present: high quality management, markets and infrastructure, and sufficient equity capital" (Backeberg et al., 1996 cited by Shah et al., 2000; IWMI, 2002). Africa's smallholder irrigation farmers have none of these, and without these, IMT can easily become a millstone around their neck.

Crosby (2000), a leading South African observer, writes: "It is unbelievable that with the exception of sugar projects, there are virtually no schemes (smallholder) that have been successful and the pattern of failure is so similar that it is not really necessary to undertake a needs analysis for individual projects". This pattern of failure is what the author refers to as 'downward ratchets'. In his analysis, the downward ratchets are evident in the common aspects, which are: 'total dependence – water supply infrastructure dilapidated- ineffective water management- low production levels- little knowledge of crop production or irrigation- ineffective extension- lack of markets and credit- difficulty to source inputs- expensive and ineffective mechanisation services- unprepared fencing, and damaged soils'. Indeed, it would be surprising if, even with all necessary stress on 'process' and capacity building, IMT programs will meet even the moderate expectation of success, namely that it 'saves the public money, improves cost effectiveness of operation and maintenance while improving, or at least not weakening, the productivity of irrigated agriculture' (IWMI, 2002)

This is not to say that African smallholders do not or cannot manage irrigation, or that they cannot engage in sustainable co-operation. Indeed, some of the most efficient, livelihood-creating irrigation types in Africa are private smallholder irrigation projects (IWMI, 2002)

CHAPTER THREE: METHODS AND PROCEDURES

3.1. Introduction

The withdrawal of government from direct involvement in the development, operation and maintenance of irrigation schemes has led to a search for alternative ways to improve and sustain irrigated agriculture. Options range from the transfer of management of irrigated schemes to the beneficiaries, to various forms of private-sector participation in the building, operation and maintenance of irrigation schemes.

This chapter describes the research methods used to analyse the variables that were used to assess the economic performance of smallholder irrigation schemes. The chapter provides a brief description of the sources of information used, the determination of the farmer population and the sampling technique and data collection method. The way the survey data were analysed is also presented in this chapter and the brief presentation of the study sites.

3.2. Selection of survey area

The selection of the study site was made in conjunction with the steering committee of the Water Research Commission, project number K5/1353/4: (Investigation of different farm tenure systems and support structures to establish small-scale irrigation farmers in long-term viable conditions). Zanyokwe irrigation scheme was selected as a study site based on the following criteria: (a) the diversity in farmer's plots size (b) diversity in land tenure system (c) diversity in farming orientation and style and (d) diversity in production features. The scheme is situated about 30km west of King William's Town and is reached via a gravel road, 20km from R63 road between King William's Town and Fort Beaufort, in the Eastern Cape Province.

Zanyokwe irrigation scheme is composed of six settlements, namely Zingcuka, Kamma-Furrow, Ngqumeya, Zanyokwe, Lenye, and Burnshill. It covers approximately 635 hectares but only an area of 534 hectares is irrigated, comprising of 64 individual small farms ranging from 1 to 10 hectares. The balance of the land is yet to be developed and irrigated. The scheme also includes an additional 78 "communal plots", 42 "communal plots" in Lenye are occupied but the 36 at Burnshill are currently not occupied and have never been irrigated (van Averbeke et al., 1998).

The Sandile Dam serves the scheme. Irrigation infrastructure and equipment consist of piped irrigation systems with valve chambers and ancillary pipes. Irrigated land actually consists of relatively small plots, scattered between Lower Nqumeya in the east to Kama-Furrow in the west. All irrigated land is intended for crop production (van Averbeke et al., 1998).

The Department of Public Works and the Department of Water Affairs and Forestry have recently injected funds for upgrading the scheme, and the Provincial Department of Agriculture supports most of the projects in the scheme through various services. The rehabilitation process is underway and a farmer-training program is being implemented. A Water Users Association (WUA) is in the process of being set up and all subsidies have been withdrawn.

A significant portion of commanded land is not cropped/irrigated (about 100ha). Uvimba Development Bank's inability to provide credit for inputs and maintenance for pumping equipment due to significant budget cuts is the most frequently mentioned reason for this.

3.2.1 Methods Employed in Data Collection

The methods used in the collection of data include observation and interviews. A questionnaire was developed based on the knowledge of farmers and farming practice in the area. The developed questionnaire comprises of several parts amongst others, the household composition, land tenure, cropping system, production costs, crop calendar, livestock description, finances, and scheme management. A specimen of the questionnaire is supplied in Appendix 1. "To learn something of people, for instance, we take some few people whom we know or do not know and study them", (van Zyl, 2002), "and draw accurate conclusions about the big world of reality from the little world of the sample" (Parasuraman, 1991). The information and data were collected between the 10th of January and 2nd of February 2003 and the second round in July 2003 for two weeks. The researcher was staying in the Agricultural College next to the villages during the period of the study. Before interviewing the individual members in each of the selected projects, group discussions were held with project management team and farmers to get background information and general information about the project. Proportional stratified sampling was adopted for the survey. In Zanyokwe scheme (located in Eastern Cape), there are villages. The population in the scheme was selected in all the villages. More people were taken from the more populated villages (e.g. Lenye and Burnshill). Leedy and Ormrod (2001) indicates that dividing the population into subpopulation that are less variable than the original population, different parts of the population can be sampled at different rate when this seems advisable. In each village respondents were selected randomly using a snowball chain sampling method. In this sampling method, the researcher follows up contacts mentioned by early respondents. The method was suitable because the research focused on plot holders in the irrigation scheme because not everyone in the village has a plot. Fifty-five out of 64 farmers were interviewed in Zanyokwe Irrigation Scheme. The number of the household interviewed in each village and the type of tenure that applies are listed in Table 1. At Zingcuka, there is a community project of about 14 members and two members were interviewed.

Table 1: List of villages, number of respondents, types of land tenure, sources of income and agricultural needs

Administrative Area	Households interviewed	Type of Tenure	Source of income	Agricultural needs
Ngqumeya	5	Freehold Leasing	Agriculture	Extension of the irrigation system, training, implements, inputs, tractors
Burnshill	13	Leasing Communal Leasing	Agriculture State grant	Training, implements, inputs, title deeds, own land
Lenye	23	Communal Freehold Leasing	Agriculture State grant	Inputs, implements, tractors, training, title deeds
Zanyokwe	5	Communal	Agriculture	Implements, inputs, training, complete

			Local wage	irrigation system
Kama-Furrow	7	Freehold Leasing	Agriculture State grant	Gravity irrigation system, access roads, implements, inputs, tractor, training, extension officer
Zingcuka	2	Freehold	Agriculture State grant	Complete irrigation system, implements, inputs, training

Source: author's data (2003) and Rural Urban Consultants (2001)

It is worth noting that one of the limitations of empirical analysis is that the characteristics of only 55 households in random sample is under consideration and generalised to the rest of the smallholder farmer in the scheme, it is assumed that the sample is representative of the whole scheme. The accuracy of the data depends on the information given by the respondents. Any bias on their part would affect the results. In general, one should note the difficulty of obtaining accurate data on smallholder respondents, especially because they hardly keep any records of their activities and nothing is accurately measured (areas, yield, etc). All the data and information reported and analysed in the study are based upon farmer's recollection of their latest activities and performances.

Due to the different contexts in the province, the findings of this study cannot be readily generalised to the rest of the province.

3.2.2. Methods used in data analysis

After collecting the data, the first stage of data analysis was to prepare the raw data and transform into a machine-readable format (Blanche and Durrheim, 1999). A database was created on the basis of information collected, in the form of spreadsheets in MS Excel. From the household interview collected information on the socio-economic and technical circumstances at household and scheme level, structured data into crop management styles and farmers' types and captured data into the model that calculates both costs incurred by scheme management and possible contributions by farmers to cover these costs. This includes information on household's characteristics, production features, resources, assets, and inputs costs. Qualitative information is also included such issues and prospects as seen by the interviewees.

The first unit of analysis consisted of selection of the most representative and common crops grown in the scheme. Each crop is described thoroughly, in the form of a crop management style (CMS), which includes crop yield, inputs, production costs and budget, water consumption obtained from standards –SAPWAT reference taking into account soil wetness for rain-fed crops, normal target yield and system efficiency which uses data from the closest station, (Alice, $32^0 87$ E; $26^0.93$ S), crop calendar, market price. Crop management style is a simplified system that represents and integrates the cultivation modes, data and schedule, crop management features and crop budget for each major crop grown in the scheme. A given crop may be grown in different ways, or with different features in one scheme, hence different crop management styles defined. Two major criteria have been used to define crop management style: average yield and level of inputs for a given crop. A monetary value has been attached to each product even those self-consumed according to the market prices for equivalent products.

The second step of analysis consisted of the development of a farmer typology. Farmers have been grouped into types. The technique has been implemented in order to address the diversity of livelihood systems and the situation that exists inside the scheme as well as to understand the farmer motivations and strategies. The typology has been oriented according to the objective of sustainable and autonomous management of the scheme.

After developing the CMS and farmers typology, data were captured to "Smile" which stands for Sustainable Management of Irrigated Land and Environment. Smile consists of five inputs modules that form the basis of the information system, as interfaces for data capturing by the user (Perret, 2002c). Each costs-generating item is listed in the "Cost" module. This module provides a framework for data capturing then calculation on the costs incurred by maintenance and operation, and by refurbishment / replacement of infrastructures and equipment on the case study scheme (Perret, 2004). Such information forms the background of the water charging system module. These costs are capital costs, maintenance costs, operation costs, and personal costs). Such information answers the question as to how much does it cost to operate the scheme in a sustainable manner. "Crop" module, the module provides a framework for data capturing and calculation on cropping systems. It requires information on existing or virtual cropping systems within the case study scheme (i.e. economic, agronomic and water-related matters). It requires establishment of a typology of cropping systems, identifying a series of typical and reasonable homogenous cropping systems that covers the reality.

This is performed prior to any data capturing within Smile. Criteria for a typology include the following elements for a given cropping system (i.e. type of crop, crop management style, level of yield, cropping calendar and market price). The typology of cropping systems just represents a model of reality and does not capture in detail the real diversity of it. It should be validated with farmers and local experts. Any crop has an average yield and a crop market price. Water consumption occurs at plot level as soon as the crop is planted and until harvesting. It generates net water consumption per crop. The ration gross margin / net water consumption is the estimated return to water, which gives an indication of the crop's water productivity. This module generates micro-economic output variables (e.g. gross and net margin per ha and per m^3) that allow comparative evaluation of crops in terms of profitability, land productivity, and water productivity. A "Farmer" module provides a framework for data captured and calculations at farm level. It requires information on existing or virtual farm types within the case study scheme. The approach suggested here establishes a typology of farms. The farms were grouped into a series of homogenous types. Criteria for such grouping may include the following elements (i.e. farm size, farming orientation, farming system and socio-economic traits). The farms typology represents a modal representation of the reality and does not capture the real diversity. It allows for further calculations and modelling. A "Water" module deals with water balance at scheme level (rainfall and resource-availability patterns, crop consumption). The losses that occur during water conveyance from bulk supply to plant watering and the actual water consumptions at farm and scheme level are addressed. Losses are considered proportional to the crop water demand, and are three fold (i.e. bulk conveyance loss: occurring between the resource and the scheme itself e.g. evaporation, leaking canals and which may represent 5 to 20%; scheme conveyance loss: occurring in primary and secondary infrastructures within the scheme and which may represent 5 to 20%; in field irrigation loss: occurring sat farm and plot level, they mostly refer to the efficiency of irrigation equipment and may represent 5 to 20%. For South Africa, SAPWAT provide a free access to rainfall data over a large number of stations throughout the country. However, SAPWAT provides net crop irrigation water demands. The last module is a water-charging system to evaluate the potential and possible options for cost recovery and financial viability of the scheme. This allows answering the question as to who may pay, and how much, for water services.

The third stage of analysis is the Sustainable Livelihoods framework (Scoones, 1998; Chamber and Conway, 1992; Fraser at al…, 2003), which provides a diagnostic assessment of entitlements, institutions and resources that influence the livelihoods outcomes of farmer households. The livelihood is sustainable when it can cope with and recover from stresses and shocks maintain or enhance its capabilities and assets, while not undermining the natural resource base (Fraser et al., 2003 and Scoones, 1998). The vulnerability context of livelihoods addresses trends, shocks and seasonally. This results to greater attention to the average livelihood strategies and the asset base of farmers that resulted in different livelihood outcomes. Averages are used to compare farm size value of output produced and marketed and analyse household characteristics.

3.3. Description of the study area

3.3.1 History

In 1977, Hill, Kaplan & Scott completed a regional analysis of the natural resources in the Keiskamma river basin. A number of proposals for the development of the Basin were formulated on the basis of the survey (van Averbeke, 1996). It was suggested that a dam be constructed along the Boma Pass, where the Keiskamma River cuts a narrow gorge through dolerite rock, and supply irrigation schemes. Hill, Kaplan & Scott (1977) recommended schemes to be developed on soils with good potential for irrigation to focus mainly on vegetable cash cropping (van Averbeke, 1996).

Plans for a dam in the Boma Pass were approved and the Sandile dam was constructed. The dam was completed in 1983. With an estimated long term yield of about 20 million cubic meter per annum and a storage capacity of 19 million cubic meters per annum, the dam was to became the main storage facility of water for a multipurpose regional water project (van Averbeke, 1996). The dam was to supply water to the urban centres and numerous rural villages located within the mid Keiskamma river basin. In the plans, an amount of 9 million cubic meters per annum was set aside to supply irrigation schemes. The availability of a reliable and relatively abundant supply of irrigation water led to the development of Zanyokwe Irrigation Scheme.

Two consulting firms were commissioned to design the Zanyokwe Irrigation Scheme. Consulting Engineers Hill, Kaplan, Scott Inc. were asked to plan and design the bulk water conveyance system to field edge. Loxton, Venn and Associates were commissioned to provide a master preliminary plan for the scheme. Five administrative areas were identified as potential beneficiaries of the scheme to be developed, namely Zanyokwe, Burnshill and Lenye and Ngqumeya and Zingcuka (van Averbeke, 1996).

The Zanyokwe Irrigation Scheme was a development project "formed by the community" and the Government in an attempt to improve standard of living, and to create job opportunity. The former Ciskei Government motivated the development of the Zanyokwe Irrigation Scheme in 1983 as a showpiece in irrigation farming in the area (Rural Urban Consultants, 2001).

Loxton & Venn drew up plans for the development of ZIS in 1983 (preliminary plan) and 1984 (final plan). These plans were reworked in 1985 and implemented from 1985 onwards by an Israeli company Agri-Carmel (van Averbeke et al., 1998). Essentially, the plans for Zanyokwe mirrored those implemented and developed elsewhere in the Eastern Cape by Loxton and Venn, such as Tyefu, Shiloh and Ncora irrigation schemes. The Loxton & Venn model of irrigation development consisted of centrally managed estate farming on 75-90% of the available land, and assigning the remainder of the land to the original right holders in the form of irrigated food plots or mini farms, on which they were more or less allowed to do what they wanted (van Averbeke, 1996).

Estate farming relied on expensive external management and cheap local or imported labour to perform production tasks. Projections of gross production capacity and associated income generation were used to justify the capital development in economic and financial terms (van Averbeke, 1996). In most cases, capital requirements were considerable because irrigation development plans proposed use of sophisticated technological solutions, which were expensive (van Averbeke et al., 1998).

In some cases the alienation of original right holders from their land posed problems, leading to the introduction of the Group Farm concept. The Group Farm resembled the Estate Farm, being externally managed by a "Central Unit" (corporation / parastatal) and using scheme labour in all production activities. It differed from the Estate Farm in that it was farmed on behalf of land right holders, who all had a share in the farm. In return for making their land available, land right holders would be paid an annual dividend or rental (van Averbeke, 1998).
Implementation of the Loxton and Venn model of irrigation development at Zanyokwe was constrained by two factors, namely (van Averbeke et al., 1998):

(i) Suitable irrigation land was scattered over a large distance, occurred in small pockets and was situated at an altitude that was insufficient to create sufficient hydraulic head to operate overhead application of water. This caused capital outlay per unit of irrigated land to be exceptionally high, and also made the recurrent cost of supplying water high, because an intricate system of pumping stations and reservoirs was called for.

(ii) Most of the land identified for irrigation was in private hands held by quitrent and freehold tenure, and the last thing land right holders were prepared to consider was their alienation from the land they owned. The exchange of land rights for the rights to an irrigated food plot was totally unacceptable.

Agri-Carmel implemented a plan whereby the land brought under irrigation would be farmed by Agri-Carmel as an estate farm for a three-year period. This initial phase would be followed by an interim period of two years, during which farmers would receive formal training at Fort Cox and practical training on the estate farm. Finally, all the land would be handed over to local people (van Averbeke et al., 1998).

It was agreed that land right holders would receive a rental for the use of their land during the first two phases of development. For agricultural land the initial rent was R20 ha^{-1} per annum, which was increased progressively to a rate of R150 ha^{-1} per annum. Land used in the development of infrastructure, which includes farm shed, pumps stations, booster pump sites, reservoirs and buildings, was subject to rental payment at rates ranging between R250 and R1000 ha^{-1} per annum. Ulimocor paid these rentals (van Averbeke, 1996).

In 1989 Ulimocor entered the Zanyokwe Irrigation Scheme and contributed to the rewriting of the project description and the redesigning of the scheme, which took place in 1989-1991(van Averbeke at al. 1998). In 1991, Agri-Carmel finally left the scheme to a subsidiary called Cis-Carmel and later to Ulimocor. The scheme was designed and managed by Cis-Carmel on behalf of Ulimocor, and was financed by DBSA and the Ciskei Government.

Following intervention by the Development Bank of Southern Africa (DBSA), which was approached to finance the ZIS development, the in-field water supply system was redesigned to accommodate for independent management of economically viable farming units. In most cases these units were obtained by consolidating the irrigable land holdings of two or more landowners. Land consolidation demanded landowners to appoint a "nominee farmer". These "nominee farmers" were trained at Fort Cox and at the scheme (during the estate phase) for which they received a R3.50 per day compensation. Training started in 1988 and the handing-over of farm units to "nominee farmers" in 1989, which was also the time when Ulimocor became involved in the scheme (van Averbeke, 1996).

The phase involving the transfer of land lasted from 1989 to 1991. In order to give " nominee farmers" a reasonable time to develop their enterprises and skill, Cis-Carmel (the local subsidiary of Agri-Camel) and, later on, Ulimocor agreed to allow them to farm on a " no-loss" basis for a period of two years, optionally extended by one additional year. Nominee farmers could draw all their inputs and mechanical operations from the central unit on a credit basis and received a monthly advance on production in the form of a stipend of R250 per month. This stipend was meant to keep their families afloat during interim periods when no income was derived from the sale of produce. Farm produce was expected to be marketed through Pack Mark, the marketing arm of ZIS, enabling scheme administration to control the accounts of nominee farmers. At the end of the financial year, the scheme drew up the balance between expenses and income generated from crop sales. When the balance was positive, the nominee farmers were paid out the profit realised. When the balance was negative Cis-Carmel or Ulimocor would write-off the dept incurred by the "nominee farmer". In many cases, nominee farmers would last the three year induction period, incur debts and exit farming when required to farm for their own account. In 1994 nominee farmers, who had accepted full independence following the end of the induction period, requested to start dealing directly with the Ciskei Agricultural Bank (CAB). Most of them failed to pay their CAB loans and did not honour the land rental agreements. In 1995, the landowners demanded Ulimocor to pay for their outstanding rentals, claiming not to have been informed by Ulimocor about the changes. Ulimocor settled the bill for outstanding rentals incurred by nominee farmers, informed landowners, and absolved completely payment of any land rentals incurred by nominee farmers (van Averbeke, 1996).

Landowners fearing a loss of income responded by subdividing the "economically viable units" into the various individually owned parcels, which had been used in the formation of the farming units. This created problems, because scheme developers had removed the beacons that identified original farm boundaries. Furthermore, since the system was re-designed to supply water to the consolidated 'viable unit', one of the land owners would have the hydrant positioned on his or her land whilst the others had to rely on his goodwill to access water (van Averbeke, 1996). This situation led to tension and quarrels amongst landowners (van Averbeke et al., 1998).

When the Ciskei was re-incorporated into South Africa, the Eastern Cape Department of Agriculture "inherited" the scheme, and attempted to rationalise the agricultural activities performed at Zanyokwe (Rural Urban Consultants, 2001).

Although the scheme was established as a major fresh vegetable production scheme, the production deteriorated due to the government's withdrawal from funding the project. This then led to the decline if not the collapse of the scheme, and the destruction of all the properties belonging to the scheme. The Zanyokwe Agricultural Development Trust (ZADT) was formed based on the principles that it will be the custodian of the assets of the Zanyokwe Irrigation Scheme and responsible for the preservation of the common assets and the provision of services to the community.

3.3.2. Physical environment of the scheme

The study area is situated in the district of Keiskammahoek at an altitude ranging between 440m to 640m above sea level. It is situated along the banks of the Keiskamma river at its junction with the Zanyokwe or Rabula tributary. Van Averbeke et al. (1998) describe the area as temperate to warm and sub-humid with a summer rainfall pattern, which reaches a maximum in autumn and is at a minimum in winter. The climate at Zanyokwe Irrigation Scheme is semiarid and relatively mild. The nearest rainfall station is Fort Cox, located close to the dry western boundary of the scheme. Rainfall is of showery nature and thunderstorms are quite frequent and are occasionally accompanied by hail. The mean annual rainfall is 590mm per annum and frost may occur from the middle of June to the middle of August (van Averbeke et al., 1998; Rural Urban Consultants, 2001). Rainfall variability is high. Mean monthly rainfall data for Fort Cox are presented in Table 2. In the winter the sky is mostly clear and the region receives about 70% of the possible solar radiation. Summer days are frequently cloudy and overcast, resulting in about 50% of possible sunshine duration (Rural Urban Consultants, 2001).

Table 2 Rainfall recorded at Fort Cox (1930-1980) and estimated Class A pan evaporation data applying to Zanyokwe Irrigation Scheme (from The Ciskei Department of Agriculture and Forestry, 1981)

Month	Mean rainfall (mm)	Estimated Class A -pan evaporation (mm)
Jan	64,3	191
Feb	70,2	147
Mar	83,6	143
Apr	43,8	108
May	36,1	98
Jun	18,8	88
Jul	22.1	98
Aug	29.4	120
Sep	39.4	136
Oct	58.5	162
Nov	66.3	164
Dec	58.3	181
Total	590.9	1636

Source: Adapted from van Averbeke et al. (1998).

The substrate at Zanyokwe Irrigation Scheme consists of shale, mudstone and fine textured sandstone of the Balfour formation of the Beaufort group sediments. Dolerite sills and dykes cover extensive areas particularly in the extreme northern southern sections of the study area (Van Averbeke et al., 1998; Rural Urban Consultants, 2001). Along the Keiskamma river, alluvial deposits are found.

The study area is situated in the foothills of the Amatola Mountains. Active dissection of the landscape has resulted in a rolling to hilly topography. The landscape is approaching maturity, the valleys have widened out and concave lower slopes have developed (Rural Urban Consultants, 2001). The alluvial terraces are generally narrow but tend to be more extensive on the inside bends of rivers.

The distribution of soils at Zanyokwe is extremely complex and varied, yet well known and described. The main limitations are soil depth, heavy texture and high fine sand and silt contents of soils. Drainage problems occur in the hydromorphic soils. A large percentage of soils have moderately low and low potential for irrigation (LVA, 1983). Small percentages of land in the study area were rated as having moderate or high irrigation suitability (LVA, 1983).

Hill, Kaplan and Scott (1991) indicated that the quality of Zanyokwe irrigation water is excellent. Richards (1954) cited by van Averbeke et al. (1998) reported also that in the area water is classified as low salinity-low sodium water and can be used for irrigation without any restrictions.

3.3.3 Infrastructural factors

The Zanyokwe Agricultural Development Trust's buildings i.e. workshops and administration offices, are currently in a state of disrepair. Doors are broken down, walls defaced and windows smashed. Office equipment and stationery have been stolen. After the withdrawal of support and the collapse of the scheme, no more care taking or guarding service took place (Mbane, 2003, personal communication).

Van Averbeke et al. (1998) argue that one of the complicating factors at ZIS is the difference in height between Sandile Dam and the scheme lands is in most cases insufficient to provide an adequate hydraulic head to operate pressurised irrigation systems. As a result, there was a need to build storage reservoirs to be fed from the main pipeline linking Zanyokwe with Sandile Dam. According to specifications supplied by Agri-Carmel (1985), the water supply system at Zanyokwe Irrigation Scheme had the following traits. The total demand for water to supply a net area of 731 ha with irrigation water was estimated at 7,765 million cubic meter per annum, which included a safety allowance equal to 50% of the mean annual rainfall to cater for droughts, and was based on an estimated at 40 000 m^3 per day, using 22 working days per month. The capacity of the main pipeline feeding Zanyokwe Irrigation Scheme with water from Sandile Dam is 40 000 m^3 and a second pipeline delivering 20 000 m^3 was planned at the time of the Agri-Carmel report (1985).

Agri-Carmel subdivided the scheme into five zones, each consisting of one or more irrigated blocks of land. Each zone has its own off-take from the main pipeline and each block its own pump station and storage reservoir. Initially it was planned that water from the storage reservoirs would gravitate to the fields. However reservoirs were not positioned sufficiently high to result in an adequate pressure head to operate the field application systems, and booster pumps had to be added to that part of the system conveying water from the storage reservoir to field lines. At Kamma Furrow, access to irrigation water was obtained by pumping directly from the river (van Averbeke et al., 1998).

The water supply system, therefore, consists of a single main pipe line from Sandile dam, with five offtake points each served by electrical pump, nine reservoirs and nine booster pumps each serving a small block of irrigated lands. At Kamma-Furrow, water is pumped directly from the river to a reservoir. The total capacity of the reservoirs is about 20 000 cubic meter and individual reservoir capacity ranges between 750 and 4000m^3. The entire system is designed to operate 22 hours per day and 22 days per month. The high cost of delivering water to field edge makes water supply at ZIS an expensive operation, requiring a considerable amount of electrical energy and daily maintenance of the pumps.

In Zanyokwe, irrigation infrastructures are currently rehabilitated. However, some parts of the scheme do not receive adequate water, owing to equipment deterioration. A lot still needs to be done on infrastructures (irrigation and water conveyance, and the renovation of buildings). The Department of Water Affairs and Forestry as well as the Department of Public Works are busy with rehabilitation works (Mbane, 2003, personal communication).

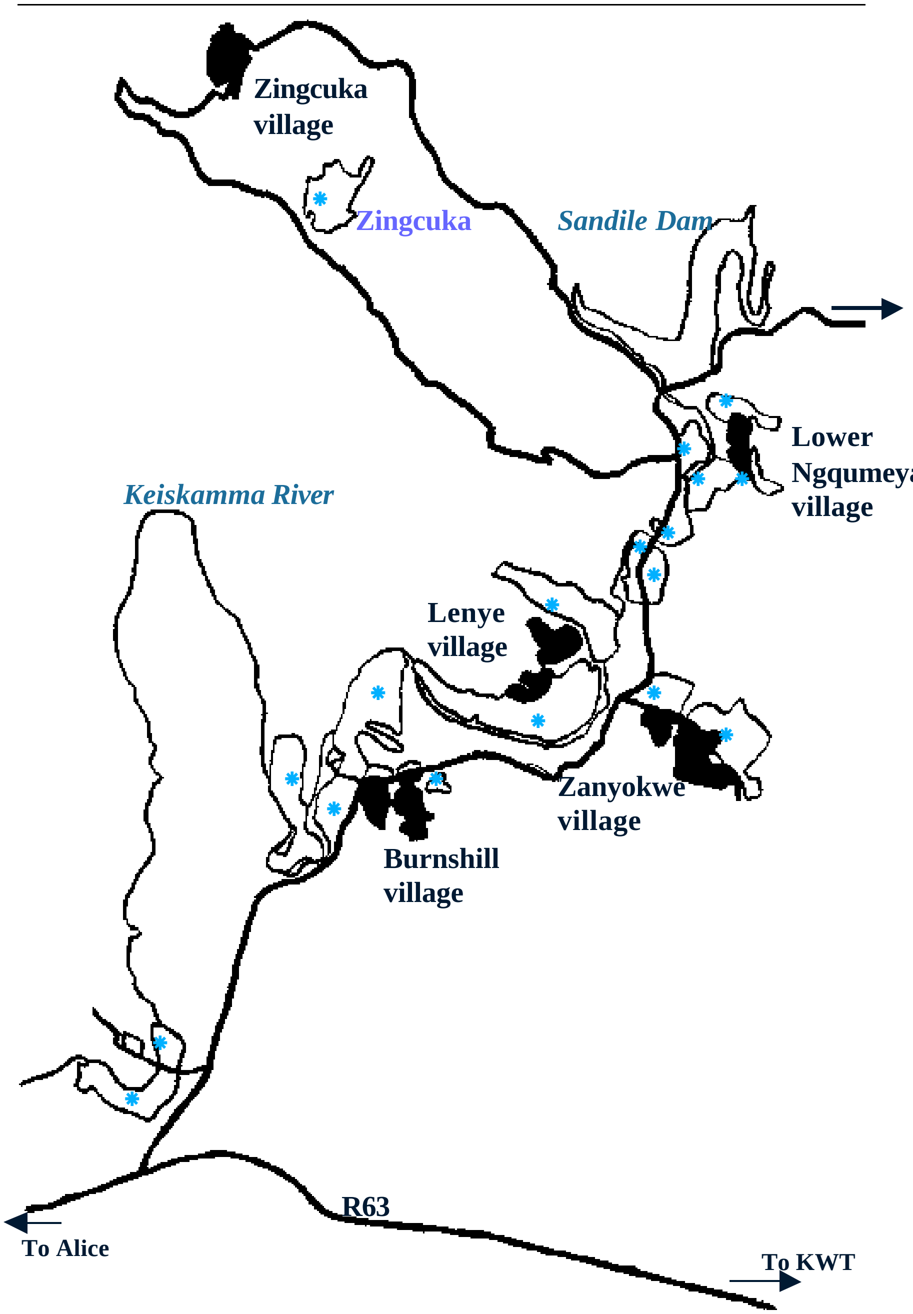


Figure 6. Map of Zanyokwe Irrigation Scheme

*N.B. * are arable land and black areas are residential areas.*

3.3.4 Agribusiness environment: credit, inputs and produce markets

For a long time access to credit, input and output markets have been a major constraint to smallholder irrigation. In terms of credit, the major problem is the lack or absence of suitable collateral against which a loan from the bank may be bonded. ZIS is located in a remote area. As a result it is very difficult for the scheme to be viable due to the lack of markets for irrigated produce in the vicinity. Farmers are also having problems in organising inputs. In Zanyokwe, farmers are selling their produce to hawkers, and they sell directly from the field. The farmers have to spend the whole day in the field, waiting for customers. As most farmers do not have transport, if they need to sell outside the village, they need to get together and hire a small truck, which is usually too expensive to finance. As a results most of the produce rots in the field. Many food plot holders had up to now been unable to obtain credit. Farmers unanimously identify marketing of crops as a major problem. Roads are poor, there is no local storage, and transport of produce is often a problem.

3.3.5 Demography and social capital

The baseline survey carried out by Rural Urban Consultants for the year 2001 shows relatively comparative population figures or results, which closely match those of the Census 1995 and of the Department of Agriculture and Land Affairs in 1997.

Table 3: Population estimates of Zanyokwe irrigation scheme

Year	Source	Estimated Population size
1995	Census -Amatola District Municipality	400
1996/1997	DALA	410
2001	Rural Urban Consultants-Baseline Survey	395

Sources: Census Report DALA and Rural Urban Consultants

Such figures are strikingly low, especially when one considers the millions that have been invested to far into the development of the scheme, with little return so far. The Zanyokwe Agricultural Development Trust is the local Community Based Organisation, which is fully functional and responsible for the scheme collective management, before any WUA is established. This legal entity has been set up and registered, to oversee the smooth transition of the scheme. All the six administrative areas resolved to elect representatives that will constitute a core to the formation of the Trust. ZADT is composed of landowners as well as landless beneficiaries.

3.4 Conclusion

The ZIS is a development project formed by the Government in an attempt to improve standard of living, and to create job opportunity. The development of the Zanyokwe Irrigation Scheme was motivated in 1983. The history of the scheme is very complex: lots of role players, lots of intervention. The complexity of the scheme has contributed to the failure of the scheme after the government have been withdrawn from active farming.

It is indicated that the scheme is situated in the semi-arid zone and the water is adequate on the scheme. But the suitable irrigation land was scattered over a large distance, which occurred in small pockets. It is highlighted that condition of buildings and offices are in a state of disrepair and the condition of irrigation is critical since infrastructure is deteriorated to a complete state of defunct. It is indicated that access to credit, input and output markets has been a major constraint to the irrigation scheme.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 . Livelihoods and descriptive statistics

4.1.1 Introduction

This chapter aims to provide some insight into the characteristics of the farming households participating in the selected scheme. The information given below is derived from 55 interviews conducted with the scheme. Swift & Hamilton (2001), Fraser et al., (2003), DFID, (2002), Chamber & Conway (1992) and Scoones (1998) argued that a livelihood comprises the capabilities, assets and activities required for means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks maintain or enhance its capabilities and assets, while not undermining the natural resource base.

4.1.2 Vulnerability context in Zanyokwe

The vulnerability context of livelihoods address trends, shocks and seasonality. Factors of production (land, labour and capital) and rainfall was contributed to the vulnerability of Zanyokwe irrigation scheme as assessed. Farmers were asked to lists constraints they faced in agricultural production. Marketing, infrastructure, irrigation equipment, transportation costs, credit, tractors and availability of land were mentioned. They also mentioned that they would be glad if the roads could be improved, because in a rainy condition they can be terrible especially when the river is overflowing. This is a major factor that limits their marketing. Farmers argued that tractors are scarce, they have to wait for long time before cultivating their fields. In terms of credit, the farmers reported that the credit that was available to them was not enough for their operations. It is reported also that access of land is very difficult for those who do not have plots. Interestingly, 35 heads of household (63%) of the sample were farmers above 50 years old and some of them were ageing, and Youth represented, 15% of the sample.

Given lack of opportunities in commodity exchange, own-labour and own production becomes an attractive livelihood strategy with an advantage of irrigation infrastructure. Hope and Gowing (2004), argued that economic theory identifies surplus labour as a precondition for rural agricultural development, and with an unfavourable employment market the local opportunity cost of labour would be zero. The dry-land agricultural constraint is spatial and temporal variation in rainfall. This creates risk for agricultural production, which is mitigated into the scheme. The vulnerability of Zanyokwe farmers depends on sufficient access to irrigation.

4.1.3 Livelihood assets

The livelihood framework identifies five capital assets: human, natural, financial, social and physical (Hope & Gowing, 2004). Human capital is captured at household structure (age, gender and education (level of education). Education, gender and household size are reported more fully in the next section. Financial capital is addressed in detail in farmer's strategy (farmer's type). Amongst the Zanyokwe farmers, 11 households (20%) receive old age pension and two household (4%) are permanently employed.

Natural capital is evaluated in terms of irrigated land, livestock and access to irrigated land. Access to irrigated land was a precondition for inclusion in the sample. In the sample survey 12.7% of farmers are farming under dry-land as explained in the chapter. One farmer household recorded ownership of cattle and goats. Just 47% (26 households) of farmers are farming also with livestock. It is reported that hail and flooding is the problem in the scheme. Those farmers under dry-land reported that drought is the major problem for them.

Physical capital includes access to water services, electricity and non-productive utilisation of the irrigation infrastructure. The farmers indicated that there is a need to renovate the infrastructure. This includes existing storage facilities and other buildings that were vandalised when schemes collapsed. Households have access to public water and electricity.

4.1.4 Labour

Characteristics for the farmers are that they rely heavily on labour provided by the household. Exception to this is those households who employ seasonal farm workers. Table 4, indicates for the main field cultivation activities, the average duration, persons in charge and the amount paid/day/person. Table 4. has been made up based on the information provided by farmers with regard to labour input. Due to the inaccuracy of the answers given by respondents with respect to the amount of labour engaged in particular agricultural activities, these figures can only serve as a guideline. Although generally the amount of hired labour was well accounted for and family labour was relatively constant and well known, labour exchanges with other households at key peak periods (weeding and harvesting) were highly variable.

Table 4: Average duration, main contributors and main agricultural activities in cultivating (source: author's data).

Activity	Duration/ha	Main actors
Land preparation		
With tractor	3 hours	Man
Planting		
With tractor	3 hours	Man
With oxen	1-2 days	Man
With hand	2-3 days	Women
Weeding	1 week	Women
Harvesting	1 week	Women

By far the most time consuming activities are weeding and harvesting. The agricultural activities are pretty well divided along gender lines, with the men chiefly concerned with the least labour demanding activities (preparing the land and sowing) and the women spending most time on fields, weeding and harvesting. Man is in charge of the activities utilising agricultural "technologies", while women's labour is performed by hand or with the aid of simple tools e.g. hand-hoes for weeding. The women are also responsible for a whole range of other tasks (mainly in running the household). Mutual aid between households at peak periods during weeding and especially during harvesting is a common feature of the labour provision pattern in the ZIS. This allows some households to manage without formally hiring seasonal labour especially during school holidays. The majority of households do hire seasonal labours, who are paid in cash (average R15 per day) or in kind (e.g. a bag of maize cob's for two weeks 'work). Overall, households spend slightly less on hiring labour for harvesting than for weeding.

4.1.5 Capital

It is important to make a distinction between two types of capital: fixed and working capital. Fixed capital is capital invested in fixed assets such as land, machinery, tools and farm buildings. Working capital is the money needed to carry on a business. Besides land, machinery and tools are the fixed capital invested for the small farmers. Almost all farmers owned one or more hand-hoes and few farmers owned large farming equipment. All large equipment was 21 years old. Most of the farmers had tried to take out loans. The operational diagram below indicates the movement of loan from the bank in-order to reach farmers.

ZIS: Framework

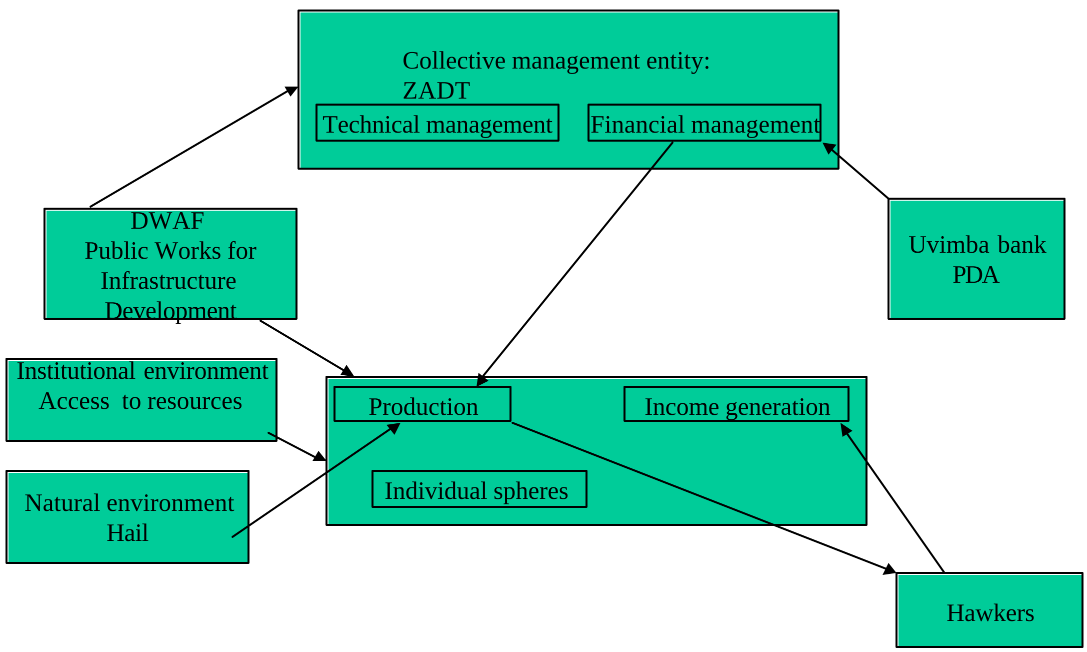


Figure 3: Zanyokwe irrigation scheme: institutional framework

Figure 3 represents the institutional framework for Zanyokwe irrigation scheme's operation. The management of the scheme involves three types of stakeholders: the individual farmers, the management entity (ZADT) and external role-players (Uvimba bank & Department of Agriculture). The Zanyokwe Agricultural Development Trust was formed as a collective entity on the basis of technical and financial management. It is reported that ZADT does not take all the responsibility of managing the scheme. But, it is seen as the intermediate for credit input between the bank and the farmers. In Zanyokwe, it is seen that there are some weakness on the collective sphere (ZADT) since they do not take part in other production functions such as marketing etc. Farmers manage production at farm level and market their products on their own which in return generates income. Hail is found to be a serious disaster influencing the production at Zanyokwe.

4.2. Socio-economic characteristics of the sampled households

4.2.1 General traits

This section first looks at household characteristics in general and provide more detailed insight into the scheme members.

Table 5: Summary of descriptive information on Zanyokwe irrigation scheme (source: authors' data)

Average age of beneficiaries in years	52.7 (10.84)
% of female headed households	9%
% of male headed households	91%
Average household size	4.8 (1.45)
Average land size (ha)	4.7 (2.42)
% of farmers using loans	81.7%
% of farming farmers	81.7%
Marketing channel	Hawkers

Mean values with standard deviations in brackets

Table 5, indicate that the majority of the interviewees believe that more than 80% of the beneficiaries are actually farming and are getting loans from the government in the form of soft loan. Hawkers form the main marketing channel in Zanyokwe. Kohl's and Uhls (1985) state that marketing to the hawker is a process of gaining competitive advantage over market rivals, improving sales profits and satisfying consumers. The hawker plays an immense role in this regard by organising sales and distribution and exposing goods for sale. According to Kohl's and Uhls, 1985 argues that hawkers buy products for resale directly to the consumer, perform a complex job and are the most numerous of the marketing agencies. They link the farmer on one hand and the user on the other in the distributive sector of marketing.

Access to credit has been a major constraint to the Zanyokwe irrigation scheme for the past few years. The problem is the lack of suitable collateral against which a loan from the bank may be bonded. This is because of the lack of title deeds for the land used for farming. But recently the Department of agriculture in the Eastern Cape Province assisted by Uvimba Development Bank developed a strategy of financing the smallholder farmer especially Zanyokwe irrigation scheme at a low interest rate for production inputs. Uvimba Bank plays an important role in uplifting the poorest of the poor in terms of supplying production inputs at a low interest rate without collateral.

Table 6: Socio-economic features as per occupational status (source: authors' data)

	Retired/pension	Full-time farmers	Part-time farmers
Size of household	4.8 (1.41)	4.7 (1.39)	4 (1.41)
Age of households (head)	63 (9.33)	50 (7.50)	49 (19.79)
Years of settlement	12 (6.44)	9.8 (5.45)	2 (0)
Land size	4.9 (2.90)	4.68 (2.07)	2 (0)

Average values with standard deviation in brackets

All households' members were asked to record their occupational status, given that all households were farming. The households were classified based on sources of income. The main categories identified were full-time farmers, retired/pension and part-time farmers. Isolating three dominant, highlights differences between farmer households. Full-time farmer's has dominated the scheme. Old age pension compared to full time and part time farmers has bigger land size. It is also observed that years of settlement and size of households are high in retired/pension than the full-time farmers and part-time farmers.

As compared to other schemes in South Africa, the low number of people in a household is observed in the case of Zanyokwe irrigation scheme. Previous report indicated that more members in a household have positive influence on risk management, as they render assistance during harvesting, storage and marketing (Kirsten, 2000). Small numbers are found in those households where for instance, the children have grown older and moved out to start their own families. In that case, the old parents remain alone and sometimes unable to provide sufficient labour of the field plots. The pension farmers are characterised by largest plot size and large number of years settled in the scheme. Recent reports indicated that agricultural and state children grants are seen as a major contribution to the household's livelihood in Zanyokwe irrigation scheme. Despite that farmers are not willing to disclose that kind of information.

Table 7: Socio-economic features as per educational status (source: authors' data)

	Grade 1-6	Grade 7-9	Grade 10-12	Certification
Size of household	4.8 (1.45)	4.5 (1.27)	5.6 (1.8)	4.2 (1.30)
Age of household (head)	56.42 (9.43)	47.85 (8.54)	45 (12.98)	47.4 (13.72)
Years of settlements	9.94 (5.7)	8.69 (6.81)	7.8 (4.66)	4.6 (3.7)
Size of land	4.65 (2.38)	4.55 (1.74)	3.54 (2.56)	6.3 (3.67)

Average values with standard deviation in brackets

It is observed on the table 7, that more educated farmers have larger size of land, younger head of household and recent settlement in the scheme. High rate of illiteracy has been one of the major bottlenecks in Zanyokwe Irrigation Scheme. On average most of the farmers interviewed were between grade one and six which constituted 58. Grade 1 to 6 in South Africa, where a person can be able to read, and write was considered to qualify as being literate person. Yokwe, (2002) indicated that farmer's low level of education can positively and significantly affect the farmer's probability of adoption of new technology and low self esteem, which affects training programs and transformation negatively (Yokwe, 2002). Rogers (1983) argued that some characteristics of early adopter are the ability to understand new techniques and to try them out, and this could only be possible when farmers are educated. Because then they will be better able to make use of mobilising savings, radio reports and marketing of farm produce, they will be able to take risks in the farm and be able to keep farm records.

Table 8: Socio-economic features as per gender (source: authors' data)

	Male headed	Female headed	Pension
Size of household	4.86 (1.42)	4 (0)	4.55 (1.69)
Age of household (head)	50.64 (9.15)	44.5 (0.71)	62.18 (12.7)
Years in settlement	8.81 (5.46)	2 (1.41)	11 (6.75)

Size of land	4.8 (2.29)	3.05 (2.19)	4.77 (3.01)

Average values with standard deviation in brackets

It is indicated in Table 8, that female-headed household have small land size, recent years of settlement and small size of household. It is reported that 91% of the farmers in Zanyokwe are male-headed household while 9% represent female-headed household. In male-headed household, the male or husband plays a major role in decision. Male-headed household tend to have largest household and the largest plots. Exception arises when the husband deceased; in that case the wife assumes the responsibility of the decision-maker. Pension household are, by definition, headed by an adult receiving the state old age remittance (R740.00 per month, 2003). The qualification of pension is based on women 60 years and men over 65 years.

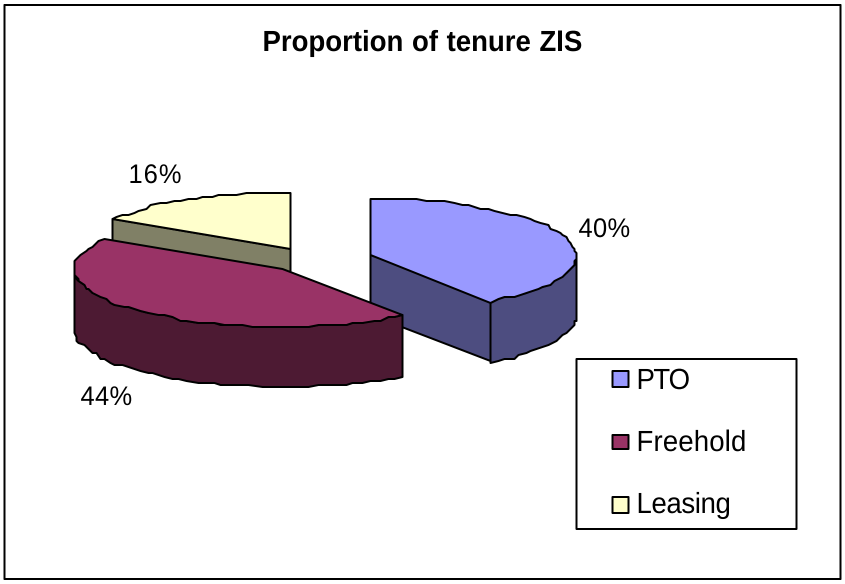
Table 9: Socio-economic features as per land tenure system (source: authors' data)

	PTO	Freehold	Leasing
Size of household	4.6 (1.17)	4.7 (1.76)	5.2 (1.20)
Age of household (head)	50.8 (8.09)	56.3 (11.89)	47.9 (11.8)
Years settled	11.7(5.21)	7.83 (5.87)	5.44 (4.25)
Size of land	4.8 (1.68)	5.34 (3.00)	3 (1.33)

Average values with standard deviation in brackets

Farmers under leasing arrangement are having small land size, recently years of settlement and youngest household head. The land tenure is a significant issue in many development contexts. The Zanyokwe Irrigation Scheme operates on a diverse tenure system: PTO, freehold and leasing agreement. Leasing arrangement is a relatively new tenure in Zanyokwe irrigation scheme. It is reported that the first tenure in the scheme was PTO, where farmers were settled. The highest land size is under freehold and very few on leasing. It is reported that on average farmers on freehold have highest land size as compare to the other. The tenure status of land is considered to be an important factor determining the productivity of farmers. The ownership status can determine whether a farmer qualifies for credit or not and it can influence his/her level of investment (Wegrif, 1998).

Figure 4: Proportion of tenure in ZIS (source: authors' data)



The figure 4 indicates that in Zanyokwe irrigation scheme three types of land tenure exist. It is observed that 40%, 44% and 16% are PTO, Freehold and leasing agreement, respectively. Most of the time cropland is rented-out by people lack access to other resources such as production inputs and labour. However, some farmers believed that, although very important, land is not always the most important determinant of wealth. According to these farmers, some people are less poor not because they have more than an average size and quality land, but because they worked harder and succeeded in non-farming activities. Conversely, institutional lenders use land as collateral since land is the least risky collateral and it is more commonly used than other forms of security.

4.2.2. Dry-land farming activities

Traditionally, rural households have access to arable land allocated by the chief and communal grazing. Although land resources per household are limited, most rural households in ZIS are still engaged in farming activities. Apart from irrigated plots in the scheme, 12.7% of participants are operating under dry land. Maize, butternut and potato are dry-land crops for the dry-land farmers in Zanyokwe irrigation scheme. The approach taken by DBSA as discussed in chapter three left some farmers in a dry-land farming in ZIS. The DBSA approach created problems, because the scheme developers had removed the beacons, which identified original farm boundaries. Furthermore, since the system was redesigned to supply water to the consolidated 'viable units' and not to each of the sections comprising such a viable units, one of the land owners would have the hydrant positioned on his or her land, whilst the others had to rely on goodwill for access to water (van Averbeke, 1996, and van Averbeke et al., 1998). This caused quarrels amongst owners about the exact location of the original boundaries.

4.2.3. Livestock farming

The proportion of households in the survey with livestock and their average holdings were as follows: cattle (51%; 28), goats (33%; 18), sheep (4%; 2), pigs (25%; 14) and chickens (31%; 17). It must be noted that these figures merely capture a moment in time and therefore might not be an accurate representation of the farmers' livestock assets viewed over an entire year. A general comment on livestock farming is that very little management is applied in animal production. Mortality rate and instances of disease are high and reproduction is not controlled. The communal tenure system is a greater disincentive for any individual to improve pasture quality, plant fodder crops or introduce better animals for reproductive purposes into existing herd. The grazing camps are not managed (e.g. rotational grazing) and are overstocked, which means in dry years the severely denuded pasture is not able to sustain the stock and the population is decimated. Time spent on the herd is limited to an hour a day when the children fetch the cattle and goats from the pasture and bring them to the kraal in the evenings. The Department of Agriculture provides vaccination and regular dipping. Most prominent diseases are Newcastle disease (chickens) scab and foot-rot (goats) and heart-water (cattle).

The macro-livestock (especially cattle) is generally not managed as a farming enterprise, but is rather viewed as a measure of social stature and wealth and functions as an alternative investment to the cash economy. When the need arises an animal will be slaughtered for ceremonial purposes (initiation ceremony, wedding, funeral) when the whole village shares in the consumption.

Table 10: Local prices of livestock in Rand

Item	Price of item (R)
Ox	2000
Cow	n/a

Piglet	50
Pig (alive)	500
Pig (slaughtered)	1500
Goat	450
Chicken	20

4.3 Farmers’ opinions on the scheme

Table 11: Opinion of respondents on who should pay for water supply and related service (source: authors’data)

All participants	Those who are irrigating	Those who are irrigating a lot	None
3.6%	18.2%	78.2%	0%

Table 11 indicates that farmers with limited demand for water, hence limited incomes from irrigation farming are not willing to pay. It also suggests that there are some farmers with high consumption. Although farmers are not yet paying for water supply in Zanyokwe, a question was asked as to who should pay for water supply related services, in order to understand farmers feelings. A majority of farmers (78.2%) believe that those farmers who are irrigating a lot should pay for water services.

Table 12: Respondents’ willingness to pay for water supply and related services (source: authors’ data)

Not willing to pay per ha/year	Less than R100 per ha/year	R100 to 150 per ha/year	R300 per ha/year	Average of all answers per ha/year
40%	12.7%	40%	7.3%	R78.25

The respondents were asked to evaluate and disclose their possible financial contribution to water supply and related services (results in table 12). The (40%) of respondents were very negative not willing to pay at all. However, the majority of farmers, 60% percent were willing to pay for water supply related services. As indicated in Table 12 the majority of farmers are willing to pay between R100 to R150 per ha/year, which constitutes 40 percent of the respondents. As indicated in Table 12, 7.3% of farmers are even willing to pay R300 per ha/year. On average the amount the farmers are prepared to pay is R78.25 cents per ha per year, according to their different figures they disclose. Interestingly, 60% of farmers are willing to pay for water services but the question remains as to how subsistence farmers with low productivity and low cash income can pay back for water supply. It is important to note that smallholder farmers are not used to pay for cost recovery of the scheme. The government used to provide free services for famers, and it proved to be costly for the government alone. These farmers are expected to pay for recovering the costs incurred.

Table 13: Problems faced by farmers in the scheme (source: authors' data)

Lack of water	Lack of equipment's (pipes)	Lack of machinery (tractors)	Lack of capital	Poor infrastructure (roads)
25.5%	9.1%	32.7%	23.6%	9.1%

(% of answers given by all interviews)

Respondents were also asked to list and rank the problems they perceive with regard to their farming activities in Zanyokwe irrigation scheme. Table 13 indicates that the majority of beneficiaries 32.7% have a problem of getting tractors at the time they want to plough. They mentioned that tractors are so scarce. They have to be in a waiting list for a long time. Also the respondents mentioned that water is also a problem as discussed 4.2.2 earlier and due to the closure of electric pumps by Eskom since the farmers fail to repay the electric charges.

Table 14: Percentage of land use in Zanyokwe (source: authors' data)

Total area (ha)	Proportion used (%)	Proportion of maize used (%)	Proportion of farmers planted maize (%)	Proportion of ha unused (%)
254.4	37	32.8	32.8	63

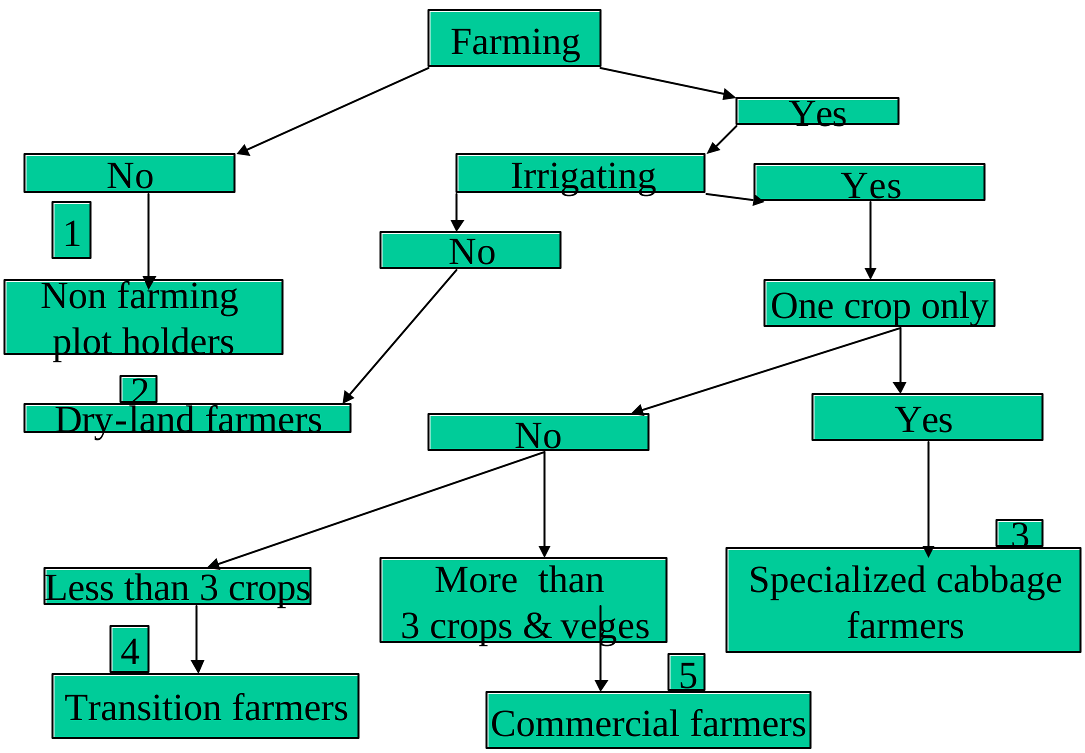
The average proportion of participants has been calculated from data collected during the interviews. According to that calculation, 83.6% of participants are farming in Zanyokwe. The largest area was found to be under maize in Zanyokwe. It is interesting to note that maize uses more land than other crops. However, the majority of the land was not utilised in the scheme.

4.4 Typologies in Zanyokwe: classifying farming styles

4.4.1. Farm typology

Farmer's categorisation in Zanyokwe irrigation scheme focused on the number of crops grown, dry-land as opposed to irrigated farmer. The typology was based on 55 deep interviews, since the sampling aimed at covering the diversity of the current situation. Five groups have been identified. The Zanyokwe irrigators, though related and belonging to one kraal are not homogenous. Many variables were taken into consideration but only one dominating was chosen as the main criterion. The typology features five types of households, as beneficiaries of the Zanyokwe irrigation scheme, as indicated in Figure 5. The Zanyokwe typology highlights that most if not all the farming participants are seriously market oriented.

Figure 5: Household classification tree (source: authors data)



Type 1: Non farming plot holders

A small proportion of farmers in this type occupied the larger portion of the scheme. They make about 17% of the sample. In this type, it reported that farmers do not have enough money for production inputs. These people are afraid of making loans. Their plots are either leased out or laid idle. In one household, an elderly couple is getting the old age pension. The seven households have some livestock. The remittances and child support grant are main sources of income.

Type 2: Dry-land farmers

Farmers within the scheme but don't have access to water, hence depend entirely on rain-fed cropping. They make about 13% of the plot holders. First reason for being dry-land farmers is that the electric pump have been closed down by Eskom just after the government parastatal have withdrawn due to inability to pay the electric costs. The second reason is the approach taken by DBSA when redesigning the water supply. The plot owners are claiming the hydrants mounded in their plots. These are the most vulnerable farmers to drought. Although these farmers made up of small number as compared to the rest of the types, an urgent solution is required for access to water to all farmers within the scheme. These farmers are planting potato, butternut and maize. The child support grant is a main source of income.

Type 3: Specialised cabbage farmers

Farmers who are planting one crop without diversifying and cabbage were the crop grown. They make up about 17% of the sample. These farmers sell their products and consumed small amount of the production. The plots that are unused are leased out to other people and some lay idle. Plot holders complained that pipes and sprinkles are not enough. They have to change pipes when they have to irrigate and that required a lot of labour. That is the reason for them to plant one crop at a time as if they are specialised. The child support grant is a main source of income.

Type 4: Transition farmers

Farmers who grow less than three crops at a time. These farmers constitute 35% of the total sample. It is the largest group observed in Zanyokwe irrigation scheme. They sell most of their products. These farmers do not have much problem of pipes. These farmers can avoid risk of loosing one crop through diversification. These farmers plough small amount of land for vegetables (carrots and beetroots) e.g. 0.1 ha for consumption. It is observed that 0.5 ha to one ha, they tend to plant butternut, maize and cabbage respectively. It is recorded that these farmers do not utilise the available land optimally, some of land left unused. The 10 households have livestock and one household under freehold have more than 50 heads of cattle. The remittances, child support grant and old age pension is a source of income.

Type 5: Commercial farmers

Commercial farmers grow more than three different types of crops. They make up about 18% of the total farming population interviewed They use most of the land available to them. One farmer is an extension worker in the Department of Agriculture. The extension worker-farmer for example does not have enough land for cropping but for him leasing some unused land is an option. This farmer has two tractors. It is seen that people choose different strategies to organise a living.

Table 15: Farmer types in Zanyokwe: average land size, age of head of household, size of household and years of settlement (source: author's data).

Farmers types	Average land size	Average age of head of household	Size of household	Years of settlements	Major crops
Non farming holders	3.6 (2.04)	58 (9.01)	4.2 (1.48)	16.2 (6.34)	None
Dry-land farmers	4.64 (1.43)	49 (7.17)	4 (0.69)	11.14 (4.09)	Maize, Butternut and potato
Specialised farmers	4.05 (2.14)	51 (8.48)	5.25 (1.16)	8.63 (5.37)	Cabbage
Transition farmers	4.8 (11.57)	52 (11.57)	4.7 (1.43)	7.81 (4.99)	Cabbage, potato,

					butternut
Commercial farmers	5.3 (2.63)	50 (13.60)	5 (1.66)	9.3 (4.95)	Cabbage, veges, maize, butternut

Average values with standard deviation in brackets

Table 15, indicates average farm size, average age of head of household, size of household and years of settlements varies per types. As shown in the table 15, that non-farming holders have settle in the scheme for more years, and they are older than other categories of farmers.

Table 16. Land tenure system in Zanyokwe in percentage (source: author's data)

Farmers types	Freehold	PTO	Leasing	Total %
Non-farming Holders	4 (7.27)	5 (9.09)	0 (0)	16
Dry -land farmers	1 (1.82)	6 (10.91)	0 (0)	13
Specialised Farmers	2 (3.64)	4 (7.27)	2 (3.6)	15
Transition farmers	7 (12.7)	6 (10.9)	8 (14.5)	38
Commercial farmers	3 (5.45)	2 (3.64)	5 (9.0)	18
Total %	30.91	41.82	27.28	100

Numbers in brackets are expressed in percentages

Land tenure does not seem to have impact on to the farming style adopted by farmers, with the exception of leasing which do not practised by non-farming holders and dry-land farmers. Specialised farmers, transition farmers and commercial farmers are seen to lease in land. Leasehold appears to increase with degree of commercialisation. Leasing agreement in ZIS occurs in different ways: In the case of farmers under PTO land tenure system, farmers tend to lease out their plots to their relatives during winter (off season) and the leasers repay the owners by preparing their land for the maize crop in spring. Alternatively the repayment is in kind, where the leaser gives the owner part of the harvest agreed. Freeholder farmers on the other hand, tend to charge the leaser an agreed upon amount of money on a per ha per year basis. Interestingly, it is reported by leasers, that some plot holders tend to lease plots once and if they saw that the leaser's harvest was good, the owners take the plots back (reasons mentioned for this are jealousy and fear of losing the land in future if is under PTO).

4.4.2. Typology of cropping system: crop management styles and crop budgets

To obtain indications of returns to different crops planted, budgets for major crops in the irrigation scheme where calculated. The crop budgets for Zanyokwe Irrigation Scheme has been developed based on crop management styles. Crop management style is a simplified system that represents and integrates the cultivation modes, data and schedules, crop management features and crop budget for each major crop grown in the scheme. A given crop may be grown in different ways or with different features in one scheme, hence different crop management styles defined (Perret et al., 2003a). Table 17 shows all major crops that are grown in Zanyokwe. This data refer to farmer's sayings and recollection of their cropping systems and performance during the last cropping season and such information should not be taken as generic and ever standing and actual water consumption's could not be estimated accurately (Perret et al., 2003a). All data are means. In differentiating the main modes of management for any given crop choices had to be made. All crops look homogenous among farmers, and have been splited into two management styles except for some of the crops. This refers to level of input and yield. Both are found to be significantly different. Such distinct management style and performances of crops are characterised by low yield and low input as opposed crops with high yield–high inputs. All figures are expressed as per ha.

Table 17: Crops grown in Zanyokwe, units and prices (source: author's data)

Crops	Units	Kilograms	Prices in (R)
Cabbage	Bags	25	15
	Heads	-	1.50
Butternut	Bags	15	15
Potato	Bags	10	15
Carrots	Bundles	-	1.50
Beetroot	Bundles	-	1.50
Maize	Bags	50	70
	Cobs	-	1.00

All prices are averages based on farmers saying. Kilograms were found from corporations around.

Table 18: Crop management styles and crop budgets for Zanyokwe smallholder irrigation scheme (source: author's data)

Crops	Average yield	Total revenue	Production costs	Gross margin	Water demand	Gross Margin/m3	Water demand	Gross Margin/m3
Potato rain-fed (low-yield)	102 (81.9)	2250 (1984.3)	1080.8 (892.4)	1169.2 (1863.4)				
Potato rain-fed (high-yield)	224 (24.7)	4480 (494.2)	1467.9 (760.3)	3012.1 (707.3)				
Butternut Rain-fed (low-yield)	86 (48.8)	1537.5 (371.2)	1322.96 (0)	214.54 (371.2)				
Butternut Rain-fed (high-yield)	233.3 (28.8)	3500 (433)	945.5 (281.3)	2554.5				
Maize dry rain-fed (high-yield)	78 (19.3)	6473.3 (1447.8)	1095.06 (66.8)	5378.3 (1384.7)				
Potato Irrigated (low-yield)	116 (61.4)	1804.5 (921)	1356.27 (988.8)	448.2 (1685.3)	5020	0.09	5210	0.09
Potato Irrigated (high-yield)	799.3 (160)	15598.33 (5175.1)	1113.9 (520.4)	14484.4 5480.9	5450	2.66	5670	2.55

All figures are expressed as per ha. All figures are means obtained from different interviews (Except "water demand", obtain from SAPWAT) and the rest of crop budgets appeared in the Appendix 1.

In Zanyokwe, dry-land farmers exist and the butternut, maize and potatoes are the crops that are grown. However, a diversity of crops does exist under irrigated farmers and more particularly cabbage and vegetables. Interesting, rain-fed farmers have high yield and more inputs, which resulted to more homogenous yield with larger standard deviation and the opposite is true under irrigation farmers. Table 18 summarises recent production activities in the selected crops. Although the scheme was producing at a loss during the last days of Ulimocor and now some farmers are still doing so, the distribution of the total revenue across the selected crops indicates a great diversity among farmers within the scheme. Some are doing fairly well while others are performing poorly. The same trend is also observed on the gross margin/m^3 "return to irrigation water" where level of heterogeneity is quite high and varies from one crop management style to another and among the farmers within the scheme. Gross margin for each crop management style is calculated by deducting directly allocatable variable costs. These include seed purchased, fertilizers, herbicides, pesticides, hired transport (casual labour was excluded since labour is not allocated per crop). These data refer to farmer's saying and remembrance of their cropping systems and performances during the last cropping seasons (i.e. winter crop 2002 and summer crop 2002-2003). Therefore, such information should not be taken as generic. It depends on circumstances that took place during the given cropping season and the market prices. Also actual water consumptions could not be reached accurately. Standard irrigation requirements for the area, taking into account average rainfall patterns, have been considered (SAPWAT).

All the figures provided are averages with standard deviation in brackets. Choices had to be made in terms of differentiating the main modes of management for any given crop. All crops in dryland farmers which management style looks homogenous among farmers were categorised into two main management styles. This referred to "High yield" and " Low yield". For the irrigated farmers some crops were divided in to three, which include also high yield, low yield and average. In Zanyokwe six major crops were identified in both dryland and irrigated farmers and 24-crop management styles were developed. The difference refers directly to a strategy by farmers, in terms of what they are doing; hence resulting in significantly different yields. The distinct management styles and performances are interesting from a support point of view (Perret, 2003a). Appendix 1 shows all the crop management styles as appeared in Zanyokwe irrigation scheme.

Table 19. Contribution of farming in farmer's livehoods in Zanyokwe

Farmers types	Average farm size	Actual cultivated Area, crop/year	Gross margin /ha	Water/ha	Average water productivity	Gross margin per farm
Commercial	5.31	9.00	2145.70	4917.71	0.44	19311.27
Transition	4.82	6.60	1771.64	5556.83	0.32	11692.81
Specialised	4.05	1.40	2931.75	4235.86	0.69	4104.45
Dry-land	4.64	2.20	-368.00	0	0	-809.60
Non-farming holders	3.55	0	0	0	0	-

Farmers types combine cropping systems, and generate aggregated net income per ha, crop water demand per ha and water consumption per ha, according to an acreage-based weighting system. The latter takes the amalgamated cropping systems water needs, and considers the losses captured in the water balance module. Number of farmers is calculated from scheme area, types area and average farm area. The percentage gross margin is a percentage of the gross margin per ha, it gives the actual willingness to pay that the farmer type might be willing to pay for water-related services. Date is also expressed as per farm: annual gross margin per farm, annual water consumption per farm taking into account data per ha and average farm area. An estimated return to water per type is also calculated. Interestingly, specialized subsistence farmers are more productive than others types of farmers, per unit of land used. Table 19 on the 'gross margin per farm' above indicates the contribution of irrigation farming in the livelihood system. Gross margin/farm is significant except dryland farmers, which are operating under loss. Except other sources of living farming can contribute much better to the farmer's livelihood in Zanyokwe. For dryland farmers training and technical advice can be spotted.

4.5 Conclusion

The assumption for diversification is that when one crop fails the farmer will benefit from the other and it's about better using land cycles instead of one crop. Interestingly, specialised subsistence farmers are more productive than others types, per unit of land used. The differences between the types are evident but there is no fine line between types. They overlap most of the time. It is clear that as opportunities vary over time therefore the livelihood strategies also change. For example, when people get old and less energetic tend to leave agriculture and depend on pension. Most of the farmers depend on family labour therefore changes in the household composition due to death or migration for instance can affect the strategies at any given time. This resulted to lease out the plots and others acquiring them and the situation is changed. Therefore the dynamic nature of the situation should be taken into account.

The descriptive statistics reveal a high degree of heterogeneity among farmers. This is true in terms of many variables especially revenue/ha and gross margin/m3/ha. The general finding on land is that there is no effect of land tenure on land productivity (yield/ha) in Zanyokwe irrigation scheme. It is also depicted that there no clear relationship between land tenure system and farming styles/ farmers types. As compare to other PTO farmers are seen to be fairly profitable, possible limitations by the PTO system are overcome by strong local organizations, institutions and social capital.

CHAPTER FIVE: SUMMARY AND CONCLUSIONS

5.1 Introduction

The new South Africa is committed to redressing former inequalities and injustices. Regeneration of the economies of the former homeland understandably plays a significant part in this. Rural Ciskei is an area which visibly has been denied vital investment and for a large part is steeped in the institutional legacies of apartheid. With growing concerns of water scarcity, poor water productivity in the smallholder agricultural sector, and difficult decisions in water allocation are rising challenges for economic growth, local development, and poverty alleviation. This study investigates the economic performance of a smallholder irrigation scheme in the Eastern Cape Province (former Ciskei).

5.2 Delimitation's, execution and results of the study

The population from which data for this study was collected consists of smallholder irrigation and dryland farmers in the Zanyokwe irrigation scheme of the Eastern Cape Province of South Africa. A snowball sampling method was employed to obtain a sample of smallholder irrigation farmers. Taking into account the cost considerations and other limiting factors, a sample of 55 farmers was interviewed using a structured questionnaire.

In an effort to study the economic performances of a smallholder irrigation scheme in the Eastern Cape Province of South Africa, three methodologies were used to investigate farmer's livelihoods and the contribution of irrigation farming within smallholder irrigation scheme in Zanyokwe irrigation scheme:

(i) Structured interviews on both technical and economic issues were carried out;

(ii) Descriptive statistics, typologies (farmers & crop typology) were developed to describe the diversity of livelihood systems, the main mode of operation and their common characteristics;

(iii) A database / simulation platform (Smile) helped investigating the economics of households and of irrigation water.

5.3. Summary of findings

Findings indicate that irrigation households pursue heterogeneous livelihood strategies due to different access to livelihood assets and heterogeneous constraints and incentives. A socio-economic comparison based on the land size of smallholder farmers indicates that the land size at Zanyokwe irrigation scheme is not uniform as it varies from one person to another. 27% of farmers in the sample survey below 3 ha of arable land, 51% ranging from 3ha to 6ha, and 22% above 6 ha. It is indicated that farmers under leasing arrangement are having small land size, recent years of settlement and youngest household head. It is reported that the first tenure in the scheme was PTO, where farmers were settled. A similar trend was observed when farmers with age above 50 years old were compared to other categories. Those farmers with age above 50 years old are more active in farming than the young ones and more productive.

It is highlighted that in terms of occupation more than 40% of farmers are unemployed. The vast majority of the farmers do not have much cash at all to invest in agricultural production. Due to the high average age of farmers, household labour supply too is limited. Level of education is very low in Zanyokwe. It is observed that 58% are illiterate. It is observed that more educated farmers have larger size of land, younger head of household and recent settlements in the scheme. Most of the farmers are operating at low productivity levels and level of direct agricultural inputs per unit area of cultivated land does not appear to predictably affect the level of output. Small farmers are willing to pay for water services though they are still at subsistence level with low productivity and low cash income. A question remains as to how these farmers can pay back for water supply. It is indicated that farmers with limited demand, hence limited income from irrigation farming are also suggested that farmers with high consumption of water should pay for water related activities. Farmers have indicated they are willing to invest in agriculture, even take out more loans, if their investment will prove productive. As the population gets older and eventually pensions no longer contribute to household income, rural households will be hit hard.

It is observed that the only way farmers market their produce is through hawkers. Farmers indicated that they do not have access to markets because of the poor marketing and a complete lack of local markets.

Marketing is poor because the lack of communication, transport facilities and knowledge of the marketing process make it difficult or impossible for farmers to take advantage of market opportunities. Marketing is not accessible and infrastructure is not in good condition in the scheme.

The results on land tenure indicate that Zanyokwe irrigation scheme is very diverse in terms of land tenure. It is highlighted that land tenure does not seem to have impact onto the farming style adopted by farmers, with the exception of leasing which is not practised by non-farming holders and dry-land farmers. Not all households in the village have access to arable land. Due to overcrowding, residential plots were subdivided to accommodate more households. Later arrivals in the villages often were not allocated any arable land. Informal renting does occur, but as rental contracts are verbal agreements and are not legally enforceable, it constitutes an insecure and unpopular form of tenure. Land is rented from villagers who otherwise would not cultivate their land; often it is rented from family at low price. Since land in an area under traditional land tenure cannot be sold, there is effectively no land market and it is very difficult if not impossible to put a price on land. It also means farmers are incapable of changing the size of their holding according to their needs. The implication of land tenure is that no effect of land on land productivity (yield/ha) in ZIS and no direct relation between land tenure system and farming styles or farmers types.

The results of farmer's typology show that there is no fine line between the categories. The farmer's type is overlapping most of the time between each other. The heterogeneity among farmers is revealed.

5.4. Conclusion

The empirical results obtained in the study raise several issues pertaining to the economic performance of the smallholder irrigation scheme. Purposeful research, being hypothesis oriented, requires conclusions to be made in terms of the formulated hypotheses.

Hypothesis 1: The low productivity of land and water limits farming income and high cash costs; therefore hinder cost recovery at scheme level, and ultimately its viability. The findings of this research certainly provide support for the first part of the hypothesis. The scheme was seen to be producing at a loss. Only very few farmers are generating enough profit. Farmers are willing to pay for water related services but a question remains as to how subsistence farmers with low productivity and low cash income can pay back for water supply without support from the government. It is indicated that farmers with limited demand, hence limited income from irrigation farming are not willing to pay and also suggests that farmers with high consumption of water should pay for water related activities.

Hypothesis 2: The lack of co-ordination and social capital impairs production, marketing and cost recovery, hence the viability of the scheme. The findings of this research certainly provide support for this hypothesis. There were no co-ordination among themselves and no collective management at the scheme level. As explained, conceptual framework; Perret et al. (2003a) argued that collective management provides irrigation water and related-services to the farmers, for them to produce. Technical managers will operate and maintain the scheme and financial management will collect funds from farmers and managed the scheme.

Hypothesis 3: In the current situation, farmers are not likely to take over the technical and financial management of the scheme. The findings of the research provide support for this hypothesis. The farmers are not paying for water-related cost any cost of water in the scheme. It is indicated that in Zanyokwe most of the production functions except credit are managed individually (see Figure 3).

5.5. Recommendation

The following recommendations arise on the basis of the findings of this study and evidence from other studies on smallholder irrigation in South Africa. Agriculture is likely to be a necessary feature of rural development in the Eastern Cape Province for years to come as it offers one of the few realistic opportunities to engage significant numbers of the rural poor in food production and income generation. Irrigation performance indicators reinforce the farmer livelihood analysis that the scheme operates on a dual system. The parallel with the duality in South Africa agricultural production between commercial and communal farming is striking. There is evidence that SIS could be economically justifiable, particularly with crop production, but there are considerable institutional, equity and efficiency constraints to promoting further investment in rural South Africa. Poor market information and access compounded by ineffective credit access at low price reduce farmer incentives.

The government wishes the farmer's organisation that has been entrusted with the responsibility of managing irrigation scheme. For this to succeed, ambiguities about ownership and user-rights in respect of land, water and irrigation infrastructure have to be addressed. Farmers do not own their land and they do not have transfer rights. Farmer's organisations do not have rights over the use of water stored in their reservoirs.

Allocating scarce water resources to irrigation is a defensible policy option if the linkage between socially equitable access to irrigation infrastructure and economically efficient production for markets is made. The proposed operation of an irrigation scheme adopted from (Perret et al., 2003a) has to be implemented. This conceptual framework encourages participation among farmers. The management was found to be important as it affects the level of O&M, the cropping pattern practised, and the general viability of the scheme. Well-planned scheme are managed properly and has better O&M than government managed scheme. Frequent pump breakdowns and disconnection of electricity are common at Zanyokwe irrigation scheme. The ability of some farmers managed the schemes like Limpompo Province to pay for their O&M costs indicate that these schemes can be self-sustaining and that the government in future should concentrate on establishing such type of irrigation schemes.

Good irrigation water management is a problem at schemes, which do not pay for O&M costs. Zanyokwe Irrigation Scheme tends not to use water efficiently. The farmers have nothing to loose. It is recommended that some cost recovery measures should be instituted to make farmers much more responsible. Given that water is a scarce resource, allowing these farmers to continue wasting water is not acceptable. Marketing, especially through contract farming, has proven to be a problem for smallholder irrigation scheme. Most of the contract is verbal and unscrupulous dealers at the end usually cheat farmers. Training in contract marketing is hereby recommended as a means of safeguarding the farmers against some unscrupulous companies. The study of the Zanyokwe irrigation scheme shows that in future smallholder irrigation development should take an integrated rural development approach to covering irrigation infrastructure and associated communication and health facilities. This will result in the scheme not being shunned by transports because of poor roads, as is happening at present at Zanyokwe scheme. Improved communication facilities will ensure that farmers got market information timely through such means as telephone. Health facilities should also be near the scheme. The recommendations that come out of this study may need to be updated.

This report focused on two modules of "Smile" namely the "Crop" module and the "Farmer" module. Difficulties were encountered in obtaining accurate data on smallholders respondents, especially because they hardly keep any records of their activities and nothing is accurately measured (areas, yield). The information required for the "Cost" module was not available (i.e. capital cost, maintenance costs, operation costs, and personnel costs). It is worth noting that one of the limitations of empirical analysis is that the characteristics of only 55 households in snowball sample is under consideration and generalised to the rest of the smallholder farmer in the scheme, it is assumed that the sample is representative of the whole scheme. The accuracy of the data depends on the information given by respondents. All the data and information reported and analysed in this study are based upon farmer's saying and remembrance of latest activities and performances. Due to the different contexts in the Province, the findings of the study cannot be readily generalised to the rest of the Province.

REFERENCES

Agri-Carmel, 1985. Zanyokwe Irrigation Scheme Implementation Plan: Revision May 1985. Agri Carmel (Pty) Ltd, Braamfontein, Johannesburg.

Backeberg, G.R., and Groenewald, J.A., 1995. Lessons from the economic history of irrigation development for smallholder settlement in South Africa. Agrekon, 34(4): 167-171.

Bembridge, T.J., 1986. Problems and lessons from irrigation projects in less developed countries of Africa. Dev. Southern Africa 3(4), 600-618.

Bembridge, T.J., 2000. Guidelines for rehabilitation of small-scale farmer irrigation in South Africa, WRC Report No 891/1/00. Pretoria.

Blanche, M.T. and Durrheim, K., 1999. Research in practice: applied methods for the social sciences. Cape Town: University of Cape Town Press.

Byerlee, D. and Murgai R. 2001. Sense and sustainability revisited the limits of total factor productivity measures of sustainable agricultural systems. Agricultural Economics, 26, (3): 227-236.

Bruwer, J.J., Van Heerden, P.S., 1997. Spotlight on irrigation development in the RSA: The past, present and the future. In: Proceedings of the Southern African irrigation symposium, 4-6 June 1991, Elangeni Hotel, Durban, p3-10.

Chambers, R. and Conway, G., 1992. Sustainable rural livelihoods: Practical concepts for the 21st century. IDS Discussion Paper 296. Brighton: IDS.

Chakravorty, U. and Zilberman, D., 2000. Introduction to the special issue on: Management of water resources for agriculture. Agricultural Economics, 24 (1): 3-7.

Crosby, C.T., De Lange, M., Stimie, C.M., and Van Der Stoop, I., 2000. A review on planning and design procedures applicable to small-scale farmer irrigation projects. WRC. Report No 578/2/00, Pretoria, South Africa.

Da Silva, L.M., Park, J.R., Keatinge, J.D., Pinto, P.A., 2001. A decision support system to improve planning and management in large irrigation schemes. Agricultural Water Management, 51:187-201.

Department for International Development, 2002. www.dfid.gov.uk/ livelihoods.

Department of Water Affairs and Forestry, 1997. Documents on the departments' water charging strategy, website: dwaf.gov.za

Fraser, G.C.G., Monde, M., and van Averbeke, W., 2003. Food Security in South Africa. A Case Study of Rural Livelihoods in the Eastern Cape. In: Nieuwoudt, L. and Groenewald, J. (2003): The Challenge of Change. University of Natal press, Pietermaritzburg, pp 171-183.

Gonzalez, F.J., 2001. Summary for the FAO, Email conference on Irrigation Management Transfer, Sept/Oct.(2001) Conference website: Hyperlink: http://www. fao.org./landandwater/aglw/waterinstitutions/default.htm.

Hendricks, F.T., 1990. The pillars of apartheid: Land tenure, rural planning and the chieftaincy. Uppsala: University of Uppsala, Sweden.

Hill, Kaplan and Scott Inc, 1991. Ciskei national water development plan. Volume1: Report. Hill, Kaplan and Scatt Inc., Belville.

Hill, Kaplan, Scott & Partners, 1977. Keiskamma river basin: natural resources survey: Maps. Hill, Kaplan & Scott, South Africa.

Hope, R.A. and Gowing, J.W., 2004. Does water allocation for irrigation improve livelihoods? A socio-economic evaluation of small-scale irrigation scheme in Rural South Africa. Centre for Resources Research, University of Newcastle-upon-Tyne, UK. Email: Robert.hope@nclac.uk

IWMI, 2002. Can poor farmers in South Africa shoulder the burden of irrigation management? http//www.cgiar.org/iwmi/home/IMTSAf.htm.

Johnson, S.H., Svendsen, M., and Gonzalez, F., 2002. Options for Institutional Reform in the Irrigation Sector: Discutional Paper prepared for the International Reform in the Irrigation Sector: Discutional Paper prepared for the International Seminar on Participator Irrigation Management 21-27 April. Beijing.

Johnson, S.H., 2002. Irrigation Management Transfer: Decentralizing Public Irrigation in Mexico. International Irrigation Management Institute. Mexico, Latin America.

Karkkainen, T., 2002. Irrigation Management Transfer. A step towards caring more for water. MSc. Research: Helsinki University of Technology, Laboratory of Water Resources Engineering. Finland.

Kamara, A., Van Koppen B., Magingxa, L., 2001. Economic viability of small-scale Irrigation Systems in the Context of State Withdrawal: The Arabia Scheme in the Northern Province of South Africa, Waternet Symposium, Cape Town.

Kirsten, J.F., Perret, S., Van Zyl, J., 2000. Land reform and the new water management context in South Africa: principles, progress and issues. Seminar of the Natural Resources Management Cluster and Land Policy Thematic Group, The World Bank Washington, DC, 27 September 2000.

Kirsten, J.F., Van Zyl, J., and Van Rooyen, J., 1990. An overview of agricultural policy in South Africa. Agrekon (31) 4.

Kirsten, J.F., 1996. 'The Potential for Creating Additional Rural Livelihoods in Agriculture and the Rural Non-Farm Sector in Semi-Arid Areas. A Case Study in the Northern Province'. In: M. Lipton, Ellis and M. Lipton (eds). Land, Labour and Livelihoods in Rural South Africa. Volume 2. Durban: Indicator Press. pp. 303-334.

Kohls, R. L. and Uhl, J.N. (1985). Marketing of Agricultural Products. Macmillan Publishing Company N.Y, 7th Edition.

Kruger, P., 1953. Land tenure systems. In: de Wet, & van Averbeke, (eds). Regional overview of land reform-related issues in the Eastern Cape Province. Pp. 185-192. Working Paper 24-EC2, LAPC, Johannesburg.

Lipper, L., 2001. Negotiating Water Rights. Agricultural Economics, 26 (1): 86-88.

Leedy, P.D., and Ormrod, J.E., 2001. Practic al Research: Planning and Design, 7th edition. Upper Saddle River, N.J.: Merrill, Prentice Hall, Columbus, Ohio.

Loxton, N.F., Venn and Associates, 1983. A master preliminary plan for Zanyokwe Irrigation Scheme. Loxton, Venn and Associates, Bramley.

Loxton, R.F., Venn & Associates, 1984. A final agricultural plan for Zanyokwe Irrigation Scheme. Loxton, Venn and Associates, Bramley.

Makhura, M. and Mamabolo, M., 2000. Socio-economic issues in small scale irrigated agriculture: A Literature Survey of the Olifants Basin, RSA, and SADC. Report to IWMI, Sri Lanka.

Magingxa, L., 2001. Livelihood strategies and irrigation: Irrigation management transfer in Boschkloof irrigation scheme (South Africa). Msc Thesis, Wageningen University. Unpublished.

Mate, R., 1995. Juggling with land, labour and cash: Strategies of some resilient smallholder irrigators. In E.Manzungu and van der Zaag, P., (Eds). The Practice of smallholder irrigation. The case studies from Zimbabwe, University of Zimbabwe, Zimbabwe.

Mbane. 2003. Personal communication. Extension officer at Zanyokwe Irrigation Scheme.

Mpahlele, R.E., Malakalaka, T.M., and Hedden-Dunkhorst, B., 2000. Characteristics of smallholder irrigation farming in South Africa: A case study of the Arabie-Olifants River irrigation scheme.

Colombo, Sri Lank: International Water Management Institute (IWMI). pp28. (South Africa Working Paper No. 3).

National Department of Agriculture, 1995. White Paper on Agriculture. Pretoria, South Africa.

NWRS, 2002. National Water Resource Strategy, DWAF – a framework for moving forward.

Ngqangweni, S.S., 2000. Promoting income and employment growth in the rural economy of the Eastern Cape through smallholder agriculture. Unpublished Ph.D. Thesis. Pretoria: University of Pretoria.

Parasuram, A., 1991. Marketing research. 2nd ed. USA: Addison-Wesley.

Perret, S., 2002d. A simulation approach to assess the economic viability of smallholding irrigation schemes in South Africa: Conceptualisation and first implementation. Department of Agricultural Economics, Extension and Rural Development.

Perret, 2003a. Assessing the economic viability of smallholder irrigation schemes in South Africa: Prospective analysis and local empowerment. Final report for Department of Water Affairs and Forestry.

Perret, S., 2002a. Water policies and smallholding irrigation schemes in South Africa: A history and new institutional challenges. Water Policy, 4(3): 283-300.

Perret, S., 2002b. Testing scenarios on the viability of smallholding irrigation schemes in South Africa: a participatory and information-based approach. In: 17th Symposium of the International Farming Systems Association, November 17-20, 2002, Lake Buena Vista, Florida, USA. 8p.

Perret, S. 2002c. Supporting decision making on rehabilitation and management transfer of government smallholding irrigation schemes: the Smile approach. In: Rural and Urban Development Conference “Implementing Development: The Practice and Effectiveness of Development Policies in

South Africa", 18-19 April 2002, Gauteng, South Africa, National Institute for Economic Policy (NIEP), proceedings published by Document Transformation Technologies, ISBN 0-620-28854-X.

Perret, S., 2003b. Insights into poverty and the diversity of livelihood systems in wool production communities of the Eastern Cape Province. In: Local institutional innovation and pro-poor agricultural growth: The case of small-woolgrowers' associations in South Africa. Antwerp/ Apeldoorn, Garant, pp 117-138.

Perret, S., 2004. Smile User's Guide. Smile documentation index. CIRAD, University of Pretoria.

Perry, C.J., 2001. Charging for irrigation water: The issues and options, with a case study from Iran. IWMI, Sri Lanka.

Rosegrant, M. and Binswanger, H., 1994. Markets in Tradeable Water Rights: Potential for Efficiency Gains in Developing Country Water Resource Allocation. World Development 22 (11): 1613-1625.

Rogers, E.M., 1983. Diffusion of innovations. New York, Free Press.

Rukuni, M., Svendsen, M., Meinzen-Dick, R., and Makombe, G., 1994. Irrigation performance in Zimbabwe. Harare: University of Zimbabwe.

RSA (1998) National Water Act of 1998. Government of the Republic of South Africa: Pretoria

Rural Urban Consultants, 2001. Transforming and Integrated Communities." Provincial Land Reform Office. Department of Lanf Affairs, South Africa.

SAPWAT (1999) Website: www.sapwat.org.za

Scogings, P.F. and Van Averbeke, W., 1999. The effects of policy and institutional environment on national resource management and investment by farmers and rural households in East and Southern Africa. ARDRI, Fort Hare.

Scoones, I., 1998. Sustainable Rural Livelihoods: A framework for analysis. IDS Working Paper 72. Institute for Development Studies, University of Sussex, UK.

Smith, L.C., and Hadded, L., 2001. How important is improving food availability for reducing child malnutrition in developing countries? Agricultural Economics, 26: 191-204.

Smith, A., and Maheshwari, B.L., 2002. Options for alternative irrigation water supplies in the Murray-Darling Basin, Australia: A case study of the Shepparton Irrigation Region. Agricultural Water Management, 56: 41-55.

Sakurai, T. and Palanisami, K., 2001. Tank irrigation management as a local common property: The case of Tamil Nadu, India. Agricultural Economics, 25: 273-283.

Shah et al., 2001. Institutional alternatives in African smallholder irrigation: lessons from international experience in irrigation management transfer. IWMI, Draft Working Paper.

Shah, T., vans Koppen, B., Merry, D., de Lange, M. and Samad, M. (2000). Farmer management of irrigation systems: Can Africa's smallholder black farmers do it? International Water Management Institute, Colombo, Sri Lanka.

Swift, J.& Hamilton, K. (2001). Household food and livelihood security. In Deverex, S. & Maxwell, S. (eds). Food Security in Sub-Saharan Africa. London: ITDG Publishers: 67-92.

Wijayaratna, C.M., and Vermillion, D.L., 1994. Irrigation management turnover in the Philippines: Strategy of the National Administration. Short Report Series on Locally Managed Irrigation, No. 4 Colombo, Sri Lanka: International Irrigation Management Institute.

Van Averbeke,W., M' Marete, C.K., Igodan, C.O., and Belete, A., 1998. An investigation into food plot production at irrigation schemes in the Central Eastern Cape, WRC Report No 719/1/98, ARDRI, University of Fort Hare.

Van Averbeke, 1996. Final Report by Task Team 2. Appointed by the Honourable MEC E. Sigwela of the Department of Agriculture and Land Affairs of the Eastern Cape. To advise on the rationalisation of Zanyokwe Irrigation Scheme.

Van Zyl, J., Kirsten, J.F., Binswanger, H.P., 1996. Agricultural land reform in South Africa: Policies, Markets, and Mechanisms. Oxford University Press, Cape Town.

Van Zyl, C., 2002. The participation of the Host community in the Aardklop National Arts Festival. Unpublished Theses, University of Pretoria, Pretoria, South Africa.

Vermillion, D.L., 1997. Impacts of Irrigation Management Transfer: A review of the Evidence. Research Report. Colombo, Sri Lanka: International Irrigation Management Institute.

Vermillion, D.L. and Sagordory, J.A., 1999. Transfer of irrigation management services guidelines, FAO, Irrigation and Drainage paper 58. IWMI, Rome, Italy.

Wegrif, M. 1998. Land tenure and sustainable land use: Tenure myths and tenure experiences. In: Sustainable land management, some signposts for South Africa, eds. Critchley W., D. Versfeld, and M.N. Mollel. South Africa: University of the North.

Yokwe, S.C., 2002. The adoption of cash crop technologies by small women farmers: Qwaqwa case study. Unpublished MSA thesis, Bloemfontein, University of Free State, South Africa.

Appendix 1. Crop budget based on crop management styles

Crops	Average yield	Total revenue	Production costs	Gross margin	Scenario one	Gross Margin/m3	Scenario two	Gross Margin/m3
Potato rain-fed (low-yield)	102 (81.9)	2250 (1984.3)	1080.8 (892.4)	1169.2 (1863.4)	0	0	0	0
Potato	224	4480	1467.9	3012.1	0	0	0	0

rain-fed (high-yield)	(24.7)	(494.2)	(760.3)	(707.3)				
Butternut Rain-fed (low-yield)	86 (48.8)	1537.5 (371.2)	1322.96 (0)	214.54 (371.2)	0	0	0	0
Butternut Rain-fed (high-yield)	233.3 (28.8)	3500 (433)	945.5 (281.3)	2554.5	0	0	0	0
Maize dry rain-fed (high-yield)	78 (19.3)	6473.3 (1447.8)	1095.06 (66.8)	5378.3 (1384.7)	0	0	0	0
Potato Irrigated (low-yield)	116 (61.4)	1804.5 (921)	1356.27 (988.8)	448.2 (1685.3)	5020	0.09	5210	0.09
Potato Irrigated (average)	286.3 (59.4)	4437.5 (2122.6)	1995.5 (2162.8)	2442.0	5450	0.44	5670	0.43
Potato Irrigated (high-yield)	799.3 (160)	15598.33 (5175.1)	1113.9 (520.4)	14484.4 5480.9	5450	2.66	5670	2.55
Beetroot Irrigated (low-yield)	253.3 (171.3)	438.3 (262.2)	675.0 (194.8)	-236.7 (243.3)	2770	0.08	3040	0.08
Beetroot Irrigated (average)	804 (455)	1518 (991.5)	846.8 (432.1)	671.2 (1052.9)	2780	0.24	3040	0.22
Beetroot Irrigated (high-yield)	5510 (2107.2)	8265 (3160.7	1109.9 (115.5)	7155 (3276.3)	2780	2.59	3040	2.35
Carrots Irrigated (low-yield)	238 (81.7)	431 (168.7)	512.6 (149.9)	-81.6 (132.3)	3350	0.02	3590	0.02
Carrots Irrigated (Average)	810 (403.4)	1314 (987.9)	1277 (1178)	36.7 (1621.1)	3610	0.01	3900	0.009
Carrots Irrigated (high-yield)	3525 (700)	6045 (21.2)	985 (248.9)	5059.4 (270)	3610	1.40	3900	1.29
Butternut Irrigated (low-yield)	112.9 (66.9)	1595.5 (1027.4)	976.2 (271.3)	619 (9750.3)	4190	0.15	4300	0.14
Butternut Irrigated (average)	370 (27.7)	6450 (887.9)	937 (447)	5512.9 (601.6)	4580	1.20	4700	1.17
Butternut Irrigated (high-yield)	777 (68.1)	10050 (2653.8)	1779.9 (1458.2)	8270 (4098)	4580	1.80	4700	1.75
Maize dry Irrigated (low-yield)	22.5 (10.87)	1493.3 (736.8)	1534.2 (627.9)	-40.9 (1110)	4960	0.008	5190	0.007
Maize dry Irrigated (high-yield)	90.7 (46.3)	6140 (4722)	1198 (239.4)	4941.4 (4824)	5420	0.91	5650	0.87
Maize green Irrigated (low-yield)	4333 (3214.5)	5000 (2645.7)	1487.5 (126)	3512 (2555.9)	4960	0.70	5190	0.67
Maize green Irrigated (high -yield)	12666 (4618.8)	17333 (8737)	2749 (1539)	14584 (7288)	5420	2.69	5650	2.58

Cabbage winter Irrigated	562 (704)	2425 (1410.4)	3446.2 (2170.6)	-1021.2 (3291.7)	4290	0.23	4610	0.22
Cabbage summer Irrigated (high-yield)	728 (574.3)	4862 (4629.5)	3577 (1743)	1284.7 (5384)	2900	0.44	3170	0.41
Cabbage Summer Irrigated (low-yield)	235 (193.6)	2825 (1780)	2635 (614)	189.4 (1932.9)	2880	0.07	3140	0.06

Appendix 2. Questionnaire