

**THE IMPACT OF HUMAN DIMENSIONS ON SMALLHOLDER FARMING IN
THE EASTERN CAPE PROVINCE OF SOUTH AFRICA**

By

DOUGLAS KIBIRIGE

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Alice
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University of Fort Hare
Together in Excellence

Supervisor:

Professor Ajuruchukwu Obi

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DECLARATION

I Kibirige Douglas declare that the thesis hereby submitted for the PhD degree in Agricultural Economic at the University of Fort Hare is my own independent work and has not previously been submitted by me at any other academic institution, except where due acknowledgement has been made in the text.

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Student's Signature

...../...../.....

Date

.....

Supervisor's Signature

Professor Ajuruchukwu Obi

...../...../.....

Date

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Douglas Kibirige

University of Fort Hare, Alice

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DEDICATION

I dedicate this thesis to my mother Ms Grace Namusu Kawooya, my brothers Kirumira Simon Peter and Kalungi James Godfrey and my sister Nanfuka Sanyu Mildred. I dedicate this also to my dearest wife Mrs. Scovia Kibirige Nampiima and Mr Lawrence Musisi. Thanks and may the Almighty God richly bless you.

ABSTRACT

Considering the backward and forward linkages, the agro-industrial sector contributes about 12% of South Africa's GDP, and employs approximately 8.5 million people. In the Eastern Cape Province, the sector contributes about 1.9% of the Provincial GDP, and over 3 million people derive their livelihoods from subsistence smallholder farming. Despite its importance, agricultural productivity has stagnated for several years across the Eastern Cape rural communities. There have been several attempts by the government to improve the agricultural productivity on smallholder farms since the end of apartheid, especially through the establishment of small-scale irrigation schemes, subsidization of farm inputs, and provision of credit facilities and enacting a number of land reform policies. In spite of the government support, most rural communities like Qamata and Tyefu are still faced with high levels of poverty affecting 76% and 91% of the population, respectively.

This research evaluated the current smallholders' production efficiency, and the link between smallholder farmers' human dimensions (entrepreneurial spirit and positive psychological capital, goals and social capital, and other efficiency related variables) with production efficiency and household commercialisation index/level. The study used participatory approaches for site selection, sample selection and data collection. The analysis was based on both information from informal interviews and formal primary data collection. The Data Envelopment Analysis and Stochastic Production Frontier techniques were used to determine the relative efficiencies of individual farmers and to identify the major factors that influence the efficiency of production. Overall, 158 farmers were interviewed both at Qamata and Tyefu irrigation schemes.

Descriptive statistics of this study indicated that most of the farmers were men with an average age of 61 years, and mean household size of 4 persons with the household head having at least obtained some primary school education. Farming is the major source of livelihood for smallholders with an average income of R4527.49 per crop season. Smallholders use improved seeds, fertilizers and tractor for ploughing with less use of pesticides and herbicides. Although smallholder irrigators generate more gross margins from maize and cabbage enterprises, generally both categories of farmers exhibited a low average household commercialization index for maize and cabbage at 0.41 and 0.22, respectively.

Both Data Envelopment Analysis and Stochastic Production Frontier results indicate that farmers are about 98% technically efficient in maize and cabbage enterprises, respectively. However, farmers were allocatively inefficient as they were under-utilizing seed and pesticides while over-utilizing inorganic fertilizers. Factors that are positively associated with technical efficiency in maize production included household size, farming experience, off-farm income, use of agro-chemical; gross margins and commercialisation level of maize output. Determinants of technical efficiency in cabbage enterprise included farming experience, amount of land owned, use of agro-chemicals, group membership and gross margins accrued to cabbage sales.

Farmers' human dimensions that could be more positively and significantly associated with production, efficiency and household commercialisation level included risk taking (hope), innovativeness (confidence) and optimism for entrepreneurial/positive psychological capital. Farmers' goals included self-esteem and independence, and only external social capital which were identified to be more positively and significantly associated with farmers' production efficiency and commercialization level. The transition from homestead subsistence to commercial oriented small-scale irrigation farming is inevitable since smallholder irrigators earn more incomes from maize and cabbage and are relatively food secure. However, the key policy options that must be considered to address inefficiencies and improved commercialization level to aid the transition include: agricultural policies geared toward attracting youth in farming, improved quality of extension services, speeding up the land reform process, and formation of cooperatives and participatory policy formulation that takes full cognizance of the farmers' human dimensions. Since farmers' human dimensions as defined in the literature and this study are not things that are amenable to direct policy intervention, they can only be modified indirectly through policy actions that affect their determinants. This means that a number of the demographic and socio-economic characteristics such as age, sex and education level of household head, farming experience, size of land owned, crop incomes, source of water for irrigation and location of the irrigation scheme that govern the way people perceive reality and respond to them must be the focus of concerted policy actions over the medium to long term.

Key words: *DEA approach, stochastic production frontier, Production efficiency, human dimensions, irrigation*

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ACRONYMS AND ABBREVIATIONS

AgriBEE	Broad-based Black Economic Empowerment in Agriculture
AP	Average Product
APEP	Agricultural Productivity Enhancement Programme
APP	Average Physical Product
BFAP	Bureau for Food and Agricultural Policy
CASP	Comprehensive Agricultural Support Programme
CE	Cost Efficient
CIA	Central Intelligence Agency
CIMMYT	International Maize and Wheat Improvement Centre
CRDP	Comprehensive Rural Development Programme
CRLR	Commission on the Restitution of Land Rights
CRS	Constant Returns to Scale
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Data Envelopment Analysis
ECA	Economic Commission for Africa (of United Nations)
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	Food and Agriculture Organisation (of United Nations)
FDH	Free Disposal Hull
GDP	Gross Domestic Product
GM	Gross Margins
GoSA	Governments of South Africa
HCI	Household Commercialization Index
HDI	Human Development Index
IMT	Irrigation Management Transfer
IRR	Internal Rate of Return
ISRDS	Integrated Sustainable Rural Development Strategy
IWRM	Integrated Water Resources Management
KMO	Kaiser-Meyer-Oklin
LRAD	Land Redistribution for Agricultural Development
MP	Marginal Product
MAFISA	Micro Agricultural Financial Institutional Scheme of South Africa

MC	Marginal Cost
MFPP	Massive Food Production Programmes
MPP	Marginal Physical Product
MRT	Marginal Rate of Transformation
MRTS	Marginal Rate of Technical Substitution
MVP	Marginal Value Product
NCCR	National Centre of Competence in Research
NGOs	Non-Governmental Organisations
NIE	New Institutional Economics
NWA	National Water Act
NWP	National Water Policy
NWRS	National Water Resource Strategies
OLS	Ordinary Least Squares
PCA	Principal Component Analysis
PIM	Participatory Irrigation Management
QIS	Qamata irrigation scheme
R&D	Research and Development
RE	Revenue Efficiency
SA	South Africa
SLAG	Settlement and Land Acquisition Grant
SFA	Stochastic Frontier Analysis
SPSS	Special Package for Social Scientist-Analytical Software
SSA	Sub Saharan Africa
TP	Total Product
TPP	Total Physical Product
TR	Total Revenue
TRACOR	Transkei Agricultural Corporation
TVC	Total Variable Costs
UNDP	United Nations Development Programme
UNWWD	United Nations World Water Development
USAID	United States of America International Development Agency
VRS	Variable Returns to Scale
WIDCORP	Water in Dry-land Collaborative Research Programme

WIEGO	Women in Inform Employment; Globalization and Organising
WRC	Water Research Commission
WUAs	Water User Associations

CHAPTER 1

INTRODUCTION

1.1 Background

Increased agricultural production and food self-sufficiency have been part of economic growth and development of most countries around the world (Eicher and Staatz, 1985). There are approximately 2.6 billion people worldwide who derive their livelihood from small-scale agriculture. In Sub Saharan Africa (SSA), 80% of the population are small-scale farmers who cultivate less than 2 hectares of land (Biovision- Foundation for ecological Development, 2012). According to the Economic Report on Africa (2009), the sector employs over 70% of the labour force and contributes over 25% to the Gross Domestic Products (GDP) of developing countries. Smallholder farmers have a potential role of supplying an extra 70% of food needed to feed the growing populations globally (National Centre of Competence in Research (NCCR), 2012; Bruinsma, 2010). Further, the transformation of subsistence to commercial agriculture through efficient use of natural resources, farmer skills and knowledge, social networks, and adoption of new technologies like irrigation is seen as a crucial development path for economic growth in developing countries (Jaleta *et al.*, 2009). Researchers are increasingly turning attention to these issues as part of a broad-based awareness of the importance of the human dimensions in explaining some of the imponderables in development especially in the developing world. Accepting that the central focus of economic governance is making decisions on how to resolve the problems human beings encounter on a daily basis, Obi (2012) remarked that the human dimensions are so crucial that they form the basis for determining what activities are undertaken in the first place. As Obi (2012) noted, the nature of any particular development problem and how individuals and groups go about trying to resolve it is linked to the prevailing value system.

A vast body of literature has recognised the importance of human dimensions in respect to human capital, social capital, farmer's goals and aspirations, entrepreneurial spirit and positive psychological capital (Steyn, 1982; CTA, 1990; Ostrom, 1998; McElwee, 2005; Djomo and Sikod, 2012). These dimensions are regarded important in identification of farmer's decision making, production efficiency and productivity. Among the importance of human capital for increased productivity include adoption of new technologies and access to farm production and market information (Djomo and Sikod, 2012). In case of

social capital, increased agricultural productivity is achieved through social networks that ease access to natural, psychical and financial resources (Ostrom, 1998; FAO, 2000). Innovativeness and calculated risk taking form part of the entrepreneurial spirit parameters crucial in maximising farm output and profits (Modiba, 2009). According to Robert (2012), farmers with high level of entrepreneurial spirit are more likely to accumulate more social capital and this eases access to production assets and financial assets important for increased productivity. Padilla-Fernandez and Nuthall (2001), Maskey, Lawler and Batey (2010) indicated that farmers' goals and aspirations influence farmers' decision making in farm management and this determines the level of productivity.

In rural South Africa, Aliber *et al.* (2009) reported that the majority of smallholder farmers' goals are predominantly cultivating food crops for home consumption with less emphasis on generating farm incomes. Smallholders' less emphasis on farming as business may influence farmer's decision to cultivate small-plot with minimal investment leading to low productivity and marketable surplus (Padilla-Fernandez and Nuthall, 2001; Maskey, Lawler and Batey, 2010). According to Aliber *et al.* (2009), smallholder farmers' output in South Africa contribute negligibly to the nation agricultural GDP although they are still regarded important for sustainable food security and self-employment among rural resource-poor households.

Despite the positive contributions to increased food security and employment, smallholder agriculture is faced with numerous challenges resulting from social, political, economic and environmental factors (Ortmann and King, 2010). According to Obi (2011), subsistence farmers, especially in the former "independent homelands" of South Africa, are locked in low productive traditional technologies. Like most rural farmers in Sub Saharan Africa, smallholder farmers in South Africa are faced with challenges such as lack of access to factors of production (mainly land and water), lack of access to credit, and limited technology accessibility and applicability (Spio, 1997). Poor rural farmers are also faced with high transaction costs associated with input/output markets and lack market information which may be as a result of poor infrastructures (Ortmann and King, 2010).

Agriculture is also faced with risks associated with climate change. Globally, climate change has led to extreme temperatures and less rainfall resulting in water shortage (NCCR, 2012). Atmospheric accumulation of greenhouse gas emissions caused by use of

fossil fuels, increased population growth, and economic activities are some of the major factors responsible for increasing rate of climate change (Ancharaz and Sultan, 2010; and Vanhove and Van Damme, 2011). Global temperature is expected to rise by 1 or 2°C in the first half of the 21st century and this would lead to decreased crop yields especially in the semi-arid and tropical regions (Ancharaz and Sultan, 2010; and Vanhove and Van Damme, 2011). By the end of the 21st century, 90% of climate simulation models predict decreases in precipitation (Vanhove and Van Damme, 2011). A decrease in precipitation would lead to water scarcity both for rain-fed and irrigation farming (Ancharaz and Sultan, 2010; and Vanhove and Van Damme, 2011). The indirect negative impact of climate change on agricultural production includes increase in resistant weeds, and plant pests and disease outbreaks (Vanhove and Van Damme, 2011). Extreme weather events like storms, floods, cyclones, hailstorms, typhoons, heat wave and drought as a result of climate change are also accountable for the disruption of agricultural production (Ancharaz and Sultan, 2010; and Tacoli, 2012). Both the direct and indirect negative impact of climate change not only affects crop yields but also the nutritional value of food. As would be expected, the negative impacts of climate change are felt to a much greater extent by the resource poor smallholder households (NCCR, 2012; Tacoli, 2012).

Specifically, in Sub-Saharan countries including South Africa, 14% decrease in precipitation would cause a decline in the net revenues of crops by USD 9 billion (Ancharaz and Sultan, 2010). Therefore, this calls for scientific and political interventions that promote increased biomass through changes in agricultural systems, improved access to natural resources (especially land and water), and reforms in social and institutional structures (Vanhove and Van Damme, 2011; NCCR, 2012; and Tacoli, 2012). Adaptation to climate change can further be achieved through water harvesting technologies, establishment of infrastructure to guard against floods and storm surges, integrated approaches in water resource management and soil moisture conservation (Vanhove and Van Damme, 2011). Although some of these strategies have been incorporated in the provincial strategic plan, in 2010, the Eastern Cape Province was declared a disaster area in terms of increased temperatures and water scarcity (ECDRAR, 2011).

In addition to erratic rainfalls, high water evaporation caused by high temperatures has caused natural water sources to be unreliable yet they are the major sources of irrigation water in the Eastern Cape Province (ECDRAR, 2011). Reduced water levels from natural

sources have led to restricted water use, resulting in a higher dependence on rainfall as an appropriate alternative for water source especially during summer (Kodua-Agyekum, 2009; Van Averbeké *et al.*, 2011). This implies that although the province receives low rainfall, rainfall still remains a perfect substitute for other natural sources like rivers, and springs. Due to its importance, rainwater harvest technologies have been developed to increase water accessibility especially in arid, semi-arid and other areas prone to long droughts (UN-HABITAT, 2005). Rainwater harvesting technologies range from small containers to larger water reservoirs. Rainwater harvest for meaningful smallholder agricultural production may require larger water reservoirs (UN-HABITAT, 2005). However, larger reservoirs may be costly and thus can be hardly afforded by the resourced-poor smallholders (DAFF, 2010).

Smallholders use of low production traditional techniques and farming on the same piece of land overtime has led to soil fertility exhaustion. This may be due to lack of farmers' participation in designing appropriate technologies that suit their needs, and lack of access to modern knowledge and skills needed to improve productivity (Spio, 1997; Sishuta, 2005; Obi, 2011). All these have led to stagnant and declining smallholders' agricultural productivity in South Africa. Therefore, there is a need for improved production efficiency and appropriate resource allocation for increased productivity and hence, increased marketable outputs, household incomes, and improved rural livelihoods.

South Africa has a dualistic agricultural economy comprising a large-scale commercial and a small-scale rural smallholder agricultural sector. The large-scale commercial sector comprises a large well-integrated and highly capitalized commercial farms, mostly owned by few white people and contributing about 95% of the country's agricultural output (Aliber and Hart, 2009; FANRPAN, 2012). The rural smallholder sector is mainly composed of black farmers the majority of whom are subsistence producers (Aliber and Hart, 2009; FANRPAN, 2012). Although about 8% of commercial farm land has been redistributed among previously disadvantaged black farmers under the land reform programmes, South African government claim that white commercial farmers still cultivate and control 87% of South African arable land, while smallholder farmers cultivate about 13% arable land (Mail & Guardian News, 2012; Political Analysis South Africa, 2013). The dualistic nature of the agriculture sector mirrors the broader South

African economy which is said to be composed of the “first world economy” juxtaposed with an under-developed and traditional “second economy” (du Toit and Neves, 2007).

The notion of the “*second economy*” in South Africa was first introduced by the former South African president, Mr Thabo Mbeki in the now-famous August 2003 “Letter from the President” (du Toit and Neves, 2007). His argument was mainly based on the racial and geographical distribution of income inequalities and poverty level in the South Africa’s economy. Mr Thabo Mbeki described the “*second economy*” as that characterized by poor people who are unskilled and lack access to financial support to lift them out of poverty and happen to be almost entirely black (du Toit and Neves, 2007). In 2004, in the South African Finance Minister’s budget speech, Mr Trevor Manuel, bemoaned the existence of a “...second economy” (Obi, 2006). Rural smallholder farmers were identified as part of this poverty stricken “*second economy*” (Machingura, 2007). After identifying smallholders as part of this economy, they were selected as beneficiaries of the South African Micro-finance Apex Fund, established to provide financial and institutional development support in the “*second economy*” (Machingura, 2007). In 2011, The National Planning Commission was set up, chaired by Mr Trevor Manuel to re-examine the country's economic status. Results of the commission indicated that many poor South Africans are still “trapped” in that “*second economy*” (Obi *et al.*, 2011).

In addition to the establishment of the South African Micro-finance Apex Fund, the post-apartheid land reform policies and legislations were formulated and enacted to trigger expansion of smallholder farms for increased productivity (Aliber and Hart, 2009). Despite the available land policies, few, if any, smallholder farmers have expanded their farms (Aliber and Hart, 2009). Partly, this may be attributed to increasing agricultural risks faced by the rural resourced-poor smallholders globally (Kisaka-Lwayo and Obi, 2012). These risks may be as a result of introduction of new technologies, change in economic environment and uncertainties resulting from changes in public policies (Spio, 1997; Kisaka-Lwayo and Obi, 2012). In order to reduce risks, farmers diversify by growing several crops on small pieces of land. The diversification consequently has resulted into low subsistence agricultural production, less marketable surplus, low household incomes, food insecurity, unemployment and increased poverty levels.

The contribution of South Africa's agriculture to Gross Domestic Product (GDP) is declining (Eastern Cape Socio Economic Consultative Council (ECSECC), 2011; Ramaila *et al.*, 2011). The decline in agriculture's contribution to the economy may have a negative effect on investments in the sector; smallholder farmers' incomes and the rate of income savings among rural farmers. Low investment and declining agricultural growth may further result in reduced activities of non-agricultural sector especially the agro-industries that depend on agriculture as an agro-input market, and source of raw materials. Reduced activities in the non-agricultural sector and laying-off of workers to reduce production costs may worsen the situation of increased unemployment and aggravate rural poverty (Khai *et al.*, 2008). Therefore promotion of smallholder's commercialisation of agriculture is thought to have a great potential in creating employment and promoting more equitable distribution of income among South Africans. Many studies have shown that income inequality in South Africa is among the highest in the world (Klasen, 1997; UNDP, 2007). Reports indicate that South Africa's Gini Coefficient which measures the extent of income inequality has risen from 0.59 in 2006 to 0.69 in year 2012 (UNDP, 2007; Westaway, 2012). The recent labour unrests in the mines and farms where workers are demanding higher wages to meet rising living costs provide stronger support to these statistics.

1.2.1 Background to the Problem

The Khoisans are believed to be the first people to settle in South Africa approximately 2,500 years ago (Byrnes, 1996). They were hunters, fruit gatherers and livestock keepers. They settled in South Western Cape between the Orange River and the Great Fish River, fertile and well watered land (Byrnes, 1996). They were later joined by Bantu speaking group who settled along the Eastern coasts of South Africa and near Limpopo River about 1500 years ago (Byrnes, 1996). The Bantu speaking group were hunters, fruit gatherer and farmers who cultivated food crops and kept livestock (Byrnes, 1996). They grew food on small scale mainly for home consumption and raised livestock as a medium of exchange in barter trading (commercial purposes) (Byrnes, 1996). In 1652, the Dutch farmers settled and built a fort in the Cape Peninsula. They grew crops mainly for commercial purposes and sold them to European traders. As more Europeans settled in South Africa in 1800s, more natives (Black people) were relocated to lesser fertile and water stressed land. This was the beginning of unequal distribution of land based on racial segregation and apartheid in South Africa (Byrnes, 1996; Thwala, 2003; McAllister, 2010).

In 1913, the Native Land Act was passed which apportioned black farmers only 13% of arable land while 87% of the arable land was reserved for white people (Seneque, 1982; Obi, 2006; Aliber and Hart, 2009; McAllister, 2010). All the black people population and their livestock were squeezed into small pieces of land. Due to lack of modern technologies, the land was used exhaustively leading to low fertility levels, low farm output, household food insecurity and increased poverty (Seneque, 1982). In 1939, betterment planning was introduced to address the soil degradation problem (Seneque, 1982). The planning also reorganised black people into settlements and homelands to supply labour in mines and commercial white farms. Black people farm land was further reduced into small plots which could not produce enough food for a single family and were forced to cull their livestock, pushing them deeper into poverty (Seneque, 1982; McAllister, 2010).

Lack of land, reduced livestock numbers and relocation of black people reduced the black people's interest in farming, separated families and relatives, and disrupted the social-kinship structure that probably provided the platform for the supply of free farm labour and transfer of farming skills within households and communities (Seneque, 1982; and McAllister, 2010). Black farmers lost faith in farming as a source of income and migrated into mines and commercial white people's farms (Seneque, 1982). The labour migration from rural smallholder farm plots to large commercial white people's farms led to the collapse of the former and growth of the latter (Seneque, 1982). This created the huge gap between the two types of farming in terms of production and control of the national agricultural markets (McAllister, 2010). To date, the imbalances in farm labour and skewed land allocation prejudiced by betterment planning and apartheid era have led to a persistent dual agricultural economy in South Africa (Aliber and Hart, 2009). The Skewed agricultural economy has robbed rural poor black farmers of the ability to compete favourably and tap into the wealth of South African agricultural business sector, leading to poverty levels that are at best stagnant, but definitely deepening in rural areas.

A vast body of literature in the post-apartheid era has observed a decline in the agricultural labour due to massive migration of energetic youth from rural to urban centres and resulting into low agricultural productivity and increased unemployment in South Africa (Obi, 2006; Liebenberg and Pardey, 2010; FANRPAN, 2012; Mabhena, 2011). The UNDP

Human Development Index (HDI) report (2008; 2009) as cited by Mabhena (2011) indicated that most household members in rural Eastern Cape Province have stopped farming and migrated to urban areas in search of employment. This has resulted in low food production, increased food prices and hence leading to food insecurity especially among the rural households that can hardly meet such costs (Bruinsma, 2010). Food insecurity, increased population and unemployment negatively impact on South African economic growth and its broader macro-economic performance. Therefore, there is an urgent need to draw more attention on increased production efficiency and productivity that stimulate growth in the new South Africa (Backeberg, 2005).

In the quest to reverse history, the post-apartheid governments introduced new legislative land and water policies that promote access and ownership of land biased towards the black people (Machethe, 2004). In so doing, it was thought that this would steer up the entrepreneurial spirit among black people for increased marketable agricultural output enough to allow them participate in South Africa's agricultural cash economy. Furthermore, South African government has injected significant amounts of agricultural support funds to empower black rural farmers through the agricultural land bank, rural credit facilities, and provision of inputs and agricultural implements (Ramaila *et al.*, 2011). Other attempts in the Eastern Cape Province include funding the *siyazondla* (Xhosa word meaning "*we are feeding ourselves*"), and the *Siyakhula* (Xhosa word meaning "*we are growing*") (GoSA Information, 2008; Tregurtha, 2009; Muchara, 2011). Despite such efforts, there is still declining input and agricultural productivity among rural smallholder farmers (Ramaila *et al.*, 2011)

The land reform policies and black empowerment programmes promoting restitution and redistribution of land included Broad-based Black Economic Empowerment in Agriculture (AgriBEE). The AgriBEE was purposely designed to create a sustainable profitable environment for transforming the second subsistence economy into a commercial agricultural economy (Obi, 2006). In addition, the Settlement and Land Acquisition Grant (SLAG) programme was introduced in favour of black rural smallholder farmers to access and own land for increased agricultural output enough for home consumption and increased marketable surplus to generate household incomes. The process was based on the willing-seller willing-buyer principle. However, this arrangement was not sustainable because individual grants were too small to purchase enough land for commercial

production, and existence of conflict of interest between authorities and beneficiaries (Machethe, 2004). This led to the introduction of Land Redistribution for Agricultural Development (LRAD). The programme was successful in some parts of the country in terms of land redistribution (Machethe, 2004). Despite the mentioned policies, the rural poor farmers in the former homelands are still caught-up in high levels of poverty. According to Eicher and Rukuni (1996) cited by Machethe (2004), based on global experience, it is fruitless to embark on a land reform programme without ensuring farmers' access to other agricultural support services.

Most smallholder farmers, especially those in the former homelands, had problems of credit accessibility and input subsidies. The government of South Africa, through its departments, established the Land Bank and the defunct Agricultural Credit Board to address the credit needs of both smallholder and commercial farmers (Machethe, 2004). The function of these financial institutions was to provide credit and agricultural loans to smallholder farmers to meet input and other production costs. Due to structural changes in the agricultural sector, many credit micro-finance institutions collapsed leaving so many smallholder farmers in a dilemma (Machethe *et al*, 2004). The problem of credit accessibility has remained and even worsened, resulting in limited agricultural input use and hence low productivity. Limited access to agricultural inputs calls for improved management and more efficient use of available resources to improve productivity especially in irrigated fields where water licencing entails additional production costs that must be covered.

The government of the Eastern Cape Province formulated a ten year strategic framework called the Provincial Growth and Development Plan (PGDP) aimed at promoting sustainable growth and human development in the province for improved livelihood for all and address the past apartheid caused inequalities (Nondumiso, 2009). Within this strategic framework, improved food security was among the issues that needed urgent attention. To achieve increased food security, in 2003 the Massive Food Production Programme (MFPP) was launched. One of the major aims of MFPP was to organise communities and support them in establishing commercially oriented farms of 50ha and above under communal land. Under this programme, farmers were receiving 100% support in the form of loans from the Department of Agriculture of Eastern Cape Province and after each succeeding year the level of support was reduced by 25%. Farmers were expected to pay back 25% of

this loan annually after harvest for a period of 4 years. The government support included start-up capital like irrigation machinery, seeds, fertilizers and other farm implements. Also, the programme (MFPP) provided a basic input subsidy of R2300/ha to smallholder farmers alongside the MFPP commercial plots (Nondumiso, 2009). Despite these privileges offered, farmers' farm productivity was reported to be low, and failed to pay back the annual 25% of the loan making the programme unsustainable. Therefore, there is need to determine the production efficiency and the cause of inefficient input use to inform appropriate policy formulation for improved productivity, increased food security, and enhanced household incomes.

The largest part of South Africa is semi-arid and this has been worsened by harsh changing climatic conditions resulting into low rainfall and water shortage, and reduced farmers' production (Van Averebeke *et al.*, 2011). The effects of climate change are leading to declining productivity among the rural resource-poor farmers calling for more appropriate technologies that match with farmer's managerial capabilities, skills and experience to optimize water resource use (Kodua-Agyekum, 2009). In a recent study in the Eastern Cape, Muchara (2011) reported instances of sub-optimal water utilization regimes on irrigation schemes as well as individual plots despite the readily availability of water. If water resource is utilized efficiently together with a mix of other resources like human capital and financial capital,, then, increased output, improved food security, incomes and livelihoods of rural smallholder farmers may be realized (McElwee, 2005; and Van Averebeke *et al.*, 2011).

Crop choice and efficient use of fertilizers and irrigation were among the major ingredients that led to the success of the Green Revolution in Asia and Latin America resulting in rapid economic development (Van Averebeke *et al.*, 2011). Green Revolution is among the initiatives implemented by South Africa's government to boost agricultural productivity in the former homelands (Oettle *et al.*, 1998; Williams *et al.*, 2008; and Muchara, 2011). Green Revolution in South Africa has not yielded convincing results despite government support towards rehabilitation and revitalization of smallholder irrigation schemes in former homelands including Eastern Cape Province (Kodua-Agyekum, 2009; Van Averebeke *et al.*, 2011). Although this support is availed to smallholder farmers the transition from subsistence to commercial farming is slow. Low output of smallholder irrigation schemes may be attributed to less information available including farmer's

intangible form of capital necessary for appropriate planning and implementing of state led projects (Bailey, 2007).

World food prices are high and are set to remain so due to increased food demand and increasing shortage of primary factors of production, particularly land and water (BFAP, 2011). Although theoretically food prices are determined by supply and demand market forces, there are other factors that shape their movements (Vanhove and Van Damme, 2011). Factors responsible for high food prices include lack of access to land and water, the slow rates of increase in farm productivity, rise in petroleum prices, and increasing demand of cereals for biofuel production (Vanhove and Van Damme, 2011). Also, declining food commodity stocks, fluctuating macro-economic factors like foreign exchange and low interest rates, and climate change are reported to be responsible for high food prices (Vanhove and Van Damme, 2011).

Increase in food prices has mixed effects on social economic development especially in the developing countries like those in the Sub-Saharan Africa region (Vanhove and Van Damme, 2011). The positive impact of a sustained high food prices is that it has the potential to catalyse increased farm production for improved household incomes and food security especially among the large-scale commercial farmers (Vanhove and Van Damme, 2011). Most rural and urban poor household in developing countries are net food buyers and thus, high food prices may lead to increased hunger associated with high poverty levels (IPTRID, 1999). According to Bruinsma (2010) and Vanhove and Van Damme (2011), recently, increases in food prices led to increased poverty levels in developing countries.

1.2.2 Problem Statement

Amidst all the challenges regarding land and water accessibility and use, same or fewer resources need to be utilized in a more efficient manner to more than double food production to feed the increasing population of South Africa (BFAP, 2011). According to Statistics South Africa (2012), 2011 census results indicate that South Africa's population is about 51.7 million people. This is expected to grow to about 82 million people by 2035 if projected using annual population growth rate of approximately 2% (FANRPAN, 2012). Most rural development projects have embarked on supporting agriculture for increased

food production and household incomes by providing free farm inputs and subsidies but farmers are still reluctant to scale up their production. Evidently, mere access to tangible assets may not yield much without incorporating farmer's intangible assets for increased agricultural production. This calls for more research to generate more information on production efficiency, and the role of farmer's goals and aspirations, human and social capital, entrepreneurship, positive psychological capital and the level of commercialisation as a basis for more appropriate development paths for a transition from subsistence to market oriented surplus of farm output.

The smallholder farmers' low productivity and some of the failed rural development programmes in the Eastern Cape Province as highlighted in the background of the problem are partly attributed to: disrupted social capital, low human capital and lack of entrepreneurial skills, and exclusion of smallholder farmers' goals and aspirations in agricultural development programmes (Seneque, 1982; Sishuta, 2005; Kodua-Agyekum, 2009; McAllister, 2010). According to Kodua-Agyekum (2009) and the Eastern Cape Department of Rural development and Agrarian Reforms (ECDRAR) (2011), most smallholder farmers in the Eastern Cape have low literacy levels and lack skills for faster adoption and use of new technologies to increase their farm productivity. In addition, the disruption of the social value system among black farmers by the apartheid policies weakened the social cohesion important in governing and use of natural resources, access to cheap farm labour, and access to markets important for meaningful productivity (Seneque, 1982; McAllister, 2010).

Due to skewed apartheid policies and top-down management approaches, black farmers in South Africa lost trust in government programmes and this worsened the poor relationship between farmers and extension workers (Seneque, 1982; McAllister, 2010). Among others, lack of trust weakened the external social networks leading to farmers' low response to activities outside their social setting, for example, the government programmes and other support from external agents (Seneque, 1982; Kodua-Agyekum, 2009). The apartheid policies and failed rural development programmes also limited smallholders' accessibility to natural, physical and financial assets needed to promote entrepreneurial spirit (Modiba, 2009; Global Entrepreneurship Monitor, 2011). Limited access to arable land and water, the slow pace of land reform processes, increased monetization of farming and failure of some rural development support programmes are partially thought to be responsible for the

low entrepreneurial spirit, and low productivity among smallholder farmers (Seneque, 1982; Sishuta, 2005; Aliber *et al.*, 2009; Aliber and Hart, 2009; Kodua-Agyekum, 2009; Modiba, 2009; Global Entrepreneurship Monitor, 2011).

To date, no systematic analysis has been carried out to establish the role of human dimensions on farmer's level of production, technical efficiency, and commercialization level in the transition from homestead gardens to smallholder irrigation farming in the Eastern Cape Province of South Africa. Favourable policy environment has been set by South African government through provision and ease access to tangible resources. However, reform in the smallholder agricultural sector is slow. Perhaps, establishment of the information regarding the role of farmers' goals and aspiration, entrepreneurship spirit and positive psychological capital, and social capital in production efficiency and commercialisation level will trigger a more meaningful policy formulation to catalyse the reform processes. A positive change in these reforms is expected to contribute to improved farm productivity, food security, employment and alleviate poverty in the Eastern Cape Province of South Africa.

1.3 The Objective

The general objective of the study is to examine the role of human dimensions on smallholder agricultural production with particular reference to entrepreneurship and positive psychological capital, farmers' goals and social capital in the transition from subsistence homestead food gardening to commercially oriented smallholder irrigation farming in Eastern Cape Province of South Africa. More specifically, this study aims to:

- i) Describe the existing farming systems among smallholder farmers in the study area
- ii) Identify and quantify the human dimensions related to entrepreneurship, farmer's goals and aspirations, and social capital, and positive psychological capital.
- iii) Establish the relationship between the selected human dimensions and farmers'/farm characteristics

- iv) Estimate the impact of human dimensions on smallholder farmers' production, technical efficiency and commercialization level in the maize and cabbage enterprises.

1.4 The Null Hypothesis

- i) Human dimensions have no significant influence on the level of agricultural production among smallholder irrigators and homestead gardeners.
- ii) Human dimensions have no significant influence on technical efficiency among smallholder irrigators and homestead gardeners.
- iii) Human dimensions have no significant influence on household agricultural commercialization level among smallholder irrigators and homestead gardeners.

1.5 Motivations

Most smallholder farmers in South Africa are located in the former homelands mainly occupied by black people (Kodua-Agyekum, 2009). Smallholder farmers cultivate on farm sizes of less than 5ha, although there are a few outliers (Fanadzo, 2012). At the same time, agricultural practices are traditional, leading to very low productivities (Obi, 2011). Therefore, there is urgent need to tackle the problem, especially in respect of rural areas where the majority of the population, mostly the previously disadvantaged black people, still reside. In recent years, policy has targeted black farmers and new farms are now being established under the Land Redistribution for Agricultural Development (LRAD) Programme launched to redress the imbalance in land distribution (Machethe, 2004; Obi, 2006). Alongside the land redistribution programme are complementary programmes for economic empowerment through credit assistance, subsidization of farm infrastructure development, and other forms of support included under schemes like the Comprehensive Agricultural Support Programme (CASP), the Micro Agricultural Financial Institutional Scheme of South Africa (MAFISA), among several others (Obi and Pote, 2012). Despite all the support and incentives, productivity is still low and stagnant among smallholder farmers leading to reduced incomes of the rural family because all food is consumed by the increasing population and less is marketed (Aliber and Hart, 2009).

South Africa is faced with high poverty rate accompanied with the highest levels of income inequality in the world (Klasen, 1997; UNDP, 2007). In addition, there is declining agricultural output, and increased unemployment rates especially in the Eastern Cape Province where 41.4% of youths and 18.4% adults are unemployed (Majodina, 2011; Department of Rural Development and Agrarian Reform, Eastern Cape, 2011). As a way of reducing these pathetic conditions especially among rural population, President Zuma restated government's commitment to the implementation of the Comprehensive Rural Development Programme (CRDP) responsible for reviving land reform projects and irrigation schemes in the former homelands (Zuma, 2011). In addition to improved access to land and water, farmers' goals and aspiration need to be incorporated in the agricultural development programmes for increased productivity (Padilla-Fernandez and Nuthall, 2001; Kibaara, 2005). This research output is thought to provide useful information to policy makers and rural development programmes implementers on the importance of human dimension for increased farm productivity and farm incomes of smallholders, and reduced unemployment rates and poverty alleviation in the Eastern Cape Province of South Africa.

1.6 Scope of the Study

The research was limited to measuring the gross margins, extent of household agricultural commercialisation or market orientation, and productivity and production efficiency among smallholder farmers of selected irrigation schemes in the Eastern Cape Province of South Africa. In addition, the study incorporated smallholder farmers' entrepreneurship spirit and positive psychological capital, and farmers' goals and aspiration, and social capital in the production, and inefficiency model. The study also estimated the relationship between the selected human dimensions and household commercialisation index/level. Furthermore, the study was limited to smallholder irrigators participating in the irrigation schemes, and the homestead food gardeners. Among smallholder farmers, the maize and cabbage enterprises were considered as units of analysis. Geographically, the study was carried out at Qamata and Tyefu small-scale irrigation schemes located in the former homelands of Transkei and Ciskei in the Eastern Cape Province of South Africa respectively. The results of this study could be used to generalize the performance of small-scale irrigation schemes whose management, operations and the general set-up are closely related to Qamata and Tyefu irrigation schemes.

1.7 Research Ethics Considerations and Arrangements

The research team first sought ethical clearance from the university. The team also sought permission from governmental departments and local leaders before meeting farmers in their communities. All information collected from individual farmers was handled as confidential data. Results were generated from processed and analysed data used in reports as grouped information. There was no discrimination on grounds of colour, tribe, religious background or race as long as the farmer fits within the location and definition of smallholder farmers stated in this study.

1.8 Structural summary of the Thesis

This thesis consists of eight chapters, the content of which is summarized as follows: The first chapter provides the general background to the study, the problem statement, general and specific objectives, hypothesis, and motivation, a brief scope of the study and the structural summary of this thesis. The comprehensive literature review presented in this thesis is spread over 3 chapters (thus, chapter 2, 3& 4), and part of chapter 6 which reviews the trends in the evolution of the methodology and estimation techniques relevant to the topic. These chapters are arranged in respect to the sequential flow of the stated objectives. A review of literature related to the first objective was presented in Chapter 2, the second and third objectives' literature was presented in Chapter 3, and part of literature review in Chapter 3 and Chapter 4 were mainly focused on the fourth objective.

For more explicit and focused description of the existing farming systems among smallholder farmers in South Africa, a review of South African agricultural sector, particularly describing its organisation, economic contribution, employability, and production and productivity in Chapter 2. Further the chapter describes South Africa's natural resource endowment concentrating mainly on land and water (for irrigation), and how they are acquired, adopted and used in agricultural production during pre-apartheid and post-apartheid era.

Chapter 3 focuses on the human dimensions and commercialization of agriculture. Under this chapter, farmers' human and social capital, entrepreneurship and positive psychological capital and farmer's goal and aspirations are described in relation to agricultural production. The last section of this chapter briefly describes the advantages

and disadvantages of the historical commercialization of agriculture in developing countries and how smallholders' agricultural commercialization level can be improved on the basis of an analysis of the compiled documentation on the subject. Since the thesis aims at using production economic analysis, it was worth describing the concepts of agricultural production theory and estimations. The fourth chapter describes the concept of agricultural production and productivity estimations starting with the production theory and examples of previous studies carried out using agricultural production economics methods. The theories of production efficiency, as well as the broader theoretical and conceptual frameworks were also presented in chapter 4.

The description of the study areas was taken up in chapter 5. The chapter was introduced by describing the Eastern Cape Province, followed by Intsika Yethu Municipality before describing the exact study area of Qamata irrigation scheme (QIS), Ngqushwa Local Municipality/Peddie Area and Tyhefu irrigation scheme communities. Information used in description of the study area included the biophysical, and climate, vegetation and soils, and socioeconomic factors of the population thereof. Also, a brief description of the irrigation operations and historical background of their establishment was provided in the chapter.

Methodological and empirical modelling of the study was presented in chapter 6. The analytical methods included estimation of the gross margins, household commercialisation level, and production efficiency of smallholder farmers in general. To address the second and the third objectives, the principal component analysis was employed for variable reduction so that more efficient analysis of farm/farmer characteristics associated with the human dimensions could be conducted. Also, modelling the impact of human dimensions on quantity produced, technical efficiency and commercialisation level estimations were also presented in this chapter. Chapter 6 further presented the sample size and important primary data used in the analysis. Results and discussion were presented in chapter 7 while conclusions and recommendations were presented in chapter 8.

CHAPTER 2

A REVIEW OF SOUTH AFRICAN AGRICULTURE, LAND AND IRRIGATION ISSUES

2.1 Introduction

A comprehensive review was carried out in this chapter to avail information on smallholder farming systems in South Africa in particular the rural Eastern Cape Province. South Africa's smallholder agriculture is not different from other Sub-Saharan Africa's agricultural sector, thus, this chapter firstly presents a general overview of the rural smallholder agricultural sector in the region. For a better understanding of the contribution of smallholder farmers' entrepreneurship spirit, goals and social capital in agricultural production, it is necessary to review the performance of the South African agricultural sector in order to better contextualize the discussion. This entails establishing the set-up of the sector based on differences in farm sizes (smallholders and large commercial farms), production share of different agricultural products (field crops, horticultural crops and animal products) and agriculture's contribution to the economy.

There is now some consensus that agricultural production is driven both by tangible and intangible capital which must function in complementarity with other resources like land, labour, water, and a host of other factors which are mediated by new and emerging circumstances and challenges. Thus, this chapter presents a comprehensive review of these issues, focusing particularly on the major agricultural natural resources available in South Africa, their acquisition and how they are used to achieve improved productivity. Land (in this case for crop production), and water (for irrigation) and adoption of technologies like irrigation are seen as the major primary factors of production and are described in this chapter. The broader theoretical and conceptual questions around these issues are also reviewed and placed in the context of the specific task of determining the role of human dimensions in farm investment decision making in the smallholder sector. Methodological issues are also reviewed and presented in this and the next chapter of the thesis.

2.2 The Smallholder Agriculture Sector in Sub-Saharan Africa

In Sub-Saharan Africa, substantial proportions of the rural-poor households are smallholder farmers and derive their livelihoods largely from agriculture. Smallholder

agriculture sector employs a significant number of the rural-poor households in the Sub-Saharan Africa and the scale of production is the basis for its characterization (Economic Report on Africa, 2009). Most of these farm units owned by rural-poor households are generally small in size, and the sector can therefore be referred to as “smallholder agriculture” (Fanadzo, Chiduza & Mnkeni, 2010). Among the numerous problems faced by the smallholder agriculture in Sub-Saharan Africa, the stagnant low productivity and the prevalence of low-level technology rank very high. Despite the phenomenal improvements in crop yield in Latin America and Asia through adoption of the Green Revolution technologies, farmers on the African continent failed to adopt these technologies (Spencer *et al.*, 2003).

Sub-Saharan African agriculture has a number of distinguishing characteristics that probably explain its numerous definitions especially for the smallholder sector. According to Gilimane (2006) small-scale agriculture can be referred to as the sector of developing economies that presents the most difficult development problems. In support of the foregoing view, Ellis (1993) defined smallholder farmers as those farm households who rely primarily on family labour for farm production to produce mostly for self-subsistence due to limited access to alternative sources livelihoods. There are several other terms that are used to describe smallholder farmers and these include “small-scale farmers”, “resource-poor farmers”, “peasant farmers”, “food-deficit farmers”, “household food security farmers”, “land-reform beneficiaries” and “emerging farmers” (Fanadzo, Chiduza & Mnkeni, 2010).

Across the African continent, studies in the field of Agricultural Economics have focused on smallholder agriculture in response to the equally growing official interest in the sub-sector as means to achieve the goal of reducing poverty by half in 2014 as part of efforts to meet the MGDs (Eastern Cape Province, Department of Rural Development and Agrarian Reforms, 2011). This has attracted many of the Agricultural Economists and rural agricultural development programmes advocates to gain a deeper understanding of the concept of smallholder agriculture. There are differing definitions of small scale farmers (WIEGO, 2012). According to Van Zyl, Kirsten and Binswanger (1996), smallholder farmers have generally been linked to small farm sizes, traditional practices, and high poverty levels caused by the low returns associated with insufficient market participation. In the context of Ghana in West Africa, Chamberlin (2007) characterized those farmers as

constrained by “limited land availability” as “smallholder”. Smallholders are generally “resource-poor” with limited capital, fragmented plots, and insufficient access to inputs for farming (Chamberlin, 2007). Jayne *et al.* (2003), identified small-scale/smallholder farmers in East and Southern Africa as those whose plot sizes fall below 1 ha. Ethical Trading Initiative (2005) defined small scale farmers as farmers who produce relatively small volumes of produce on relatively small plots of land; they are generally more resource poor than commercial-scale farmers and usually considered to be part of the informal economy. They lack social protection and have limited records and are highly dependent on family labour, but may hire workers

Though some agricultural economists suggests that small-scale farming plays an important role in rural economic growth, Nyandoro (2007) indicated that peasant or small-scale farming is an inadequate foundation for development. According to Nyandoro (2007), the majority of smallholders are committed to subsistence production resulting in ‘a highly variable’ marketable surplus, thus imposing risk to both consumers and producers and ultimately the state’s food security. This is an indication that larger-scale producers are viewed as more reliable source of marketable surplus and therefore creating a stronger basis for planning both in agricultural and national development.

The high predictability of the large-scale producers probably explains the seeming bias of national policy in their favour and the apparent neglect of the small farmers who are considered ‘subsistence-minded’ and restricted by such factors as “tradition, fatalism, lack of innovativeness, low aspirational level, limited time perspective and lack of differed gratification” (Dorward, Moyo, Coetzee, Kydd and Poulton, 2001; Ngqangweni, 2000). Exclusion of smallholder farmers, particularly in South Africa has led to their extremely low participation from mainstream food markets (Louw *et al.*, 2008). One of the major reasons for excluding smallholder farmers was due to poor performance of their production systems, which were characterized by high production and transaction costs, resulting in poor quality, in addition (Louw *et al.*, 2008).

2.3. Smallholder Farmers in South Africa

In South Africa’s context, Ortmann and King (2010) define them as farmers with limited access to factors of production, credit, information, markets and are often constrained by inadequate property rights and high transaction costs, and the household labour use is

dominant on the farms. Smallholder farmers in South Africa command larger holdings and are relatively more market oriented when compared to homestead food plots, and sometimes are referred to “emerging farmers”. These "emerging farmers" are associated with the land reform programme and are basically black smallholders who are expected to produce more for the market but are probably not doing so (Van Auerbeke *et al.*, 2011).

According to Aliber *et al.* (2009), geographically, smallholder farmers in South Africa are unevenly distributed. Aliber *et al.* (2009) assumed a broad definition of agricultural smallholders in South Africa, including farmers who operate independently, farm in groups, subsistence farmers, and the market orientated whose purpose is mainly commercial. Thus, there are two categories of smallholders that can be identified using this broader definition, those whose farming is mainly subsistence and the commercially oriented smallholders. In total, there are about 4 million smallholder individuals who participate in South Africa’s agricultural sector and of the 4 million, about 92% are engaged in farming mainly for home consumption and only 8% of these farmers mainly produce for household income (Aliber *et al.*, 2009). This statistics provided by Labour Force Survey (LFS) of Statistics South Africa categories smallholders in terms of their major purpose of farming (Aliber *et al.*, 2009). Statistically this may be used as a proxy to distinguish between the “subsistence smallholders” and “commercial smallholders”.

The 92% of subsistence smallholders indicated that they purposely farm to ensure household food security vis-à-vis accumulation of wealth. Although subsistence-smallholders contribute less to the national agricultural market share and the national economic growth at large, their role in mitigating hunger cannot be ignored (Aliber *et al.*, 2009). This can be best explained by the high public expenditure incurred by the government to establish irrigation schemes and provided food parcels to needy households during the 1930s and the early 2000s hunger experiences in South Africa. Therefore, efforts to enhance subsistence production, is necessary.

In 2007, during the Polokwane conference, the African National Congress (ANC) government called for land reform and agrarian change as one way of supporting subsistence food production, expanding the productivity of commercial-smallholders and maintaining a vibrant and competitive agricultural sector (Aliber and Hall, 2009). Siyazondla is among the government programmes that have been designed to promote food

security through support of subsistence-smallholders, and the concept is explained in details in this Chapter 2. Commercial-smallholder farming has been promoted through several government support programmes. These programmes include land reform policies, additional grant money for farm improvements and initial operational costs, and use of mentors or strategic partners, the purpose of whom is to ensure adequate farm and business management (Aliber and Maluleke, 2010).

The land redistribution and restitution programmes targeted the resourced-poor commercial-smallholders and this led to failure of numerous projects. According to Aliber and Maluleke (2010), of projects delivered between 2001 and 2006, 29% were not actively involved in agricultural production and were generally deserted, and another 22% were producing extremely low outputs that generated low income. Nevertheless, there are a few commercial-smallholders' projects that have been successfully integrated in the South African formal agricultural markets (Aliber, 2011). The identified successful farmers were grouped into associations or cooperatives, and shared input costs, group labour, and marketed their produce collectively. These groups realised high production and farm gross margins (Aliber, 2011). For increased number of successful commercial-smallholders, there is a need for government interventions to resurrect the large number of failed projects across the country (Aliber and Maluleke, 2010). In addition to land redistribution and restitution, the government of South Africa availed capital funding through its Comprehensive Agricultural Support Programme – CASP (Aliber and Hall, 2009). In this programme, land reform beneficiaries were entitled to 70% share while 'other agrarian reform beneficiaries' were entitled to only 30% of the capital funding (Aliber and Hall, 2009). However, this support has not yielded much in terms of saving the declining agricultural productivity of smallholders (Aliber and Hart, 2009).

2.4. The General Overview of South Africa's Agricultural Sector

South Africa's agriculture is made up of a commercially oriented sector and the small-scale subsistence sector (Seneque, 1982; Obi, 2006; Aliber and Hart, 2009; AgriSETA, 2010; FANRPAN, 2012). The commercially oriented agricultural sector operates on a large scale, endowed with natural resources and well developed and skilled and semi-skilled labour, more purchased input and sophisticated technologies acquisition, and mainly composed of white people. The second sector includes the small scale subsistence agriculture predominantly occupied by resource poor black People ("Black" means "non-

white” and includes Africans, Coloured and Asians/Indians). Due to South African’s post-apartheid agricultural reforms, a new category of black farmers known as transition/emerging farmers has been established.

All development policies and programmes formulated and launched by apartheid and post-apartheid governments for the sector have been following almost the same direction (ISRDS, 2000). Policies and programmes in the apartheid era and the immediate post-apartheid era mainly supported commercial farmers and virtually neglected the rural smallholder farmer’s interests. This situation limited the extent to which rural smallholders, mainly black people, participated in both the national and international agricultural markets while the large commercial farms which are predominately white-owned earn enormous profits. The low participation of smallholders in the main stream of the economy has led to scarcity of information regarding this group especially on production and its importance in formulating appropriate policies for improved food security and rural development.

By 2003, the large scale commercial farms occupied about 87% of South Africa’s agricultural land approximated at 82 million hectares and mainly owned by 60,000 white farmers (FANRPAN, 2012). The number of these farmers has significantly reduced to 35,000 with an average farm size of 2,500 hectares (FANRPAN, 2012). The reduction may be a result of post-apartheid land restitution and redistribution policies (FANRPAN, 2012). The post-apartheid government set a target of redistributing 30% of farm land from white commercial farmers to emerging black commercial farmers by 2014 (Obi, 2006; and FANRPAN, 2012). Although there is a reduction of large-scale commercial farmers, they still contribute 95% of South Africa’s marketable output.

Large-scale commercial farmers mainly depend on irrigation farming to grow both horticulture and field crops. Commercial farmers have a well-coordinated social network both nationally and globally. These networks include linkages with agro-input/output industries, market outlets, and research and consultant services from both the public and private sector. The social networks ease access to technical and financial support, and market opportunities gained by commercial farmers. Furthermore, commercial farmers can easily practice precision farming system because they own relatively larger farm fields (Peter, 2001). The system allows farmers to subdivide their fields into small portions based on data gathered that avail important information on soil fertility, and this allows efficient

input allocation (Peter, 2001). Efficient allocation of inputs results in maximization of returns to investment (Peter, 2001).

In contrast, South African smallholder farmers predominantly living in rural areas are faced with lack of basic resources such as economic, social and human capital (Obi *et al.*, 2011). They are resource poor and the majority lack access to credit. Due to limited access to credit, smallholders can hardly adopt new technologies which may require a combination of purchased inputs for increased productivity (Essa and Nieuwoudt, 2001). Low productivity limits them in participating in the local, national and international markets (Obi *et al.*, 2011). Further, smallholders' economic resource constraints frustrates their efforts to access the desired trainings, services, and market information which are essential for increased productivity and market participation (Grootaert and Van-Bastelaer, 2001). Smallholders' pathetic situation has been worsened by deepening monetization of the agrarian economy which led to the abandonment of their fields and resorted to 'intensifying' cultivation of small garden plots adjacent to their homestead (du Toit and Neves, 2007; and Nondumiso, 2009). For example, poor smallholders can hardly meet additional input costs required to hire either a tractor or animal attraction to plough (du Toit and Neves, 2007).

Due to the introduction of schooling, children are no longer available to participate in farming activities and this prevents the transfer of skills from parents to the young generation, referred to as '*bovine deskilling*' (du Toit and Neves, 2007). Lack of transfer of skills as the old generation fades, exposes the sector to increased abandonment of fields, declining productivity, high risks of food insecurity, unemployment, and increases in poverty levels (du Toit and Neves, 2007). Further, du Toit and Neves (2007) indicated that smallholders' undermine farmer groups/cooperatives which are a potential supplier of cheap group labour for weeding and ploughing, and collective marketing. Also, most smallholders are relaxed to invest and expand their farms due to indistinct land tenure system and water rights transfers especially in the former homelands (News24, 2011).

In the South African context, smallholder farmers can much be defined based on past racial differences and are subsistence farmers who mainly produce for home consumption with low, if any marketable surplus (Machethe *et al.*, 2004). In other words, their priorities are dominated by the need to provide food for their households and marketable surplus is

subordinate to this basic need. There are approximately 4 million black people practicing subsistence smallholder agriculture in South Africa (FANRPAN, 2012). Most smallholder farmers live in “former homelands” (rural, segregated and demarcated areas for black people during the apartheid era) including former Transkei and Ciskei in Eastern Cape Province of South Africa. Most smallholder farmers are illiterate, aging, resource poor and lack access to services like training/extension services, markets and good public infrastructure with less accumulated social capital. Smallholders depend on both rain-fed and irrigation farming, and mainly grow maize, beans, potatoes and horticulture crops in small quantities just enough for home consumption (Liebenberg and Pardey, 2010).

In its endeavour to stimulate rural economic growth and alleviate poverty among Black farmers in the former homelands, by 1996 the African National Congress (ANC) government embarked on formulating economic policies geared towards establishing and or strengthening the existing class of emerging black commercial farmers (Greenberg, 2003). This was implemented by restructuring the agricultural sector which resulted into three categories of farmers namely, the “subsistence”, “emerging” and “commercial” farmers, respectively. Agricultural technicians, extension officers who served in the former homelands and former black employees of the Agriqwa were targeted as beneficiaries of the emerging black commercial farmers’ project (Greenberg, 2003; Obi, 2006). The major purpose of selecting these categories of people was that they had some resources that matched government funds and this could fasten the transition from subsistence to commercial agriculture (Greenberg, 2003). “Emerging” farmers are sometimes grouped together with smallholder farmers. This category of farmers is composed of approximately 200,000 black farmers since 1994 (FANRPAN, 2012). Machethe *et al.* (2004) cited Van Zyl *et al.* (1991) defining emerging farmers as those who have limited economic resources which prevent them from participating in the agricultural market economy in a meaningful way.

2.4.1 South Africa’s Agricultural Democratization

South African government has changed the direction of its agrarian policy to more explicitly target the black population with a view to fully integrating them into the mainstream economy since 1994 (Obi, 2006). The emphasis has been on empowerment of the black population and providing an enabling environment for black economic participation in the agricultural economy. In this regard, some of the more explicit

empowerment programmes include rural development programs, revitalization of irrigation schemes, land reform policies like the Settlement Land Acquisition Grant (SLAG), the Land Re-distribution for Agricultural Development (LRAD), Proactive Land Acquisition Strategy (PLAS), Farm Equity Schemes, Municipal Commonage Programmes, Land Restitution, the Comprehensive Agricultural Support Programme (CASP) (Aliber and Hall, 2009).

Among the new era of agricultural support, the emphasis has been on enhancing market access especially to smallholder farmers. The mechanism of integrating new and emerging farmers into the country's agricultural economy through access to markets has been observed by the National Department of Agriculture (DoA, 2001). Several experts like World Bank (2003), Roe (2003), Magingxa (2006), Pote (2008), Obi and Pote (2011), Obi *et al.* (2011), among others, shared the same view. Therefore, agricultural market reforms have been identified by the Government of South Africa as a veritable strategy for small farmer development. Along with the market reforms, South African government has instituted a range of programmes aimed at strengthening the emerging black farmers, whether they are producing merely for subsistence or making some attempts to commercialize and become absorbed into the nation's agricultural and market economy (FANRPAN, 2012).

Despite the market reforms, to date, these measures have produced little or no improvement in the circumstances of the rural smallholder producers whose conditions have either stagnated or actually become worse (Aliber and Hart, 2009). Researchers concluded that, the measures introduced to liberalize the domestic food market and integrate the country into the international system might actually have hurt rather than helped the smallholder farmers within the former homelands of South Africa (Makhura and Mokoena, 2003; Van Schalkwyk, Groenewald and Jooste, 2003). According to Pauw (2005), and Pote (2008), the phenomenal success of both the macro-economy and the commercial agricultural sector has largely by-passed the smallholder sector given that these were the victims of the discriminatory policies implemented under the apartheid regime, there are grounds for concern.

2.4.2 Homestead Food Garden Farmers

Pre-apartheid history, betterment planning and homeland settlement policies, and apartheid are the major contributors of establishment and dependence on subsistence homestead food gardens in the former homelands of South Africa (Butler, Rotberg, and Adams, 1978; McAllister, 2010). According to Perry (2012), a homestead garden is an old phenomenon where Bantu settlers in the Eastern Cape Province designed their homesteads based on location of natural resources such as water sources. Since they were mostly agro-pastoralists they designed their homesteads in such a manner that accommodates both livestock rearing and crop production. Most agrarian practices were dependant on nature and labour to plough, plant, weed and harvesting was mainly collectively rendered by the community, thus reducing costs of production. To date, despite changes in climatic conditions, the rural farmers in Eastern Cape Province have knowledge of how seasons evolve among most villagers, whereby they start to prepare land for planting in November (or before) for the planting of crops in December (Perry, 2012). During field preparations, activities like spreading of organic fertilizers from kraals into gardens and edges of the garden are done. The organic fertilisers is further soaked into soils during rain. Perry (2012) indicated that, these agronomic practices save labour which could have been used to move fertilizers to far gardens.

Partly, betterment planning and apartheid policies are responsible for the smallholders' shift from extensive field cultivation to homestead food gardening in the former homelands of South Africa (Hajdu *et al.*, 2012). During betterment planning and apartheid period, rural households in the homelands were constrained by labour shortages due to forced labour migration into urban areas, the mining sector and white commercial farms (Butler, Rotberg, and Adams, 1978). Wives and children were left to farm on the small plots and energetic men were forced to join the mainstream commercial sector in urban areas. According to McAllister (2010), most farm fields in rural villages were usually located 2 to 4km away from the homesteads and situated in low-lying areas near water bodies such as rivers and streams. Field labour was mainly dependent on sharing of agricultural work between households on a mutual basis (Hajdu *et al.*, 2012)

However, the far fields got less and less fertile with low output and people's investment interests towards these fields reduced (McAllister, 2010). Due to the resource poor rural

farmers' inability to innovate methods of maintaining fertility of larger farm fields and the bureaucratic means of accessing land for extensive farm production in their communities, they resorted to establishment of gardens near their homesteads (McAllister, 2010). The homestead food gardens are meant for subsistence food production, that is, enough for home consumption and sometimes supplemented with output market purchases (Hajdu, Jacobson, Salomonsson, and Friman, 2012).. However, they are considered to be efficient and intensive compared to distant fields which were less fertile and demanded more of the unavailable human labour (Hajdu, Jacobson, Salomonsson, and Friman, 2012).

The homestead food gardens produce diversified types of crops which include high value vegetables like tomatoes, cabbage, salads vegetable, and grain crops like maize, sorghum as well as legumes. Vegetables and other high value products are produced in the homestead gardens because it simplifies the management and other agrarian practices such as watering, pest control, manure application. This strategy seem to save more labour than cultivating far field (Hajdu, Jacobson, Salomonsson, and Friman, 2012; Perry, 2012). In larger gardens that are a little farther away from homesteads, farmers grow crops that call for less attention like maize and legumes (Perry, 2012).

Maize is often planted with a variety of beans and squash, albeit beans and squash are often grown more along the edges of gardens. Legumes are planted for purposes of improving soil fertility derived from nitrogen fixing bacteria contained in the nodules. After harvesting, farmers leave the land to fallow (Hajdu, *et al.*, 2012; Perry, 2012). Homestead food gardening uses conservational type of agriculture though it yields small quantities of output. Therefore, for more meaningful transition from subsistence to smallholder commercial farming, there is need to scale-up and shift from homestead food gardening to smallholder irrigation schemes that are commercially oriented. Also, farmers may be encouraged to use their homestead gardening experiences and other skills where applicable (Butler, Rotberg, and Adams, 1978; Muchara, 2011; Van Averbeké *et al.*, 2011).

2.4.3 South African Agricultural Contribution to the Economy

South African's primary agricultural sector contributes 3% to GDP (FANRPAN, 2012). Considering the forward and backward linkages, agro-industries contribute about 12% to

GDP (AgriSETA, 2010; FANRPAN, 2012). According to Liebenberg and Pardey (2010), agriculture's contribution to GDP significantly declined from 12.3% in year 1961 to 2.5% in year 2010 (Liebenberg and Pardey, 2010; FANRPAN, 2012). Although agricultural production has increased, South African's agricultural exports have reduced from 78.4% in year 1932 to 6.9% in year 2009. With exception of year 2002 when South Africa's agricultural export grew due to exchange rate depression, agricultural export growth has been reported to be slower with increasing agricultural products and food importation (AgriSETA, 2010; Liebenberg and Pardey, 2010; FANRPAN, 2012).

Actually, Machethe *et al.* (2004) reported a decline in the value of agricultural exports from over 10% in the 1970s to 4% in the 1990s. Therefore, there is need to scale-up agricultural marketable surplus to increase the country's agricultural export for increased incomes and also avail food enough for the rural poor households who cannot afford high prices of imported food. The major South African's agricultural exports include avocado, clementines, ostrich products, grapefruit, table grapes, plums and pears. The major agricultural imports include wheat, rice, vegetable oils and poultry meat (DAFF, 2012).

With increased production, agriculture has a strong multiplier effect on employment when based on the input-output analysis than any other sector of the economy (van Zyl and Vink, 1988) cited by Machethe *et al.* (2004). Thus, this fits into government's priorities and intentions of investing in agriculture and rural development for increased production to reduce on unemployment level and eradication of poverty. According to Liebenberg and Pardey (2010), and FANRPAN (2012), the sector is employing about 7% of South African labour work force and in 2006, the sector was reported to employ over 1.32 million farm workers, which is about 10.6% of the country's labour force (Liebenberg and Pardey, 2010). Agriculture employs in total 4.75 million people, 4 million of whom are engaged in subsistence small scale production and the sector has a potential of employing about 33% of smallholder farmers (FANRPAN, 2012).

In their study, Liebenberg and Pardey (2010) indicated fluctuations in agricultural labour markets due to introduction of new technologies like tractors and combine harvesters between years 1947 to 1970s. Increased use of machinery was sparked by the government's introduction of farmers' easy access to credit and tax breaks (Liebenberg and Pardey, 2010). Further, the introduction of the Pass Law in 1952 resulted in farm labour

scarcity because black farmer movement was restricted (Liebenberg and Pardey, 2010). However, when access to credit ceased, coupled with the devaluation of the rand in the early 1980s, use of imported machinery was relatively more expensive (Liebenberg and Pardey, 2010). Between the late 1980s and early 1990s, new legislations were introduced which advocated for provision of land tenure security to farm labourer working on commercial farms, and they also fixed a minimum wage rate (Liebenberg and Pardey, 2010). Owners of large-scale commercial farms perceived the new legislations as a threat to their wealth and farm profits, so, they resorted to use of machinery (Liebenberg and Pardey, 2010). Also, the long-term decline experienced in agricultural employment may be attributed to decreases in number of farming operations, younger generation being less interested in farming, and the market deregulation among others (FANRPAN, 2012).

2.4.4 South African Agricultural Production and Productivity

Liebenberg and Pardey (2010) carried out a study to estimate South African agricultural production and productivity trends between 1910 and 2007 (Table 2.1 and Figure 2.1). Their findings generally indicate a steady growth in value of agricultural production in South Africa. However the country experienced stagnant growth in the value of agricultural production in the 1990s. The information presented indicates that the horticultural sector is growing faster than field crops and livestock sectors. The field crops category includes maize, wheat, oilseed, cotton, sugarcane, tobacco among others. Vegetables and citrus fruits combined are categorised as horticultural product. Livestock products as defined by the South African department of agricultural include slaughtered goat, sheep, cattle, calves, chicken, and ostriches.

Further, results in Table 2.1 and Figure 2.1 indicate a positive relationship between the value of field crops, horticulture and livestock production curve, and the farm size curve. The values of production of each sector were increasing with increasing farm size. The information presented in Table 2.1 also indicate that between the 1970s and 1980s South Africa's production was at the peak and this may be due to the intensive farm mechanization and available cheap labour which further resulted into expansion of farm size, leading to increased output and total value of agriculture production (Liebenberg and Pardey, 2010).

Table 2.1: Trends in Value of Agricultural Production and Farm Size in South Africa, 1910-2007												
		Decades										
	UNIT	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000 to 2007	
Total Area	1000ha	77,042	81,810	84,339	87,392	88,150	89,256	86,814	85,862	82,404	83,701	
Average Farm Size	ha	1,006	928	833	781	788	817	1,094	667	1,260	1,400	
Value of Field Crops	R Million (2000)	4,063	4,568	5,339	8,938	14,982	20,267	26,524	23,658	15,677	16,722	
Value of Horticulture	R Million (2000)	1,180	1,552	2,043	3,593	5,322	7,659	9,526	10,323	11,392	14,493	
Value of Livestock	R Million (2000)	5,991	6,700	6,748	11,628	19,603	20,531	21,760	24,775	20,518	24,352	
Total Value	R Million (2000)	11,234	12,820	14,130	24,159	39,906	48,458	57,810	58,756	47,586	55,567	
Share of Field Crop	Percentage	36	36	38	37	38	42	46	40	33	30	
Share of Horticulture	Percentage	11	12	14	15	13	16	16	18	24	26	
Share of Livestock	Percentage	53	52	48	48	49	42	38	42	43	44	
<i>Source: Liebenberg and Pardey (2010)</i>												
<i>Note: Data were deflated using the GDP deflator from SARB 2009</i>												

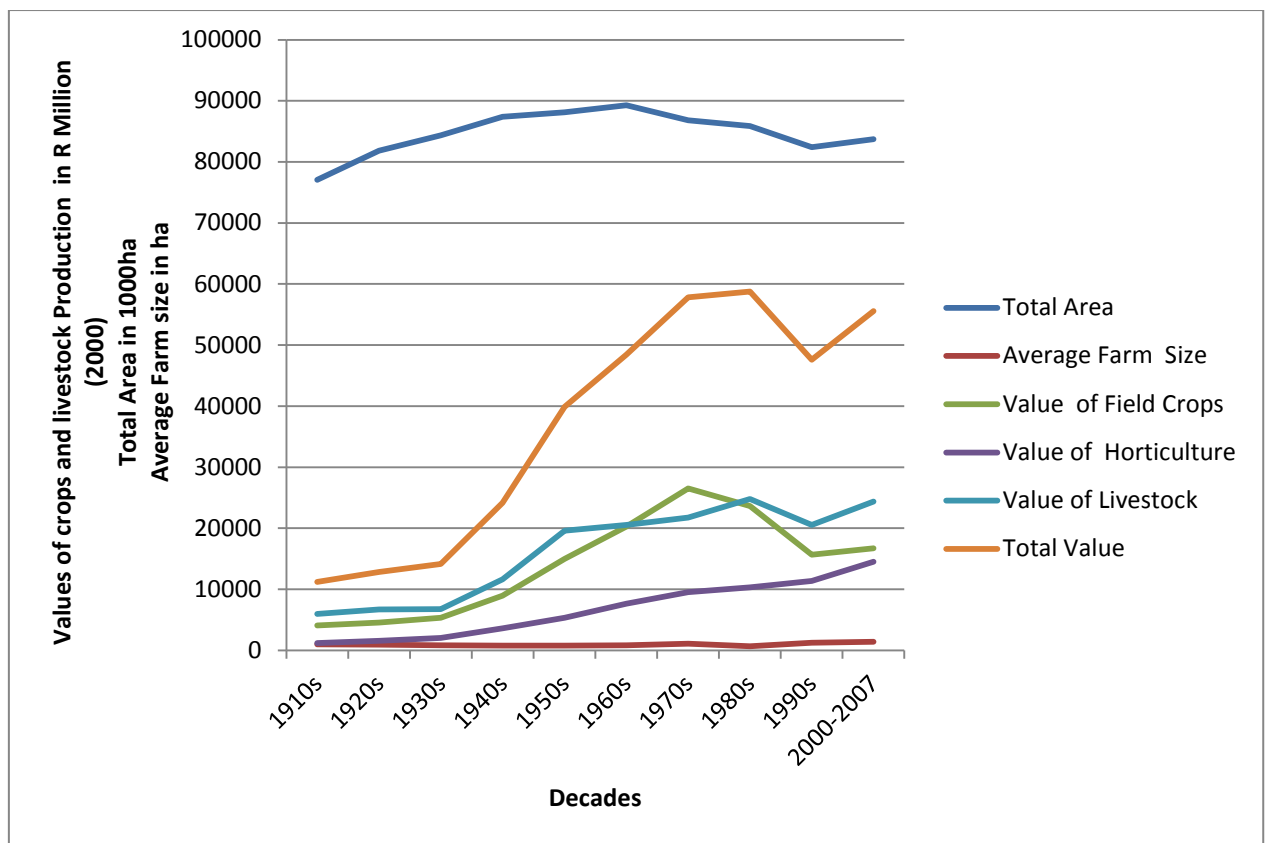


Figure 2.1: Trends in Value of Agricultural Production and Farm Size in South Africa, 1910-2007

Source: Liebenberg and Pardey (2010)

According to the Department of Agriculture, Forestry and Fisheries (DAFF, 2011), the gross value of agricultural production (total output at a given production season valued using the prevailing average basic prices received by producers in the same season) declined from R127 568 to R126 433 million in the 2009/10 season. The decline could have been due to a decrease in the value of field crops (DAFF, 2011). DAFF (2011) results indicate that the contribution of livestock products, horticultural products and field crops to the total gross value of agricultural production in 2009/2010 was 51.3%, 25.7% and 23%, respectively. This concurs with the information in Table 2.1 and Figure 2.1 for the livestock product, because, it had the biggest share of production value of 44% compared to the 26% for horticultural products and 30% for field crops in 2000/2007, respectively (Liebenberg and Pardey, 2010). These results suggests that there was a percentage increase in livestock products' and a percentage decrease in horticulture products' and field crops' contribution to the total gross value of agricultural production between 2000/2007 and

2009/2010. Though volumes of field crop production may be higher than the horticulture and livestock volumes in tonnage, horticulture and livestock products fetch more gross value than the field crops because of their higher market prices (DAFF, 2011).

In 2012, a comparative analysis of South African agricultural production performance was carried out by the DAFF for period between 2009 and 2011 (DAFF, 2012). The comparison of the 2009/2010 and 2010/2011 results show that the volume of field-crops decreased by 4.5%. The decrease was mainly attributed to a decline in output of summer harvest. Although it was slight, horticulture production volumes increased by 0.2% and this was mainly attributed to increments in potato production by 6.8% (134 834 tons), onion by 14.6% (71 214 tons) and citrus fruits in particular grapefruit and lemons by 5.9% (31 744 tons) (DAFF, 2012). Increment in Cattle and calves slaughtered by 3.6% (24 698 tons) and poultry slaughtered by 3.3% (47 000 tons) contributed to a slight increase in animal production volumes (DAFF, 2012). The increment in horticultural and animal production was reflected in the increased total gross value of South African agricultural production estimated at R138 904 million in 2010/2011 compared to R 129 883 million in the previous year between 2009 and 2011 (DAFF, 2012).

However, it should be noted that about 98% of these estimated agricultural values are mainly attributed to commercial farmers with little smallholder production being considered in the national agricultural production and marketed output in South Africa (Kodua-Agyekum, 2009). Thus, commercial farmers account for the largest share of farm incomes, widening the income gap in the country. The insufficient consideration of smallholder statistics in the national agricultural production and market estimations may be attributed to negligible marketable surplus produced by smallholder farmers and scarcity of data for this category of farmers (Aliber and Hart, 2009; Cousins, 2013).

2.5. Agricultural and Natural Resource in South Africa

Land and water are primary inputs in agriculture and essential to every living creature. Thus, there is need to use them optimally and sustainably (Business Dictionary; Obi, 2006; Bruinsma, 2010; Boyce, 2011). South Africa has a total area of 1,219,090 km², of which dry land is 1,214,470 km² and water occupies 4,620 km² (CIA, 2012; Obi, 2006). Of the 12.5 km³/year total available fresh water, 31% is used for domestic purposes, 6% is used in

industrial and 63% is used in agricultural production (CIA, 2012). South Africa is endowed with 12.1% of arable land for seasonal crops, 0.79% is land under permanent/perennial crops and 87.11% for other purposes such as forests, physical infrastructure, and barren land (CIA, 2012). Thus, arable land (12.1%) is limited of which more than half of it is used by large-scale commercial farmers. Therefore, there is a need to efficiently utilize the available land and scarce water for both food security and marketable surplus output to transform subsistence to commercial farming (Spio, 1997).

2.5.1 Trends in land holdings, and field sizes in South Africa

The San (Khoi) are believed to be the first settlers in the South Western part of South Africa near the well-watered and fertile lands of Orange River (Byrnes, 1996). They were herdsmen, hunters and fruit gatherers (Byrnes, 1996). The second sets of people believed to settle in South Africa were Bantu Ethnic group who settled near River Limpopo and the Eastern Coast line and were both farmers and pastoralists (Byrnes, 1996). In 1652, the Dutch settled at the Cape Peninsula (Byrnes, 1996). They were commercial farmers and used large pieces of land for food production to feed and trade with European traders who were using the Pacific-Indian Ocean trade route (Byrnes, 1996). The settling of Europeans in South Africa marked the beginning of relocation and segregation of the black African who had previously occupied the land (Seneque, 1982; Thwala, 2003). The 1913 Native Land Act allocated black people less arable land compared with white people who owned big portions of land (Obi, 2006). Furthermore, the betterment programme was introduced in 1939 which further reduced the black man's land to an extent of not producing food enough for their households, resulting in farm labour migration to mines and white commercial farms (Thwala, 2003). Black people were instructed to cull their cattle and their social-organisational interactions were disrupted through forced homeland settlement (Seneque, 1982; Thwala, 2003; McAllister, 2010).

This led to low zeal for farming, low food output, less incomes and hence, pathetic poverty levels among rural black people (Seneque, 1982; McAllister, 2010). Racially discriminatory practices and apartheid deprived black people of the rights to land ownership and use, and hence excluding them from fully participating in the main stream of the commercial agricultural sector of South Africa (Seneque, 1982; Department of Rural Development and Land Reform; SA, 2003). The post-apartheid South African government

introduced land reform through restitution and redistribution in the bid to redress the inequalities in land distribution associated with the apartheid regime as well as transforming subsistence farming to commercial production (Obi, 2006). This in turn, is a strategy aimed at aiding rural economic growth and a reduction in poverty.

2.5.2 Land Reforms and Agricultural Productivity

South Africa borrowed a leaf of the land reform strategy from some countries in the East Europe, Asian and Latin American, where it yielded positive agricultural output (Economic Commission for Africa-UN (ECA), 2003; and Adams *et al.*, 2004). The land reform strategies were aimed at boosting agricultural productivity among rural black people especially in former homeland and as an engine for economic growth and rural development (Obi, 2006). Thus, land ownership and accessibility were found to be crucial factors for increased agricultural productivity (Padilla-Fernandez and Nuthall, 2001). In South Africa, the most deprived people were the rural landless including black smallholder farmers living in former homelands of Transkei and Ciskei in the Eastern Cape Province. Improved access to land through land reforms was seen as an incentive to lure black farmers to expand their farms for increased production and marketable surplus leading to improved incomes, food security, employment and poverty alleviation (Obi, 2006). Land reforms in South Africa were implemented through three main components which included restitution, tenure reform and land redistribution. Land ear-marked for distribution included state land appropriated during the apartheid period for conservation and military programmes and land held under large scale commercial agriculture dominated by the white people's population (Obi, 2006).

2.5.2.1 Land Redistribution Programmes

In 1994, the Settlement and Land Acquisition Grant (SLAG) programme was established and beneficiary households, especially the black people, received the sum of R15, 000 each to acquire agricultural land (Machethe, 2004; Obi, 2006). The programme was intended to use the principles of willing-seller willing-buyer for a more flexible land market. This was done based on the World Bank's argument of using a state facilitated land market and distribution that allows more transfer of land to the poor who could not afford high land prices in the free market economy (Adams *et al.*, 2004; Machethe, 2004; Obi, 2006). The SLAG programme was faced with challenges like the inadequacy of the little individual

cash grants to purchase sizeable pieces of land for commercial production and conflicts of interest between authorities and beneficiaries regarding who was fit to receive the money. Thus, the programme did not last long. The assessment of this programme highlighted such shortcomings and thus paved the way for the establishment of the Land Redistribution for Agricultural Development (LRAD) programme in 2000 (Adams *et al.*, 2004; Machethe, 2004; Obi, 2006).

The LRAD programme increased the amount of cash grant per individual from R15,000 to R20,000 and acquisition of this cash grant was attained when the beneficiary availed his/her own contribution of R5,000 (Swanepoel *et al.*, 2004 cited by Obi, 2006). The contribution was considered as a commitment of the applicant. Some people agreed to form groups to purchase farms because there was no individual plot that could be purchased with the individual small grant received (Adams *et al.*, 2004; Obi, 2006). Though the LRAD was reported to be successful in terms of poor farmers' acquisition of land, farmers still faced low agricultural productivity (Machethe, 2004).

In addition to the LRAD, the Proactive Land Acquisition Strategy (PLAS) was initiated by the government of South Africa to acquire land suitable for redistribution to those who have already benefited from LRAD or anticipated beneficiaries (Aliber *et al.*, 2009). This PLAS programmes employs the principle of lease-to-buy arrangement where land is only transferred to success farmers and those who fail to succeed hand-back the land to the government for redistribution to potential candidates. According to Aliber *et al.* (2009), though it was thought to early to conclude its success, PLAS was recommended for its ability to stimulate efficient land use among smallholder and medium-large-scale black farmers.

2.5.2.2 Land Restitution in South Africa

Over 3.5 million Africans were forcibly removed and relocated to the homelands and black people's townships since the 1960s as a result of furthering the apartheid goal of racially-based discriminatory legislation or practices after 19 June 1913 (Lahiff, 2002). To redress the dispossession and denial of land rights of black persons or groups, the Restitution of Land Rights Act of 1994 was enacted and a Commission on the Restitution of Land Rights (CRLR), a statutory body, was established under the same Act (Lahiff, 2002). But the,

processes seem to be slow while at the same time agricultural productivity is falling with increasing unemployment and widespread poverty levels in the rural communities of South Africa (Aliber and Hart, 2009, FANRPAN, 2012).

2.5.2.3 Land Tenure Reform in South Africa

Due to social re-organisation under apartheid, most people in the former homelands (Transkei, Ciskei, and Kwazulu Natal), as well as in other areas such as the South African Development Trust areas, are unable to establish clear legal land rights (Economic Commission for Africa-UN (ECA), 2003). The situation today is that they occupy the land assuming ownership mainly through neighbours' recognition. This can be a relative measure of tenure ownership (Lahiff, 2002; ECA, 2003). Further, the most common tenure systems in these former homelands was mainly communal land where traditional chiefs and colonially appointed chiefs had more powers of control and land use. Former homelands at present are located in the Eastern Cape, Limpopo, KwaZulu-Natal and North-West Provinces of South Africa (Lahiff, 2002; Obi, 2006). To protect this group of people and improve on land tenure security and accommodation of diverse forms of tenure, including communal, especially in these provinces, the 1996 South African Constitution enacted land tenure reform laws under its human rights provision (Lahiff, 2002; ECA, 2003).

Under the Land Reform Law, an Interim Protection of Informal Land Rights Act, No. 31 of 1996, was established to serve as a temporary measure of occupants without formal land tenure acquisition. The constitution further availed the Communal Property Associations Act, 28 of 1996 that enables people in groups to acquire, own and make decisions on how to utilize their land (Lahiff, 2002; ECA, 2003). Despite the presence of all these Acts, little has been achieved to secure land tenure among people living in the former homelands and thus slowing down the adoption of new technologies, increased investment in smallholder agriculture and declining agricultural productivity (Lahiff, 2002; ECA, 2003; Obi, 2006). This has led to deteriorating rural livelihoods, food insecurity and increased poverty levels. Thus, more research is needed to unearth the ways that smallholder farmers can use the services availed by the government and private sector together with the available land to boost productivity enough for marketable-surplus.

Smallholder farmers can achieve increased agricultural production through efficient use of household labour and land (Van Zyl *et al.*, 1996). Hattingh (1986) reported a positive relationship between farm size and efficiency for both irrigated and dry land grain farms in the Orange Free State of South Africa. Small farmers are scale inefficient relative to the larger units. Thus, increase in land size of the smallest farms fosters overall efficiency (González and Lopez, 2005). Further, this indicates that smallholder farmers can realize improved production efficiency if they gain access and own, and expand land for crop production through land reforms. According to Adams *et al.* (2004), for land reform to have a significant impact on increased agricultural productivity and reduced poverty, it must be part of a broader process of political, social and economic change, rather than a narrowly-focused intervention of simply redistributing land.

In his work entitled “*Smallholder irrigation schemes, agrarian reform and ‘accumulation from above and from below’ in South Africa*”, Cousins (2013) urged that South African land reforms had no clear development path. During the apartheid era, most land reforms were targeted to boost large-scale commercial farmers’ (mostly white people) for accumulation of national wealth (*‘accumulation from above’*) (Aliber and Hart, 2009; McAllister, 2010; Cousins, 2013). This capitalistic development approach was aimed at creating a class of poor black farmers who provided labour to large-scale commercial farms. The approach worked for a few capitalists and left out a large population of black farmers in deep poverty (Seneque, 1982, McAllister, 2010). At inception of democracy, the African National Congress (ANC) government vowed to reverse the rural development strategies (Aliber and Hall, 2009). The pro-poor smallholder land reform policies were enacted and smallholder irrigation schemes revitalized as part of the rural development strategies to alleviate poverty and promote equitable income distribution, this development path is viewed as *‘accumulation from below’* (Cousins, 2013). According to Cousins (2013), characteristics of the old *‘accumulation from above’* still exist. This is because large-scale commercial farmers still control the largest agricultural market share, and thus, most national agricultural development policies tend towards this group with less attention given to small-scale farmers (Aliber and Hart, 2009; Cousin, 2013). This could be one of the factors frustrating the land reform programmes and the performance of smallholder irrigation schemes (Cousins, 2013).

2.6 Irrigation and Agricultural Production

Nearly 70% of the world's water use is devoted to agricultural production, and majority of this water is used for irrigation (Disrude and Grossman, 2004). Irrigation accounts for more than 40% of the world's production on less than 20% of the cultivated land (UNWWD, 2012). Due to population pressure, there is increasing demand for water and food. Increased agricultural productivity is seen as a remedy to mitigate food shortage, hunger and high food prices in developed and developing countries. However, natural resources like land and water which are important for increased agricultural productivity are fixed. This has led to limited and uncertain water availability for agriculture and the situation may worsen in many developed and developing countries. However, South American and Sub Saharan African countries still have the potential of expanding their irrigated area to meet the rising food demands (UNWWD, 2012). Strategies to expand irrigation should consider physical, social and economic hazards associated with uncontrolled irrigation management practices.

Availability of water is essential for food security and sustainable development. However, water is increasingly becoming scarcer due to high demand caused by high rates of population growth and climate change (UN-HABITAT, 2005). In Sub Saharan Africa, subsistence smallholders are dependent on rainfall as their major source of water for agricultural production (NCCR, 2012). Rainwater is left to drop and flow directly in farmers' fields without a systematic conservation method. More than 4000 years ago, rainwater harvesting has been practiced especially in low rainfall areas (UN-HABITAT, 2005). According to UN-HABITAT (2005), rainwater harvesting is a technology used for collecting and storing rainwater for human use. Rainwater can be harvested from house rooftops, land surfaces or rock catchments using simple techniques that range from simple containers to engineered techniques. Since agricultural production is a large user of water, rainwater harvest may not be reliable for all year production, and thus can be complemented with irrigation farming (Makombe *et al.*, 2011).

Irrigation can be defined as the artificial distribution and application of water to arable land to initiate and maintain plant growth (Disrude and Grossman, 2004). Irrigation can also be defined as the deliberate application of water by humans to the soil for the purpose of supplying moisture essential for plant growth (Kodua-Agyekum, 2009). Studies carried out

worldwide indicate that irrigated crop yields are 2.7 times more than those of rain-fed farming (UNWWD, 2012). In the 1970s, both the developed and developing countries invested in irrigation infrastructures in order to increase agricultural production. An observable increase in agricultural production was achieved in countries which invested in irrigation infrastructures under appropriate management systems. However, in the 1980s, the rate of investing in irrigation infrastructures declined in both the developed and developing countries (Disrude and Grossman, 2004). Hervé (2003), and Svendsen and Turrall (2007) identified some factors that are responsible for the declining rate of investing in irrigation infrastructure around the world and these include:

- In some countries around the globe, they have fully exploited the natural sources of fresh water and there is less room for expansion of the irrigated area.
- Rapid industrial growth and increasing urban population have resulted in increased inter-sectoral competition for water resource and hence, reducing the potential of expanding the irrigated area
- Introduction of restrictive environmental rules and regulation are also limiting increased investment in the irrigation infrastructure.
- The massive investment in the irrigation infrastructure in the previous decades led to increased yields, resulting into an historical low world food prices. In business, the low food prices are less attractive while the countries had a perception that they had attained their food sufficiency, and hence countries reduced investing in the irrigation infrastructure.
- Cost associated with the construction of new irrigation schemes are increasing day by day, and reported to have risen to two or three times compared to their previous levels. This makes the present irrigation development less profitable than it was in the past decades. Presently, most countries have resorted to revitalisation and rehabilitation of the existing schemes, because the costs associated with these processes are cheaper compared to establishing new ones.

- Donors have lost interest in funding irrigation infrastructure development due to the poor performance of irrigation schemes in developing countries caused by deficiencies in management, institution and policies.

Declining rate of investment in the irrigation infrastructure has a negative impact on the economic growth and development of most developing countries, especially in the Sub-Saharan Africa (IPTRID, 1999; and Svendsen and Turrall, 2007). These negative impacts are mainly associated with declining agricultural productivity, increased food insecurity, unemployment, and poverty level (IPTRID, 1999; and Svendsen and Turrall, 2007). Low investment in irrigation infrastructure development and increasing dependence on rain-fed agriculture will not be able to sustain the growing demands to feed the increasing populations (IPTRID, 1999). A slow growth rate in agricultural productivity could lead to increased food prices, low household incomes, and worsened by unemployment and high poverty level (Vanhove and Van Damme, 2011). Thus, there is a need to increase investment in irrigation infrastructure development to increase productivity to supply cheap and high-quality food, improve household incomes, and reduce people's vulnerability to risks associated with external shocks and climate change (Svendsen and Turrall, 2007).

According to Steduto *et al.* (2007), water productivity is defined as the ratio of the net benefits from crop and mixed agricultural systems to the amount of water required to produce the benefits. Water use efficiency is sometimes defined as the relationship between water (input) and agriculture product (output) (Fairweather *et al.*, 2003). Water productivity is divided into two, the physical water productivity and economic water productivity (Steduto *et al.*, 2007). Physical water productivity can be defined as the ratio of the mass of agricultural output to the amount of water used, and economic water productivity is defined as the value derived per unit of water used. Increased water productivity in semi-arid areas like Eastern Cape based on value produced per unit of water can be an appropriate entrepreneurial pathway for poverty alleviation (Hussain and Hanjra, 2004). Increased water productivity results in increased agricultural output, food security, employment and general livelihood in rural communities (Steduto *et al.*, 2007). Therefore, it is worth assessing the farmers' efficient water utilization as a basis for drawing up more effective policies towards improved efficiency.

Hill (1984) reported that the Mesopotamian plains are known to be the sites of the first systematic use of water in this form for purposes of growing crops throughout the year. According to IPTRID (1999), and UNWWD (2012), the importance of irrigation technology in agricultural production has been recognized for a long time, and can be discussed within the broader framework of the role of improved technology in agricultural development. The induced innovation model discussed by renowned economists such as Hayami and Ruttan (1971), Grabowski (1979), Ruttan and Hayami (1984), made an excellent case for the importance of technical change in the process of agricultural development, observing how production coefficients change as a result of changes in resource allocation. The major contribution of the model was focused on explaining the mechanism which determines the choices made by society among alternative technological paths to achieve the desired agricultural development.

The neoclassical economists had earlier indicated that technical change and institutional reform were exogenous to the system. However, the development of the induced innovation model by Ruttan and Hayami (1984) established a firm basis for considering technical change as endogenous to the system because internal pressures exerted from the constraints imposed on the system by changing resource endowments are the major factors driving change. The induced innovation model has informed the development and use of new technologies like irrigation technology to bring about rapid improvements in agricultural development.

Due to its ability to increase agricultural productivity, there is strong evidence that an adequate supply of water leads households to shift from traditional self-sufficiency goals to profit/income-oriented decision-making and resource allocation where farm output becomes more responsive to market trends (Chirwa & Matita, 2011). According to the econometric study carried out by Dillon (2011), irrigation technology causes a shift of cropping patterns in favour of high value cash crops, culminating in increased value of crop production, greater investment in farm equipment and durable assets, with overall positive impact on socioeconomic status of smallholders. The positive impact can be observed through improved household incomes, nutrition and health. One of the concluding remarks of the study indicated that increased adoption of irrigation technology reduces poverty and inequality. Irrigation also increases physical output and the value of

production through intensification of cropping and innovation in crop choice (IPTRID, 1999).

Further, the introduction of irrigation most commonly improves the overall level of quality and leads to less variation in quality between producers and from year to year (Riddell, Westlake & Burke, 2006). According to Riddell, Westlake and Burke (2006), the concentration of inputs around irrigated production offers a means to service specific export-market demand. Hanji (2006) asserts that with the common belief on the important role of irrigation in agricultural growth, many developing Asian countries have promoted irrigation development over the last five decades to achieve such broad objectives as economic growth, rural and agricultural development. In addition, irrigation boosts total farm output hence, with unchanged prices, raises farm incomes. Achieving such non-inflationary growth in output is particularly attractive in an era of dwindling real incomes as a result of general increases in prices that have ignited intense protests some of which have turned deadly as was witnessed recently in the North-West Province of South Africa (SABC, 2012).

A research carried by Lipton *et al.* (2003) declared that first direct impact of irrigation is on output levels. Irrigation brings a range of potential changes in agricultural production (FAO, 2009). Increased output levels in irrigated farming may arise for any of at least three reasons (Pundo, 2005; Hagos *et al.*, 2009). Firstly, irrigation improves yields through reduced crop loss due to erratic, unreliable or insufficient rainwater supply. Secondly, irrigation allows for the possibility of multiple-cropping, and so an increase in annual output. Thirdly, irrigation allows a greater area of land to be used for crops in areas where rain-fed production is impossible or marginal. Hence irrigation is likely to boost output and income levels. The higher yields, higher cropping intensity and all year-round farm production lead to increased market-oriented production, implying a shift in supply (marketable surplus production) and perhaps food Security (Hagos *et al.*, 2009). Gebreselassie and Ludi (2010) indicated that the introduction of irrigation scheme resulted to changes in cropping pattern which led to a significant improvement in the commercialization of smallholders in Ethiopia. Research findings in other African and Asia countries strongly indicate that farmers who have adopted irrigation technology have generally benefited from the intervention as the number of cash crop growers increased after the introduction of irrigation technology.

It should be noted that in the struggle to promote increased use and expansion of irrigated area for increased agricultural productivity, there is a need to consider the negative effects that can emanate from uncontrolled irrigation. These negative attributes can be physical, social and economic resulting from poor irrigation management style and farming practices (Backeberg, 2005; Disrude and Grossman, 2004). The water conflicts within communities and across international boundaries as a result of competition for surface water rights are parts of the social negative impacts. Depletion of underground aquifers, ground subsidence and build-up of toxic salts on soil surfaces in regions of high evaporation rates, salinization are the physical negative attributes of poor irrigation management. Reduced soil fertility and human health hazards caused by toxic and contaminated water lead to low farm income earnings and increased health expenses or even deaths (Backeberg, 2005; Disrude and Grossman, 2004).

Irrigation can also be a source of water contamination through infiltration into the ground or runoff of applied irrigation water mixed with fertilizers, pesticides, herbicides and other agro-chemicals into streams, dams and other water bodies whose waters are used domestically by households especially in rural areas of developing countries (Disrude and Grossman, 2004). Domestic use of contaminated water exposes people to health hazards like water borne diseases. Contaminated water also exposes livestock drinking of it to health hazards (Disrude and Grossman, 2004). Use of too much irrigation water exposes soils to heavy leaching. Through leaching agro-chemicals infiltrate through the soil into the ground water (Munguambe, 2007; Van Rensburg *et al.*, 2011). In places where there are high rates of leaching crops are deprived of enough uptake of nitrogen and this leads to low productivity (Disrude and Grossman, 2004; Munguamb, 2007; Van Rensburg *et al.*, 2011). Therefore, irrigation farming needs a more integrated system for improved efficiency of water use without causing much of the social, economic and physical disruption in communities both nationally and internationally.

2.7 Irrigation and Agriculture in South Africa

South African's agriculture suffers from limited water availability. Only 49 228 million m³ per year of runoff water, mainly from rivers, is available for over 51.7 million people in South Africa, thus, only 952m³ per year of water is available for use per person. According to Samuel (2009), for a country to be declared “*water stressed*”, the annual water supplies

drops below 1,700m³ per person, while Backeberg (2005) indicated a threshold of 1000m³ of water supply per person per year. Therefore, the per capita water availability of 952m³ per year is below the two thresholds, indicating that South Africa is a “water stressed” country (Backeberg, 2005). Furthermore, the country is faced with erratic rainfalls and semi-arid conditions which can hardly prevent high rates of water evaporation (Van Averbeke *et al.*, 2011). For example, Backeberg (2005) reported variation in rainfall patterns across South Africa ranging from over 800 mm/year in the East, less than 200 mm/year in the West, and about 65% of the area countrywide receiving less than 500 mm/yr. This amount of precipitation is insufficient to support the agricultural sector in the country. Therefore, irrigation is indispensable for maintaining agricultural production at acceptable levels.

Irrigation farming utilizes more than 50% of South Africa’s water resource on over 1.3 million hectares (Van-Averbeke *et al.*, 2011; FANRPAN, 2012; GoSA, 2012, CIA, 2012). There are over 300 irrigation schemes in South Africa established 60 years ago on both smallholder and large commercial scale (Manona *et al.*, 2010; Van-Averbeke *et al.*, 2011). These irrigation schemes support over 25% of national agricultural production, and largest area (80%) is used to mainly grow crops such as potatoes, vegetables, grapes, fruit and tobacco, maize and about 20% of the area is mainly under sugarcane and cotton production (Backeberg, 2005; Manona *et al.*, 2010; Van-Averbeke *et al.*, 2011)

Irrigation farming started as early as 1652 at the arrival and settlement of Europeans in South Africa on a private basis. From 1912 onwards systems have been developed to coordinate irrigation operations countrywide (Perret and Touchain, 2002; Kodua-Agyekum, 2009). The developed and coordinated category of irrigation schemes include, the irrigation board schemes, white settlement schemes and Bantustan schemes’ food plots and community garden schemes (Perret and Touchain, 2002). During the severe drought and economic depression of the 1930s, South African development and economic growth programmes were directed toward irrigation farming as a remedy for increased agricultural productivity, food security and rural employment (Van Averbeke *et al.*, 2011).

However, there was unfair distribution of access to irrigation facilities in terms of land sizes, where white farmers receiving areas under the large irrigation schemes (8 ha to 20ha), often 10 times larger than the 1.5 ha allocated to black farmers (Van Averbeke *et*

al., 2011). Even the smallest irrigation plots allocated to black farmers collapsed due to the management gaps and institutional failures that existed among the smallholder irrigation scheme operators (Van Averbek *et al.*, 2011). The revitalization of these schemes began in 1994 through the introduction of canal irrigation schemes in the Eastern Cape and these included Ncora, Keiskammahoek, Tyefu, Shiloh and Zanyokwe. Despite these developments, smallholder farms still faced low outputs and productivity (Van Averbek *et al.*, 2011). The reasons for this unrelenting poor performance remain a puzzle to researchers and policy makers alike.

2.7.1 Operational Status of the Smallholder Irrigation Schemes in South Africa

The Smallholder irrigation schemes account for 4% of irrigated land of South Africa (Manona *et al.*, 2010). South African registered irrigated land amounts to 1 675 822 ha in 2008 (Van Averbek *et al.*, 2011). Only 1 399 221 ha is irrigated annually, of which in 2010, only 47 667 ha were under smallholder irrigation schemes (Van Averbek *et al.*, 2011). The 96.7% of total smallholder irrigated land draws water from rivers, sometimes diverted by means of dykes, and stored in dams. Smallholder irrigation makes use of 3.0% ground water, 0.2% municipal water, and only 0.1% spring water (Van Averbek *et al.*, 2011). Methods used to withdraw water from the rivers, underground and springs include water pumps, gravity flow and a combination of gravity and pumping (Van Averbek *et al.*, 2011). The government meets 68% of costs needed to pump or avail the water to the smallholder irrigation schemes (Perret, 2004). The most frequently used smallholder irrigation system is overhead ($\approx 59\%$) followed by gravity-fed surface ($\approx 28\%$), micro ($\approx 9\%$) and pump surface ($\approx 4\%$), respectively. Table 2.2 indicates that 34% of the smallholder irrigation schemes were not operating by year 2010. Available evidence (Van Averbek *et al.*, 2011) indicates that Limpopo had the highest number of smallholder irrigation schemes with 101 operational and 69 non-operational followed by the Eastern Cape Province with a total of 67 (50 operational and 17 non-operational).

Table 2.2: Operational status of Smallholder irrigation Schemes in South Africa

Province			
	Operational Irrigation Scheme	Non-operational irrigation Schemes	Total number of irrigations schemes
Limpopo	101	69	170
Mpumalanga	7	12	19
North West	2	0	2
KwaZulu-Natal	35	0	35 +1*
Free State	1	1	2
Northern cape	2	1	3
Eastern Cape	50	17	67 +5*
Western Cape	7	1	8
Total	185	101	296 +6*

*There are 6 irrigation schemes whose operational status wasn't known making a total of 302
Data Source: Van-Averbeke et al. (2011).

Regardless of their operational status, smallholder irrigation plots in rural areas of South Africa are not intensively utilized and most of them are lying idle (Manona *et al.*, 2010; Perret, 2004). Sub-optimal use of land and water resources by smallholder farmers in the irrigation scheme may be due to poor land markets and indistinct land tenure system (Machethe *et al.*, 2004; Perret, 2004; Manona *et al.*, 2010). Other factors that impede intensive and productive use of smallholder irrigation facilities in former homelands of South Africa include lack of appropriate user-friendly irrigation infrastructural design, poor management and maintenance of the facilities. Lack of requisite irrigation skills among beneficiaries and government extension officers, low farmer's interest and participation, inadequate institutional structures, a history of dependency and subsistence orientation, low land productivity and high investment costs, also negatively affected these irrigation schemes (Machethe *et al.*, 2004 and Perret, 2004).

According to Perret (2004), Backeberg (2005), Manona *et al.* (2010) and UNWWD (2012), attempts to resolve these challenges need an understanding of the complex interaction of the natural, physical, social and economic factors using an integrated systems framework. There are eight major factors that influence the interaction within the system and these include natural resources; knowledge; institutions; infrastructure and technology; economic location and factors; financial services; feasibility of farming systems; and support to farming systems (Manona *et al.*, 2010).

Backeberg (2005) indicates that the most important steps needed for efficient use of smallholder irrigation facilities is to enhance management capacity of both smallholder farmers and extension officers working in rural areas, improving land-tenure security on state and tribal land especially in former homelands where chiefs have more influence on land accessibility, and using dialogues that are pro-resource poor farmers. In addition, farmers should be helped to increase their farm size holdings, and provide appropriate technology which can be easily operated and managed by those who are less skilled (Machethe *et al.*, 2004; Backeberg, 2005; Kodua-Agyekum, 2009; Manona *et al.*, 2010). There is a need for improved access to agricultural finance through credit or loan facilities with manageable interest rates and long payback period to enable farmers acquire capital enough to invest in their fields (Machethe *et al.*, 2004; Backeberg, 2005; Manona *et al.*, 2010). Also, improved access to training and extension services for improved human capital and reducing the dependency on the government through establishment of the necessary supportive infrastructures that ease farmers' access to input and output markets and market information flow is needed to facilitate efficient utilization of smallholder irrigation schemes (Machethe *et al.*, 2004; Backeberg, 2005; Manona *et al.*, 2010).

2.7.2 Water Use Policy Reforms and Agricultural Production in South Africa

Based on the historic settlement patterns of different groups of Bantu and Europeans in South Africa, before racial conflicts, water rights had two forms namely, the prior-appropriation water rights, and riparian water rights (Backeberg, 2005, Muller, 2012). According to Ostrom and Ostrom, (1972), and Welden (2003), prior appropriation dictates that the first people to settle in an area and use the water maintain the right to continue using it in this manner, unless they elect to sell or lease these rights, whereas riparian water rights are allocated to persons in ownership of land adjacent to a body of water and in most cases their water rights are inseparable from the land rights, and had to transfer the water found within or outside the watershed of origin (Welden, 2003; Backeberg, 2005; Muller, 2012).

In South Africa, the past racial segregation and past Water Act undermined the prior appropriation water rights due to relocation and social reorganisation programmes like betterment planning and resettlements that moved black people from more water rich areas to water scarce areas (McAllister, 2010; Seneque, 1982). After moving black people in specific resettlements, white people retained water rich areas for commercial farming and

enacted the Water Act in 1957 in favour of the riparian water rights (Backeberg, 2005). Such skewed water distribution denied smallholder farmers in the former homelands water to irrigate their crops resulting in low productivity and hence lost interest in farming as a business.

Through 350 years of colonialism and 17 years of post-apartheid in South Africa, there have been vital policy changes in water use and allocation among users (Muller, 2012). Water being a scarce resource that needs to be shared and utilized optimally, former governments in South Africa as early as 1875 instituted water policies that incorporated irrigation policy. The major policy and institutional changes were as a result of political, social, economic and natural events in the country (Backeberg, 2005; Muller, 2012). Droughts and food scarcity faced by South Africa in 1930s, resulted in changes in the irrigation policies where most government-governed irrigation schemes were established and encouraged more establishments of privately owned schemes (Backeberg, 2005; Van-Averbeke *et al.*, 2011).

Due to industrial growth and urbanisation in the 1950s, water use and allocation policy were re-designed to integrate these developments (Backeberg, 2005, Muller, 2012). Most agricultural-related policies developed in the pre-apartheid era as well as the land-related legislation were discriminatory. These undoubtedly contributed to unequal access to water resource. To reverse such imbalances in the past policies, post-apartheid governments have developed policies on water use and allocation policies aimed at improved equitable acquisition of potable water for both domestic and farm use especially among the disadvantaged rural communities whose livelihood mainly rely on subsistence agriculture (Backeberg, 2005; Muller, 2012).

Backeberg (2005) characterized South African water as a sector with increasing water demand, intensive competition among water uses and users (domestic, industry and agriculture), high rehabilitation costs for water supply infrastructures, high social cost attached to subsidization of increased water supply and socio-economic and water rights that are enshrined within the constitution. To address these issues, policies, legal instruments and organisational approaches have been established. Through consultative processes, policies and legal instruments like the National Water Policy (NWP), National Water Act (NWA) and National Water Resource Strategies (NWRS), were developed and

enshrined in the constitution. Among others, large-scale commercial farmers, smallholders and technocrats participated in the consultative processes. In all these entities, promotion of equitable water use and allocation especially among smallholder farmers was paramount for reduced government dependence, unemployment and poverty reduction (Backeberg, 2005; Gabru, 2005; Muller, 2012).

In the quest to achieve positive results, the NWP called for Water use licencing for all stakeholders to enable each user to own water user rights/entitlement (Backeberg, 2005, Gabru, 2005, Muller, 2012). The 1956 Water Act that promoted the system of water rights based on riparian ownership of surface water and private ownership of groundwater was abolished, though some portions of the Act still hold until water users apply to formalize ownership through license acquisition (Backeberg *et al.*, 1996, Backeberg, 2005). Though there were anticipated resistance from traditional leaders to the changes in ownership of water rights and lack of knowledge about the new system, small rural farmers acquired the water user rights. To allow flexibility in water use transfers, water trade was introduced among users in some of the irrigation schemes (Carey and Sunding, 2001; Backeberg, 2005; Muller, 2012). The term water trading can be defined as the process of buying and selling of water access entitlements/water rights. This type of trade can be either permanent or temporary, depending on the legal status of the water rights (Carey and Sunding, 2001).

According to the economic point of view, water trading can promote more efficient water allocation because a market based price acts as an incentive for users to allocate resources from low value activities to high value activities (Backeberg, 2005; Muller, 2012). Despite the anticipated positive contribution to improved water use efficiency and productivity, the rural poor and less educated farmers had little information and limited understanding of how the National Water policy worked especially on issues regarding water trade (Backeberg, 2005, Muller, 2012). Lack of information and knowledge about transfer of water rights resulted in farmers' unwillingness to invest in land that was not covered by their water rights and hence low agricultural productivity (News24, 2011).

Factors like prolonged droughts and increased demand for food resulted in increased demand for irrigation water yet most rural farmers had no idea about exchange of water user rights (Backeberg, 2005). Farmers' lack of knowledge about the exchange of water user rights called for training to avail information on water trade and transfer of user rights

from low to highly demanded irrigation water users. The training was facilitated by government entities and local municipal authorities in rural South Africa (Backeberg, 2005). Trained farmers put into practice the water trade and exchange of water user rights on several irrigation schemes especially among smallholder and commercial farmers and these trainings yielded positive results (Backeberg, 2005). In 2011 the Gauteng North High Court, the judge made a ruling in favour of the transfer of water usage rights raising hopes of increased investment in agriculture especially among rural smallholders who own limited arable land and some landless households. Further, this was thought to reduce unemployment levels among the rural population through increased engagement in agricultural related activities (News24, 2011). Even though, the ruling favoured the smallholder farmers, small scale irrigation schemes especially in the former homelands of Transkei and Ciskei are still underutilized with observable idle irrigable land, low agricultural outputs and productivity (Sishuta, 2005; Kodua-Agyekum, 2009; Muchara, 2011; Van-Averbeke *et al.*, 2011).

Throughout the past decades, policies to regulate the management of water resource both in South Africa and internationally have been formulated and implemented (Backeberg, 2005; UNWWD, 2012). Policies and programmes implemented have elements of transferring management and operational responsibilities from government to farming communities. These policies are aimed at instilling a sense of farmers' ownership, equity and shared responsibility, reduced public expenditure, increased water productivity (both physically and economically), sustainable management and recovery of investment costs. The Irrigation Management Transfer (IMT) system is one of these programmes implemented to achieve these objectives in South Africa, and it is part of the Integrated Water Resources Management (IWRM) system employed globally for sustainable water use and management (Backeberg *et al.*, 1996; Perret, 2004, Backeberg, 2005; UNWWD, 2012). In South Africa, Water User Associations (WUAs) were established to address the intended objectives of the IMT strategy. Communities elected the water users committees to ensure proper management, operation and sustainable water use (Backeberg, 2005; Sishuta, 2005; Kodua-Agyekum, 2009; Muller, 2012).

At the commencement of democratic rule in South Africa, the economic development policy framework called the Reconstruction and Development Programme (RDP) was established but its focus seemed to be on funding community-based projects (Van

Averbeke and Mohamed, 2006). For more economic growth, the framework and focus changed with the establishment of the Growth, Employment and Redistribution (GEAR) which replaced the RDP. The GEAR approach mainly targeted private sector development as a way to achieve economic development. The Growth Employment and Redistribution policy identified revitalisation of smallholder irrigation schemes as a way of empowering and improving rural livelihoods especially in the former homelands. Revitalisation was associated with IMT (Van Averbeke and Mei, 1998; Van Averbeke and Mohamed, 2006). Among others, the IMT was adopted as a strategy with three key aims: to improve scheme management performance; to increase the profitability of irrigated agriculture; and, reduce recurrent government spending on operation and maintenance of the schemes (Vermillion, 1997; Shah *et al.*, 2002).

Revitalisation of Smallholder Irrigation Schemes (RESIS) is one of the numerous initiatives under the IMT policy implemented in Limpopo Province (Van Averbeke and Mohamed, 2006; Cousins, 2013). The RESIS replaced the 'Water Care' programme which previously operated in the same area for a period of five years (Arcus, 2005). Water Care programme was a multi-sectoral programme that covered a wide range of issues such as infrastructure development, leadership, management and productivity as means to revitalize the irrigation schemes. The scheme also employed a participatory approach which involved smallholder farmers in planning and operation, and provided training to empower these communities to gain managerial and operational skills that are sufficient to take full responsibility of the irrigation projects (Arcus, 2005; Van Averbeke and Mohamed, 2006; Cousins, 2013). As the programme progressed, it embraced commercialization through empowerment of farmers to move from subsistence to more market-oriented production (Cousins, 2013). Embracing commercialisation of smallholder agriculture on irrigation schemes is thought to have been influenced by the introduction of other national development programmes which included the Black Economic Empowerment (BEE) strategy (Department of Agriculture, 2006).

2.7.3 Irrigation in the Eastern Cape Province of South Africa

Establishment of irrigation schemes in semi-arid and areas prone to prolonged droughts in the rural communities of former homelands of South Africa was viewed as one of the development pathways for increased agricultural productivity, improved food security,

increased employment and poverty alleviation (Backeberg, 2005; Kodua-Agyekum, 2009, Van Auerbeke *et al.*, 2011). Following the recommendations by the Tomlinson Commission many irrigation schemes were established in the Transkei and Ciskei former homelands of the current Eastern Cape Province during the 1960s and 1970s. These irrigation schemes were established to stimulate economic growth and rural development (Sishuta, 2005 and Kodua-Agyekum, 2009).

The use of irrigation is informed by international experience, for example, Lipton *et al.* (2003) indicated that, regions like Eastern Asia and the Pacific, and North Africa and Middle East have experienced a greater poverty reduction because they established some of the large proportions of irrigated land. In Nepal, with the implementation of the irrigation projects, agricultural labour increased by 25%, employing most of the smallholders, and increased the production potential by over 300% and income by over 600%. This greatly enhanced increased food security, increased employment and poverty reduction (Lipton *et al.*, 2003). However, the results in the Eastern Cape Province have not matched the international experience (Legoupil, 1985; Lipton, 1996; Kodua-Agyekum, 2009; Manona *et al.*, 2010; Auerbeke *et al.*, 2011). In 2008, at Qamata irrigation scheme, established in the late 1960s, 87.1% of the population in the surrounding communities was unemployed and 76% of households were still affected by high levels of poverty. At Tyefu irrigation scheme, established in the late 1970s under Peddi area, by 2007, 78% of the population was unemployed and 79.9% of the population was below the poverty line (Insika Yethu Municipality, 2008; Ngqushwa Municipality, 2007).

Many small scale irrigation schemes were abandoned because the black rural farmers lacked knowledge and skills on how to manage and operate them and thus calling for simplified systems (Kodua-Agyekum, 2009). The government established small scale irrigation schemes mainly for increased agricultural productivity with less attention given to commercialising of small scale farming in former homelands in Eastern Cape. Lack of commercialisation of agriculture concept in government's rural development programmes jeopardised smallholder farmers' entrepreneurship and management capabilities for sustainable development and general improvement of livelihood among black people communities (Sishuta, 2005). Currently, Eastern Cape Province has a total of 154 930ha of land under irrigation and an additional 48 629ha of undeveloped irrigation land (Machethe *et al.*, 2004). According to Bembridge (2000), by the end of 1999, there were

more than 50 small scale irrigation schemes run by 6350 farmers on over 9500ha of land in the Eastern Cape province, and by 2010, the number of these irrigation schemes had risen to more than 67 (Van Averbeké *et al.*, 2011). Some irrigation schemes were modified during their revitalisation using modern and sophisticated technologies.

Expensive technological investment, high operational and maintenance costs, and sophisticated management systems exposed the resource-poor farmers' inability to sustain their operations for increased marketable agricultural productivity resulting into low farm output, low incomes, food insecurity and ever increasing levels of poverty in communities where they exist. Furthermore, Van Averbeké *et al.* (2011) cited several studies, including Bembridge (1997), Bembridge (2000), Kamara *et al.* (2001), Shah *et al.* (2002), Machethe *et al.* (2004), Iseneke Developments (2004), Tlou *et al.* (2006), Speelman *et al.* (2008), Yokwe (2009), Mnkeni *et al.* (2010) evidently indicating that poor management, theft and corruption were among the major contributors of failure and below-expected performance of smallholder irrigation schemes in South Africa. Results from Van Averbeké *et al.* (2011) study indicate that farmers had insufficient management capabilities and these negatively affected the performance of these schemes. Thus, there is need to address the management deficiencies among smallholder irrigators to uplift the rural poor from the widespread poverty in the Eastern Cape Province. Figure 2.2 presents the major Smallholder irrigation schemes located in the Eastern Cape Province.

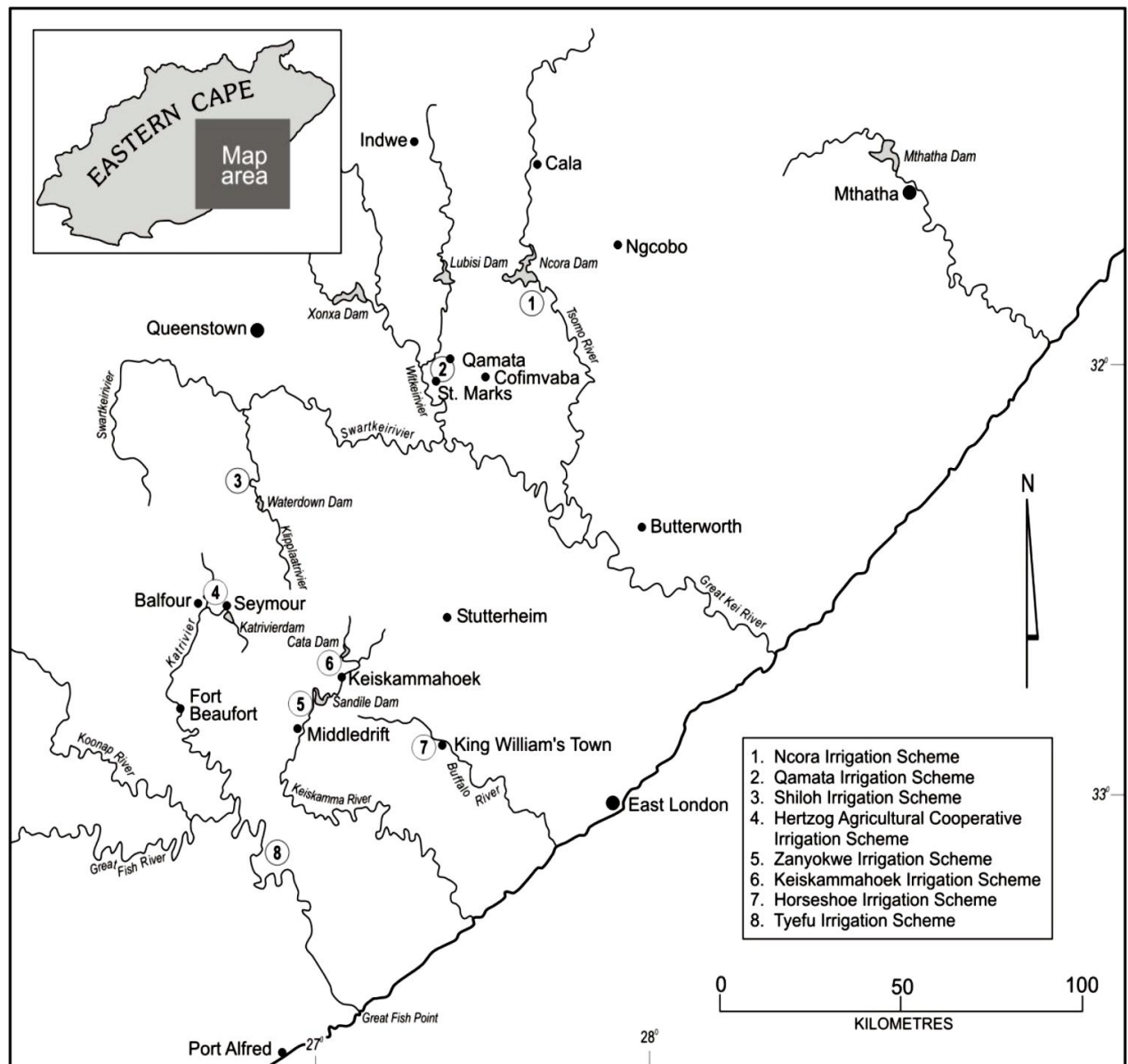


Figure .2.2. Major Irrigation Schemes in the Former Homelands in the Eastern Cape Province

Source: Kodua-Agyekum (2009)

2.8. Government Support for Food Security and Poverty Alleviation in Eastern Cape

In 2007, the government of South Africa and the Eastern Cape Provincial government restated their commitment to promote agrarian economy through stimulation of agricultural growth (Buthelezi, 2007). Stimulating agricultural growth was observed as one sure way to eradicate poverty and improve food security among the rural poor smallholders (ECDRAR, 2011). According to ECDRAR (2011), an integrated programme of Rural Development, Land Reform, and Agrarian changes was initiated. The integrated programme was mainly

focused on development of social and economic infrastructures and improved services, land redistribution, agrarian changes, and protect the rights of farm workers and farm dwellers, and adequacy of post-settlement support (ECDRAR, 2011). According to Eastern Cape, Department of Agriculture (2007), the provincial systematic poverty eradication through a holistic, integrated and multi-dimensional approach to pro-poor programming was designed, which included:

- i) Food production (through projects like Massive Food Program, *Siyazondla*, and *Siyakhula*)
- ii) Animal production (through animal health, livestock improvement and veld management)
- iii) Infrastructure lay-out (through social infrastructure, economic infrastructure and equipment/implements/machinery) Agrarian transformation and strengthening of food security.
- iv) The production management system (institution building), the social market system (infrastructure and social facilitation), agro-processing (circulate money within rural communities), and external markets

For a more strategic implementation for increased food production objective, the Department of Rural Development and Agrarian Reforms (DRDAR) categories farmers into three groups, namely, the subsistence, smallholders and commercial farmers. Three farm support packages were developed according to farmer categories. These included *Siyazondla*, *Siyakhula* and Massive Food Production Programme (MFPP) (GoSA Information, 2008).

2.8.1 Siyazondla

The siyazondla programme was aimed at supporting the poor households to produce their own food through cultivation of homestead gardens (subsistence farming). The farm plots in this category are a maximum of 12 X 12 meters in size or less than 1 hectare (GoSA Information, 2008). The department provides a grant of maximum value of R2, 000 in the first year (GoSA Information, 2008). The programme provides a starter pack of farming tools like wheel barrows, forks, spades, rakes and watering cans, and production inputs like seeds, fertilizer, seedlings and insecticides, and irrigation pipes, garden fencing and water

harvesting equipment (GoSA Information, 2008). Due to farmers' proximity to gardens, less labour requirement, and use of less purchased inputs/implements, farmers have attached more value to the *siyazondla* homestead food production (Fay, 2011).

Farmers often divert inputs and funds from the *Siyakhula* and massive food production programme and utilize them in the homestead food gardens. *Siyazondla* programme has realized potential benefits in several communities especially through increased food security and nutrition, transfer of skills and knowledge, adoption of new crop varieties, increased use of purchased inputs, and household incomes (Fay, 2011). Further, the programme has triggered farmers' improved use of existing resources like manure and compost to increase agricultural productivity, resulting in reduced input costs (Fay, 2011). Despite its positive contribution, the plot size of the *Siyazondla* is insufficient for a substantial increment in farm productivity enough to lift them out of poverty (Fay, 2011).

2.8.2 Siyakhula

Siyakhula package was designed for smallholder farmers whose interests are to up-grade to commercial farming (GoSA Information, 2008). This package subsidises farm inputs and mechanization costs for smallholders with plot size between 1 and 50 hectares through a conditional grant scheme. Other support from the Department of Agriculture included land rental costs (Tregurtha, 2009). The package is designed to encourage smallholder farmers to expand their field, and catalyse the transition to large-scale commercial agriculture (GoSA Information, 2008). The government provides 100% start-up capital which then is reduced annually by 25% of the production cost for four years (Tregurtha, 2009). Inversely, farmers are supposed to pay back the conditional grant in the same proportions starting with 25% deposit at the end of the first year and completion of pay back at the end of the fourth year. At 0% of state support, the project is thought to be self-sufficient both financially and technically. Farmers in this category were faced with low yield in the first two years of the programme and this led to failure to pay back the required 25% of the grant received at the end in the first and second year (Tregurtha, 2009). The conditional grants are not different from those of the Massive Food Production Programme (MFPP) as indicated later. Also, monitoring and evaluation of both *Siyakhula* and MFPP was done simultaneously (GoSA Information, 2008; Tregurtha, 2009).

2.8.3 Massive Food Programme

According to Tregurtha (2009), in 2001, South Africa experienced a localised drought resulting in low food production, and the situation was worsened by depreciation in the exchange rate which led to increased food prices. Low productivity and high food prices led to a short term food scarcity. In response to the situation, the government distributed food parcels to the needy households (Tregurtha, 2009). Distribution of food parcels was short lived because the government realized that the approach was expensive and unsustainable (Tregurtha, 2009). On realizing, the provincial agricultural departments were tasked to formulate programmes that encourage households' participation in food production as an alternative solution. In the Eastern Cape Province, among others, the Massive Food Production Programme (MFPP) was introduced to champion increased food security and poverty alleviation (Department of Agriculture, 2008; Manona, 2005; Tregurtha, 2009).

After designing and formulation of the MFPP, the government availed funds for the programme. Increased food security was the fundamental objective of the MFPP through increased productivity and improved nutrition among households (Manona, 2005). By design, the programme scheme was meant to rely on community initiatives and was expected to run for 5 years (Department of Agriculture, 2008). In addition to food security, more strategies were incorporate in the programme scheme (Tregurtha, 2009) and these included promoting black people economic empowerment, stimulating private sector development and markets in rural areas, and promoting conservation farming for environmental sustainability. Promotion of black people economic empowerment in the agricultural sector was mainly to boost production for local, national and international markets and establishment of agro-industries (Department of Agriculture, 2008). In this particular package, government support included, mechanization of the farms, link farmers to micro-finance institutions, infrastructure development, farmers' education and trainings, and research and technology development (Department of Agriculture, 2008; Tregurtha, 2009). Further, the government subsidized inputs like inorganic fertilizers, agro-chemicals and improved seed varieties (Machingura, 2007).

2.8.4 Conditionality of the Grant for Siyakhula and Massive Food Programme

According to Buthelezi (2007) and Tregurtha (2009), the beneficiaries of the MFPP had to observe these conditions: Fields characteristics included an area that receives a mean rainfall of at least 500mm between November and April and has a potential of being irrigated, with soils effective rooting depth of at least 600 mm, and a gentle slope not exceeding 8%. For farmers to enjoy economies of scale, field sizes above 50 ha were required, and for inclusion purposes, the project had to be a contiguous block of land. Households/farmers had to form cooperatives at village level to ensure that all households participate in the programme and encourage self-reliance after the end of the state support. These cooperatives or trust had to be registered, or in the process of registering as legal entities. Also, farmers had to ensure that the proposed fields were fenced to protect them from risks of crops destruction by livestock. Proposed fields had to be located close to access roads for easy movement of inputs and outputs from and to the market.

Furthermore, participants had to develop production and marketing plans that indicate viable returns and had to be endorsed by the Department of Agriculture. In the business plan, gross margins would at minimum equal to 10% of the production costs. The Department of Agriculture had all the rights to recommend the best conservation agricultural practices in the production plan. The government provides 100% start-up capital which then reduces annually by 25% of production cost for over five years. Farmers were supposed to pay back the conditional grant starting with 25% deposit at the end of the first year until the fifth year. At 0% state support, farmers were expected to be financially and technically self-sufficient. The roles played by the farmers included harvesting and marketing of their own produce (GRAIN, 2008). Through the Uvimba Bank the government would release funds needed by the farmers to purchase inputs and meet other farm expenses (GRAIN, 2008; Tregurtha, 2009)

In years 2003/2004 and 2004/2005 the programme experienced high losses due to low productivity, thus 1 ton of maize per hectare (Tregurtha, 2009). The low productivity was mainly attributed to late planting, adverse weather conditions and delayed transfer of funds to farmers to procure the necessary inputs (Tregurtha, 2009). Further, the project sites did not meet the agronomic conditions set with respect to land size, rainfall and soil-depth, and communal farmers were not willing to give up their individual plot rights. In addition,

production plans were poorly implemented, mechanization work was of poor quality, farmers' resale of inputs, and farmers lacked knowledge of applying agro-chemicals (Tregurtha, 2009).

All these led to farmers' failure to pay back the required deposits in the first 2 years of the programme. Based on these mentioned challenges, the programme implementation strategies were revisited and amended in 2005/2006. These amendments yielded a great improvement in the yields in years thereafter. A study carried out by Tregurtha in 2009 indicated some positive results of the MFPP. These included increased food security, reduced public expenditure on food parcel packages, and improved farmers' business and farm production skills. The MFPP also led to expansion of social and economic networks among all stakeholders. Although some successes were observed, by 2009, the programme was still faced with a challenge of farmers' failure to pay back the required deposits (Tregurtha, 2009)

2.9 Adoption of Agricultural Production Technology

Huffman and Evenson (1993) indicated that adoption of new technologies can lead to production efficiency and productivity growth by either expanding the total output or increasing application of the relatively cheap inputs and trimming down use of the more or less expensive inputs. Lack of access to farm land, high unemployment rates and low farm productivity among smallholders in the Eastern Cape's rural communities suggests that traditional agricultural technologies need to be replaced by a system that produces higher output but uses less land and more labour (Kodua-Agyekum, 2009). This system may include high yielding technologies such as inorganic fertilizer, high-yielding disease-resistant varieties, quality declared seeds and irrigation.

To a farmer changing from rain-fed to irrigation farming, irrigation is a new technology. Additionally, labor-saving chemical or mechanical technologies are essential complementary technologies (Van Averbeké *et al.*, 2011). Adoption of a single technology may not result in expected yields. Therefore, this calls for adoption of more than one technology to generate high yields necessary to pay the higher cost of especially the irrigation technology which includes construction of the infrastructure, purchase of machinery and the day-to-day operational costs (Van Averbeké *et al.*, 2011).

2.9.1 Theories on Adoption of Technology

According to Bridges to Technology (2005), technology adoption has no specific definition and can be achieved through a sequence of five stages. The five stages are awareness, assessment, acceptance, learning, usage. Awareness involves potential users learning enough about the technology and its benefits to decide whether they want to investigate further while assessment involves potential users' evaluation of the usefulness and usability of the technology, and the ease or difficulty of adopting. After the processes of awareness and assessment, potential users decide to acquire and use the technology, or decide not to adopt (Acceptance). Those who decide to acquire and use the technology then develop skills and knowledge required to use the technology effectively (learning). The usage stage is achieved when users demonstrate appropriate and effective use of the technology.

Rogers (2003) defines adoption as the process an individual passes through since they heard of an innovation (technology) until it starts to be used on a continuous basis. Technology is defined as any idea, object or practice that is perceived as new by the members of a social system (Rogers, 2003). Innovation involves transformation of inputs to a product and the end product for consumption as innovation. The level of adoption is the degree or intensity with which a new technology is used when the farmer has complete information about it. It can be measured as the amount of use of that technology or as the farmer use or not uses that technology (Zalweski and Skawi-Ska 2006).

2.9.2 Factors Affecting Adoption of Technology by Smallholder Farmers

Empirical studies show that adoption of new technologies among smallholder farmers is affected by several factors (Dadi, Burton and Ozanne, 2004). These factors include socio-economic characteristics of individual farmers, farm characteristics, weather/climate change, and risk consideration (CIMMYT, 1993). Age of the farmer, gender, education, farm experience, level of household income and access to credit are some of the socio-economic factors that are thought to influence adoption of new technologies. Generally, the attributes influencing the adoption of agricultural technologies are inherent in the farmer and farm, and in the technology itself (Adesina *et al.*, 2002).

2.9.2.1 Impact of Age in Adoption of Technologies

Age has been extensively considered as a socioeconomic factor influencing adoption decisions. According to Staal *et al.* (2002), and Adesina and Baidu-Forson (1995), there is a controversy on the direction of the effect of age on adoption depending on the individual farmer and technology involved. Saha (2000) and Yenealem (2006) findings indicated that age significantly influences adoption of new technology. Age was found to positively affect the adoption of sorghum in Burkina Faso (Adesina and Baidu-Forson, 1995). The effect is thought to result from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. Adoption pay-offs occur over a long time and, while costs occur at earlier stages, age of the farmer can have profound effect on technology adoption. Due to confidence and investing several years in a particular practice, older farmers may not want to jeopardize it by trying out a completely new method. Farmers' perception that technology development and subsequent benefits, require a lot of time to realize, can reduce their interest in the new technology because of their advanced age, and the possibility of not living to enjoy it (Caswell, Fuglie, Ingram, Jans and Kascak, 2001; Khanna 2001).

2.9.2.2 The Role of Gender in Adoption of Technologies

In many smallholder farms, agricultural production resources and technology is mostly controlled by men whereas women contribute 70% of agricultural production (Lubwana, 1999). This suggests that men are more likely to adopt new technologies than women. A study carried out by ACFODE (2001) argued that most women in Uganda did not own land and this made them less effective in making decisions on whether to adopt or not adopt new technologies. Although Doss and Morris (2001), and Phiri *et al.* (2004) indicated a neutral impact of gender on adoption of new farm technologies, Essa and Nieuwoudt (2001) found that in South African male farmers tend to adopt hybrid seed maize and fertilizer. They also argued that constraints to adoption of technology by women include socially conditioned inequalities in the access, use and control of resources and credit. A positive association between adoption of maize and the presence of male decision makers among smallholder farmer has been found to support programmes in South Africa.

2.9.2.3 Impact of Education and Training in Adoption of Technologies

Generally, education is expected to create a favorable mental attitude for the acceptance of new practices (Caswell *et al.*, 2001; Waller *et al.*, 2005). A study carried out by Rogers (1993) indicated that technology complexity negatively impacted on adoption especially where the adoption of information and management-intensive practices is involved. Therefore, education level is perceived to reduce that amount of complexity perceived in technology thereby increasing technology's adoption. According to studies conducted by Moser and Barrett (2003) education is an important determinant of production efficiency and technology diffusion. Formal education and training in agriculture improves farmers' ability to acquire accurate information, evaluate new production processes, use new agricultural practices and understand the benefits of adopting appropriate farm practices (Hollaway, Shankar and Rahman, 2002). Although education can encourage new technology adoption by lowering learning costs, it may also discourage adoption through exposing the educated to profitable off- farm employment opportunities.

Farmer training is another most critical factor of the technology transfer processes. According to results generated by Makokaha *et al.* (2007), increased contact between the extension officers and farmers had a significant influence on perceptions and adoption decisions. Another study carried out by Stroebel (2004) stated that training to enhance technology transfer and adoption programmes at sheering sheds played an important role in improving the small ruminant farmers' correct use and adoption of veterinary medical technologies. In these cases training projects are essential to develop the desire for new technologies and its implementation by the farmers (Abdulai, Owusu and Bakang, 2011). The type of communication used in training farmers is equally important because it can determine the rate of adoption of new technologies. For example, a participatory and hands-on training may be more effective than mere verbal communication system. The effectiveness of extension service and other communication media coupled with individual efforts have a great influence on the use of improved technologies (Chilot *et al.*, 2006).

2.9.2.4 Contribution of Income in Adoption of Technologies

Farmers with higher incomes are likely to venture in profitable risky ventures because they have the ability to access information, possess a longer-term planning horizon and greater

capacity to mobilize resources (CIMMYT, 1993). The initial adoption of agricultural technologies is highest among high-income earners and low among the low-income earners (CIMMYT, 1993). Available literature indicates that several studies have shown the significance of income on the adoption of improved agricultural technologies among smallholder farmers (Langyintuo and Mekuria, 2005). However, most rural households especially in the Sub-Saharan region are resource poor (Langyintuo and lowenberg, 2006). Farmers with more wealth and liquidity maybe better able to finance the adoption of new technologies and farming practices (Essa and Nieuwoudt, 2001). A study carried by Langyintuo and Mungoma (2008) showed a positive relationship between wealth and technology adoption among households in Zambia. Another study carried out in Sri Lanka also generated the same results (Iqbal, Ireland and Rodrigo, 2005).

2.9.2.5 The Role of Natural Resources in Adoption of Technologies

Access to land and water are expected to have a significant influence on adoption of new technologies. According to results generated by Catherine (2002), farm size was highly correlated to the adoption of agricultural innovations. In 2006, the Uganda Bureau of Statistics (UBOS) and the Uganda Participatory Poverty Assessment Process (UPPAP) carried out a qualitative assessment, and findings revealed that land is regarded as the most important asset in farm production and had a significant relationship with adoption of new technologies (UBOS and UPPAP, 2006). This suggests that farmers with access to large farm land are more likely to take-up risks associated with experimentation of new agricultural practices (Nkonya *et al.*, 2006).

2.10 Adoption of Agricultural Production Technology in South Africa

In South Africa, a wide range of technologies have been innovated and transferred to farmers to boost productivity and production efficiency (Kodua-Agyekum, 2009; DAFF, 2010). Establishment of irrigation schemes, animal traction, improved seed, fertilizers and agro-chemical application are among the technologies developed to benefit farmers. Black smallholders and subsistence farmers have been among the targeted beneficiaries of these technologies (Kodua-Agyekum, 2009; Van Averbek *et al.*, 2011). To ensure high adoption rates, the government of South Africa incurred investment costs to establish the irrigation schemes and provided input subsidies through rural development programmes

(Kodua-Agyekum, 2009; Van Auerbeke *et al.*, 2011). However, adoption rates of these technologies such as irrigation, fertilizer and agro-chemical application among smallholder farmers seem to be low mainly due to poor extension services, low participation of farmers in decision making, and lack of investment capital (Kodua-Agyekum, 2009, DAFF, 2010).

Large-scale farmers are more likely to adopt these technologies compared to smallholders because they have more investment capital to source for credible information about the new technologies and experiment on the new technologies (DAFF, 2010). Due to the relative increase in the cost of labour, large-scale farmers have resorted to adoption of labour-saving and intensive capital-using technologies (DAFF, 2010). Labour saving and intensive-capital-use technologies seem to be more productive and efficient though they may worsen the high unemployment and declining smallholder agriculture situation. Probably this may be due to high costs associated with these new technologies and most rural-poor black farmers cannot afford adopting them (DAFF, 2010). For example, the use of long-lasting herbicides and more efficient mechanized agriculture which is costly, and has led to loss of employment among seasonal farm workers (DAFF, 2010). Low rates of adoption of new technologies especially on the small-scale irrigation schemes have led to low production efficiency, low productivity, low household incomes, unemployment, increased food insecurity and wide spread poverty levels among Eastern Cape's rural communities (Kodua-Agyekum, 2009).

2.11 Chapter Summary

South African agricultural sector is dualistic, comprising of large-scale commercial farmers and smallholder farmers. Large-scale commercial farmers are mainly white people who control the largest portion of South African arable land, and use sophisticated and mechanised farming and control about 95% share of the country's agricultural market. The rural smallholders constitute the largest population of South Africa's farmers, mostly black people and aged, illiterate. They lack access to extension services, lack access to credit, lack access to investment capital, lack access to input/output markets, and use traditional technologies in farming. Though a few have access to the irrigation facilities, smallholders mainly depend on rain-fed farming, and produce low output. South Africa's nature resources essential for agricultural production are limited. For example only 13% of land can be potentially cultivated and only 952m³ of water are available per person per year.

Both land and water are considered to be fixed inputs in the agricultural production equation. This means these limited resources need to be used in the most efficient way for increased food production to ensure food security for the increasing population.

Historically, apartheid land laws and regulation led to the skewed distribution of land and water in South Africa, where smallholders were apportioned less watered, less fertile and extremely small plots. Less access to land and water for agricultural production among smallholders has led to persistent high poverty levels especially in the former homelands. Agriculture being one sure way of alleviating rural poverty, the post-apartheid government has tried to provide services through land reforms and revitalization of small irrigation schemes coupled with subsidised inputs for improved productivity. Despite these efforts, smallholders are still faced with low and declining agricultural productivity. Most literature has mainly recommended improved access to tangible assets for improved productivity with less emphasis on smallholders' intangible capital like human capital, social capital, goals and aspirations, and entrepreneurship spirit (Sishuta, 2005).

CHAPTER 3

A REVIEW OF THE HUMAN DIMENSIONS, AND COMMERCIALISATION OF AGRICULTURE

3.1 Introduction

The role of human dimensions for increased agricultural productivity and smallholder agricultural commercialisation remain issues of major concern especially in the rural economy of developing countries. This chapter gives an overview of the role of human dimensions in agricultural production, and natural resource management. The chapter proceeds to describe the human capital, social capital, entrepreneurship and positive psychological capital, and farmers' goals and aspirations as forms of the human dimensions important for both social and economic growth. Furthermore, the definition and description of the importance of agricultural commercialisation for economic growth and development in the developing countries are presented. The chapter concludes with a review of South African commercial agriculture and how smallholder commercialisation can be enhanced.

3.2. The Role of Human Dimensions

The human dimension in complementarity with natural, physical and financial assets was found to be crucial for improved production and productivity especially in rural development and economic growth (Ostrom, 1998; FAO, 2000). Human dimensions refer to how and why human beings value natural resource management and how humans affect or are affected by natural resource use decision making for sustainable production and profitability (Decker, Brown and Siemer, 2001). In a study carried out by Machethe (2004) stated that, not only space, energy and cropland are the major determinants of production in improving the welfare of poor people, but also improvement in population quality and advances in knowledge.

According to Steyn (1982), "human element" is a key factor in agricultural development because of its importance in farm decision making. Success depends on rational decision making, which in turn, depends on the social-physiological characteristics of the farming communities (Steyn, 1982). Most agricultural development programs used a top-down decision making in most rural agricultural communities, denying rural farmers to

participate in decision making on how and whether to accept the intended goals of such programmes. Lack of farmers' participation in decision making has become more of a constraint for improved farm-household production efficiency and adoption of new technologies (Steyn, 1982).

Numerous studies have been done in the world related to human dimensions. These studies have mainly focused on the people's attitudes and values towards wildlife, natural resource management and climate change (Butler *et al.*, 2001; Bruinsma, 2003). Some of these studies have been mainly carried out by Cornell's University, Human Dimensions Research Unit (HDRU) (Butler *et al.*, 2001; Decker and Powers, 2011). Human dimensions measuring tools have been developed in form of attitudes and value scales across natural resource use and management (Butler *et al.*, 2001). The findings and recommended policies of these studies have been considered as important tools in natural resource management and mitigation of climate change (Butler *et al.*, 2001; Bruinsma, 2003; Decker and Powers, 2011). In USA, human dimensions studies have played a great role in the conservation of national game parks and promotion of the tourism industry (Butler *et al.*, 2001; Decker and Powers, 2011). Human dimensions and natural resource management studies are mainly centred on sustainable agricultural to mitigate climate change with less emphasis on their role for increased production efficiency and farm incomes (Bruinsma, 2003). Across Africa, few studies are being carried out to address a direct link between human dimensions and agriculture development (CTA, 1990). Some of the on-going studies have concentrated on farmers' human dimensions related to human capital, social capital, entrepreneurial spirit, positive psychological capital, and farmer's goals and aspiration, and their impact on agricultural productivity.

3.3 Human Capital and Agricultural Productivity

Ostrom (1998), FAO (2000), and Padilla-Fernandez and Nuthall (2001) defined human capital as the acquired knowledge and skills through education, training and experience that an individual brings to an activity. Many studies carried out on agricultural production have attested to human capital's importance for increased productivity and efficient use of agricultural resources. Educated, experienced and well trained farmers are proven to be early adopters of new technologies and more efficiently productive than their counterparts (CIMMYT, 1993 and Padilla-Fernandez and Nuthall, 2001; Ogundari and Ojoo, 2005;

Tjornhom, 2006). This is because such farmers have the ability to read, keep records, organise and manage, and adopt new market oriented technologies more easily. Through reading they can easily access general agricultural and market information needed for improved management and entrepreneurial skills. Thus, educated and well trained farmers have more capabilities of operating, managing and coordinating irrigation facilities more efficiently, which can be translated into improved productivity, food security, employment and poverty reduction in rural communities (FAO, 2000).

Djomo and Sikod (2012) defined human capital as a stock of competencies, knowledge and personality attributes embodied in the ability to perform labours so as to produce economic value. The concept of human capital was introduced by neoclassical economist that included Schultz (1961) and Becker (1964) a way back in the 1960s (Djomo and Sikod, 2012). In their publications they identified education, trained and healthy worker as components of the human capital that allow efficient use of the natural, physical, and financial resources. Improved quality of human capital provides an economic return to individuals by increasing both the employment rate and labour income. According to Timmer (2002) cited by Djomo and Sikod (2012), human capital is of great importance in countries where the share of agriculture in gross domestic products remains high, it has the ability to increase agricultural productivity, and enhance the total economic growth through “diverted and indirect links”.

In the early economic theories, human capital was simply referred to as workforce (labour), one of the three major factors of production (Djomo and Sikod, 2012). Djomo and Sikod (2012) urged that there are few studies that have explicitly carried out to estimate the impact of human capital on agricultural production using the Stochastic Frontier Analysis (SFA) method. The stochastic frontier analysis findings generated by Djomo and Sikod (2012) indicated that an additional year of experience and levels of education increases agricultural productivity. Further, their findings revealed that an additional year of education and years of experience squared increases farmer’s income.

3.4 Social Capital, and Agriculture and Rural Development

Social capital is an essential complement with the concepts of natural (land and water), physical (roads, irrigation facilities, telecommunication, markets and other infrastructures),

human (education, skills, training and experience) and financial (credit, and loans) capital for improved agricultural productivity. A combination of natural, physical, human, financial and social capital can enhance economic and political growth of developing countries, and none of these capitals can function in isolation to stimulate the desired development (Ostrom, 1998).

Hanifan (1916) seem to be the first author to acknowledge the use of the term, and several authors, including MacGillivray and Walker (2000), Smith and Kulynych (2002), give the credit for the contribution. Hanifan (1916) viewed social capital as “goodwill, fellowship, mutual sympathy and social intercourse among a group of individuals and families”. In the opinion of writers like Routledge, and Amsberg (2003), the sense in which Hanifan approached the concept of social capital was as a coordinating mechanism in business where it is assumed to provide the essential social structure for the people participating at that sphere. Woolcock and Narayan (2000) provided a different interpretation which was proffered by who saw Hanifan’s work as focusing on the value of community participation. The main focus of Hanifan’s 1916 work was on school performance but it was clear that a much wider application of the concept was feasible considering that Hanifan recognized the role of what he termed “those tangible substances” that are invaluable in human existence, such as goodwill, fellowship and sympathy. There is no question that these issues have application beyond education and can be effectively deployed to advantage in other spheres of life.

Following Hanifan’s use of the concept/term, the literature records the emergence of thinking around the networks in a cosmopolitan setting such as an urban area where blood relationships are minimal and people are brought together by other factors. Jacobs (1961) is associated with the application of the concept of social capital to urbanized social relations where it was shown that “networks” are essential in forging close associations among otherwise disparate individuals and groups. Later in the mid-1970s, Loury championed a different view of social capital whose chapter entitled “*A Dynamic Theory of Radical Income Differences*” explored these questions a lot more deeply and is frequently cited by other researchers who consider him the creator of the concept (Loury, 1992). Hofstede (1980) contribution to the concept is also given credit for the early conceptualization although his main writing did not explicitly refer to the concept as it is known today.

According to Putnam *et al.* (1993) and Yamaoka (2007), social capital refers to features of social organizations such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit. Further, Halpern (2005) defined social capital as the social networks and the norms and sanctions that govern their character. The concept acknowledges the interactions and interdependencies between social and economic development. According to Yamaoka (2007), and Liverpool-Tasie, Kuku and Ajibola (2011), social capital can be divided into two types, the bonding and exclusive types of social capital. Bonding social-capital is formed when people of the same culture or family work together towards common goals and are internally oriented. Exclusive social capital refers to different social-groups coming together to perform a task to achieve a common goal and it is referred to as externally oriented. The bonding type of social capital promotes unity and cooperation within the organisation or community although it exhibits characteristics of resistance to external influence that may be beneficial to the community. The major benefit of exclusive social capital is the ability to create social networks both horizontally with other communities and vertically with government, private sector and other development partners. Therefore, it is crucial to consider both social capitals for sustainable management, productive and profitable agriculture.

Social capital is also defined as the ability of actors to secure benefits by virtue of membership in social networks or other social structures (Liverpool-Tasie, Kuku and Ajibola, 2011). Also, Liverpool-Tasie, Kuku and Ajibola (2011) cited Burt (1992) defining social capital as “friends, colleagues, and more general contacts through which one receives opportunities to use their financial and human capital”. Grootaert and Van-Bastelaer (2001) defined social capital as the institutions, the relationships, the attitudes and values that govern interactions among people for economic and social benefits. Economic and social gains from social capital can be realised when it is accumulated over time like any other assets/inputs used in production of goods and services (Grootaert and Van- Bastelaer, 2001). Social Capital sometimes can be referred to accumulated social networks and it is essential for increased agricultural productivity.

Based on different authors, there could be three categories of social capital depending on whether or not they are oriented to similar, dissimilar or both groups at the same time. Externally-oriented social relations would draw from mechanisms that forge bridges between and among the groups. These are referred to as “bridging” relations or social

capital. There are similarities in this categorization with the two-tier view that identifies an exclusive orientation. Woolcock (1998) agree with these definitions. Other writers whose definitions are aligned with those of the proponents of “bridging” include Baker (1990), Belliveau, O’Reilly and Wade (1996), Portes (1998), among others. Representative definitions in this category include those of Portes (1998) which defines social capital as “the ability of actors to secure benefits by virtue of membership in social networks or other social structures”, and that of Knoke (1999) which defines social capital as “the process by which social actors create and mobilize their network connections within and between organizations to gain access to other social actors’ resources”.

Another approach used to define social capital is the internally-oriented and sometimes referred to as the “bonding” or “linking” social relations. In direction of the definition, the entities involved are similar in the important respects crucial to forging effective relationships but some nurturing is needed to guarantee the productive outcome. Those writers whose definitions have leaned in that direction include Putnam *et al.* (1993), and Thomas (1996), among others. Thomas (1996) sees social capital as “those voluntary means and processes developed within civil society which promotes development for the collective whole”.

Some authors like Loury (1992), Pennar (1997), and Woolcock (1998) view social capital as both internally-oriented and externally-oriented. For example, Loury (1992) defined social capital as “naturally occurring social relationships among persons which promote or assist the acquisition of skills and traits valued in the marketplace.....an asset which may be as significant as financial bequests in accounting for the maintenance of inequality in our society”.

The concept of social capital is reported to have a vital role in rural development especially among farming communities in developing countries. This type of capital has exhibited successful impacts in aiding economic development globally. In recent decades, governments’ policies have been directed towards empowering rural communities through social capital accumulation to govern and manage common natural resources, physical and financial assets for social-economic growth and development. Social capital enables these communities to improve on their capacities and responsibilities in turn helping farmers to assess and resolve disparities and unequal opportunities for both social and economic gains

(Grootaert and van- Bastelaer, 2001; Yamaoka, 2007; Liverpool-Tasie, Kuku and Ajibola, 2011). The accumulated social networks and institutions and the human interaction within the system affect the efficiency and sustainability of development programmes. Social capital contributes to efficient, productive and innovative ways for improved livelihood like any other assets or capital used in agricultural production (Grootaert and van- Bastelaer, 2001; Liverpool-Tasie, Kuku and Ajibola, 2011). Governments have a role in the formation of social capital and should be more of facilitators rather than players in this venture.

3.4.1 Measuring social capital

There are different ways of measuring social capital. However, most studies in rural communities concentrate much on the number of social networks an individual is connected to. Also, social capital can be measured by individual membership in community-based organizations (Liverpool-Tasie, Kuku and Ajibola, 2011). According to Liverpool-Tasie, Kuku and Ajibola (2011), social capital can also be measured by considering groups and networks (membership in formal or informal organization or association; ability to get support from those, other than family members and relatives, in case of hardship. Other concepts needed to consider are, ability to learn from one's network or group, particularly the impact on technology adoption, access to various markets (labour, input, or output via the group), and remittances); Collective action and cooperation can be classified together with groups and networks and can be estimated as; community's time or money contribution towards common development goals, and people's cooperation within the community solving common problems.

People and individual's trust and solidarity within the community is a type of social capital and this can be measured by assessing people's perceptions about whether most people in the community can be trusted and social support provided by group members in times of hardship. Such can results in social cohesion and inclusion where people have a strong feeling of togetherness within the community, and safety from crime and violence when alone at home. Furthermore, empowerment and political action can be measured by who has control in making decisions that affect everyday activities and political participation such as voting and being voted for in local elections. Access to information and communication is another parameter of social capital that can be measured by how

frequent an individual or group read or listen to news sources such as radio, newspapers, and television.

3.4.2 Contribution of Social Capital to Irrigation Farming Communities

According to Tshikolomo (1996), if farmers develop a culture of sharing production resources like labour, land, water, farm implements and work as a group, there could be increased production which can be further translated into improved efficiency in farming. The process of sharing resources allows easy flow of information and ideas within the network and hence, improved access to input-output markets and reduced production risks and efficient resource allocation.

Areas where social capital has demonstrated positive results include the adoption of Participatory Irrigation Management (PIM) in Asian countries like Japan where farmers manage their irrigation schemes sustainably as a community (Yamaoka, 2007). These arrangements have resulted in sustainable resource use through farmer's sharing benefits and costs within schemes. Also, such has resulted in improved farmer's self-governance and cemented relationship between government service providers and farmers. Hongmei and Mangxian (2011) investigated the factors influencing collective water management and their impact on technical efficiency among rice farmers in China. Results generated indicated that water user groups with high social capital had a positive and significant influence on technical efficiency. Thus, increased social capital accumulation results in increased technical efficiency of rice farmers. A study carried out by Wolz, Fritzsche and Reinsberg (2005) indicated a positive relationship between social capital and farm incomes among 410 farmers in Poland.

A study carried by FAO (2000) in Zimbabwe indicated that there were two types of management style employed among smallholder irrigation schemes, some are managed by farmer groups and others managed by the government. Farmer-managed irrigation schemes comprises leadership committees that were responsible for overall management of scheme, cropping programme formulation, collection of operation and maintenance funds from farmers, and linking the scheme with various institutions. For government-managed smallholder schemes, the government role was to act as a link between institutions and farmers. Also the government helped farmers in cropping programme formulation, linking

farmers with institutions and markets, plot allocation and collection of operation and maintenance funds from farmers. Sometimes activities are shared between farmers and the government.

Group cohesion was observed to be a major contributor to the success of many smallholder irrigation schemes in Zimbabwe. Farmer groups that showed high cooperation exhibited better performance than groups which had loose cooperation. Lack of cooperation among such groups resulted in failure of some irrigation schemes. Social capital both internally and externally-oriented was crucial for the success of these irrigation schemes. Farmers' participation in planning and decision-making in managing irrigation schemes showed positive and sustainable production results whereas irrigation schemes planned and managed by government only were performing poorly. Grootaert and Van-Bastelaer (2001) cited Fafchamps and Minten (1999) reporting that farmers and traders who had a wider social network in addition to physical and human inputs as well as entrepreneurial skills enjoyed higher sales and gross margins than farmers/traders with limited social networks. They further reported that trust was a major component in improving social capital among farmers/traders and such reduced transaction costs, improved access to credit, improved access to reliable market information and provided better quality services and goods to their clients.

According to McAllister (2010), in the pre-betterment scheme in South Africa, there was a form of bond (internally oriented) social capital among African tribal and cultural groups. Within these communities, access to and use natural resources were vested in traditional leadership. There were rules, norms and procedures of accessing land to build, farm and graze. Furthermore, in this type of organisation, all homesteads belonged to different work groups which performed a wide range of farming tasks. Such work parties included ploughing companies that combined labour, oxen and tools to plough and plant in fields and gardens of different homesteads in a rotation form. Other group work farm tasks included weeding, harvesting, cutting grass and fencing. However, McAllister (2010) reports that the betterment programmes undermined and disorganised the accumulated social capital through relocation and separation of families, groups and the general social organisation.

In the post-apartheid era, there are fewer studies that have attempted to examine the role of social capital in rural development especially in former homelands of Transkei and Ciskei of South Africa (ISRDS, 2000). The Integrated Sustainable Rural Development Strategy (ISRDS) documented in year 2000 acknowledged the importance of social capital in bridging gaps of social networks caused by disintegrated institutions and distrust between groups as a result of past racial oppression and inequalities among South African citizens. Traditional leaders and present structures were identified as key players in facilitating and reviving social groups and networks for improved resource management, productivity and sustainable rural development. Hebinck and Lent (2007) and Katungi *et al.* (2007) cited by Obi (2011) who indicated the importance of social capital in improving livelihood and poverty reduction among the rural communities of South Africa. Therefore, there is still room for research to avail information about the current situation of social capital's contribution towards rural development in particular agricultural productivity for appropriate South African government, private sector and NGOs interventions.

Although human and social capital were reported to have negative attributes especially in absence of rules, regulations, norms, trust and precedence, they exhibit several positive attributes. Such attributes include improved group/community cohesion, increased production and productivity efficiency, reduce transaction costs due to reliable market information flow, sustainable management and use of natural resources, source of cheap labour, shared risks in production, ease credit access, improved food security, increased household incomes and poverty reduction among rural communities.

3.5 Entrepreneurial spirit and Positive Psychological Capital

A vast body of literature attests to positive psychological capital's contribution to improved productivity and future anticipated returns (Luthans, Luthans and Luthans, 2004; Carver *et al.*, 2005; Judge *et al.*, 2007; Luthans *et al.*, 2007; Ryan and Caltabiano, 2009; Pepe *et al.*, 2010). In the world business, especially when developing the entrepreneurial spirit this type of capital has been reported to be of great importance. According to Sudharani (2010), the positive psychological capital related concepts essential for a successful entrepreneur they include self-confidence, confronting uncertainty (optimism), hope and perseverance. Luthans, Luthans and Luthans (2004) simply define the term positive psychological capital as "*who you are*". To be more specific, the term can be

defined as the positive and developmental state of an individual as characterized by high confidence (self-efficacy), optimism, hope and resilience. Some empirical studies have attempted to define each of these four concepts as described below.

Confidence: Confidence and self-efficacy are interchangeably used to define the ability to achieve a specific goal in a specific situation or to take on and put in the necessary effort to succeed at challenging tasks (Luthans *et al.*, 2007). According to Luthans, Luthans and Luthans (2004), confidence can be defined as the “individual’s conviction.....about his or her abilities to mobilize the motivation, cognitive resources, and courses of action needed to successfully execute a specific task within a given context. Moreover, Judge *et al.* (2007) cited Bandura (1994) defining self-efficacy as individuals’ beliefs about their capabilities to produce designated levels of performance. The concept can be of great relevance in adoption of new technologies for increased agricultural productivity and enhancing farm business.

Optimism: This can be defined as individuals’ future expectation and optimists always expect good outcomes. The concept can also be defined as a positive attribution about present success and in the future (Carver *et al.*, 2005; Luthans *et al.*, 2007). The concept is mainly based on the expectancy oriented value model which speculates that, unless there is a valued goal, no action occurs (Carver *et al.*, 2005). The opposite of optimism is pessimism, and pessimists think negative about succeeding now and in the future. Optimists have a sense of confidence and persistence in confronting tough situations (Carver *et al.*, 2005). Moreover, optimists interpret bad events as being only temporary while pessimists interpret bad events as being permanent.

Hope: There are two components that define hope. The first component entails an individual’s perception of the existence of pathways that are needed to achieve his or her goals and the second component dwells on the individual’s level of confidence to manipulate those pathways to achieve the goals (Carver, 2005). In addition to the ability to redirecting paths to goals, Luthans, Luthans and Luthans (2004) and Luthans *et al.* (2007) indicated that persevering or goal oriented determination also contributes to the definition of the hope concept.

Resilience: According to Ryan and Caltabiano (2009) the concept of resilience can be defines as; the ability to maintain or regain positive levels of functioning or bouncing back

despite adversity and even beyond to attain success. Resilience can also be defined as a positive way of coping with danger or distress (Luthans, Luthans and Luthans, 2004).

3.5.1 Entrepreneurship Concept

Whereas Schumpeter (1942) viewed entrepreneur as an agent of change who innovates new product or production processes or new sources or goods ("gets new things done."), Hayek (1937) urged that an entrepreneur is an agent who adjusts his/her production based on new information or knowledge of facts, or newly-perceived changes in the plans of other market participants (Learning). According to Hayek (1937), the old ideas are not completely destroyed as suggested by Schumpeter (1942) but rather the ideas are improved based on factual information or future market forecasts. A related view is put forward by Kirzner (1973) who asserts that an entrepreneur explores the undiscovered opportunities to gain by changing the existing production or creating a new product and creates a future image in his mind and acts to bring it about. Other contributors to the knowledge of entrepreneurship include Mises (1963), Shackle (1968), Knight (1971), and Lachmann (1979), whose entrepreneurial theories were mainly focused on future market forecasting.

Although entrepreneurship has no definite definition, it can be defined based on the entrepreneurs' activities or as a person endowed with knowledge, skills, initiative and spirit of innovating to achieve his/her set goals. Some of these activities include initiation, risk calculation, resource mobilisation and setting up new businesses through innovations to meet clearly defined market demands (Einstein College of Engineering, 2011). An entrepreneur is an economic agent who combines resources by all means of production to maximize profit. An entrepreneur recognises an opportunity, sets a goal, and takes advantage of the prevailing situation (Einstein College of Engineering, 2011). Sudharani (2010) defined entrepreneurship as a continuous process which aids the entrepreneur to cause changes and innovation in production, mobilize and create new production methods, and new markets among others.

Entrepreneurial spirit is among the human dimensions and can be described as a person who is creative and constantly looking for opportunities to improve or expand businesses for increased profits. Entrepreneurs have ability to calculate economic risks and mind about profits and losses, and they are innovative in nature to catch-up with growing global

competition (LEISA Magazine, 2009; McElwee, 2005; Masaviru, 2011). They are goal-oriented, persistent hardworking and energetic, willing to take initiative, and have a strong sense of commitment. Smallholders' low agricultural production may be attributed to low entrepreneurial spirit.

3.5.2 Categories of Entrepreneurs

According to Sudharani (2010), entrepreneurs can be classified into four categories, namely, aggressive/innovative, imitative/adoptive, fabian and the drones. Aggressive/innovative entrepreneurs are individuals who use knowledge, skills and formulate a product out of a new combination of inputs. They sense opportunities and develop new technologies, new markets, and set-up new organisations to satisfy a given need. They are very important in the development of communities and nations. Imitative/adoptive entrepreneur are individuals who adopt and imitate enterprises innovated by other people. They are treated as economic development agents because they adopt already tested technologies that create employment opportunities. The fabian entrepreneurs are always cautious and timid in adopting technologies and sceptical to change their old-aged production styles, unless their businesses fail or are at the verge of collapsing and they do not attempt to adopt new technologies. Drone entrepreneurs are always stuck in their traditional way of doing business and feel more comfortable in such old-styled business operations. They use the same technology and management style throughout the business or project life cycle. They are laggards and are resistant to change.

Also, entrepreneurs can be classified based on ownership, examples include the private and public entrepreneur. The private entrepreneur is mainly driven by profits and does not invest in any ventures where there are less monetary gains. However, the public sectors, the government share enterprise with the public especially among rural resource-poor population in developing countries. Entrepreneurs can also be classified based on the scale of the enterprise and this includes small and large scale. Small scale entrepreneurs normally operate small businesses, lack skills and resource poor and commonly found in developing countries whereas large scale entrepreneurs have relatively sufficient finances and skills to invest in new technologies. In most cases they run multinational companies and are mainly located in developed countries (McElwee 2005; Sudharani, 2010).

Robert (2012) identified three types of entrepreneurial values, namely, the Western values, and non-Western or African values, and the hybrid values shaped by a combination of the western and the African values. The Western values include individualism, materialism, industriousness, need for achievement and risk taking, while African values include communalism, caring and sharing, and compassion. Although, much of the literature considers the Western values as the only key to entrepreneurial success, Robert (2012) urges that both the African and Western values need to complement each other (hybrid) to achieve a meaningful entrepreneurial capital. Promotion of either value, say, the Western values may encounter resistance to some communities especially those with strong beliefs of own cultural values (Robert, 2012). Therefore, one needs to first understand the indigenous entrepreneurial values before integrating them in the hybrid values. African values strengthen social bonding and networks in communities, and are important in providing access to resources like economic capital while adoption of the Western values enhances acceptance in the formal institutions (Robert, 2012).

3.5.3 Steps Taken in Developing Small Scale Farming Entrepreneur

There are several steps taken to start-up a smallholder farming enterprise (McElwee 2005; Sudharani, 2010; Einstein College of Engineering, 2011). Such steps include idea generation and this depends on the vision, insight, observation, experience, education, training and exposure of the entrepreneur. The farmer thinks about farm as an enterprise to run. When selecting, the farmer should consider the commercial viability of an enterprise and his/her management capabilities. Goals/objectives are set for the selected enterprise based on the nature and type of business. The entrepreneur seeks for information regarding sources of funding; he/she identifies cheap and regular sources of supply of raw materials that favour low costs of production; he/she identifies cheap and appropriate farm implements/machinery to be used in production; identifies networks and markets of the input/output; establishes sources of labour needed, and lastly implement the idea/innovation.

3.5.4 Factors Affecting Entrepreneurship Growth among Smallholder Farmers

Economic environment is one of the major factors that affect entrepreneurship. Such environment includes availability of capital, labour, farm inputs and implements, and markets. Most rural smallholder farmers in Sub-Saharan Africa always lack capital to invest

in commercial farming. This prevents them to invest in new businesses that have high production risks yet such may be a potential for capital formation and entrepreneurship development. Also farmers lack access to labour saving technologies and skilled labour (quality). They also lack credit access and are poor to afford purchase of agricultural inputs. Market structures in most rural areas are poor and lack access to market information. Lack of capital, labour saving technologies, low farm input use, and markets and market information negatively affects the entrepreneurship drive and spirit (McElwee 2005; Sudharani, 2010).

Social environment also affects entrepreneurship. The social environment in which an individual grow, shapes his/her attitudes, norms, values and beliefs. For example, cultural beliefs can shape a person towards adoption or not adopting a certain technology or through family inspiration an individual adopts a given style of management, innovation and expansion of business. Social mobility can be an instrument of sourcing for more information helpful for innovation or access to better markets (McElwee, 2005). If there is no social mobility, then the population forms part of cheap labour and market for produce. Rural smallholder farmers in developing countries are less mobile due to poor infrastructures and thus, creating more barriers to access knowledge, skills and information, and hence low innovations and low entrepreneurial spirit (McElwee, 2005).

The compelling factor affecting entrepreneurship emphasise use of prevailing situations like individual's strong desire to do something independent. Smallholder farm entrepreneurs need to use government incentives like free inputs/input subsidies, extension services, regulations and policies on smallholder land and irrigation water utilization, farmer-private sector market and technical linkages to improve on their businesses (Sudharani, 2010; Einstein College of Engineering, 2011). Also, entrepreneurs should make use of their technical and professional skill, business experience, and technical know-how to innovate, plan and produce goods that are market appealing.

3.5.5 Enhancing Smallholders' Entrepreneurship Development

Rural farmers are faced with high poverty resulting into low entrepreneurial spirit. Therefore, for improved rural smallholders entrepreneurship, there is need to encourage accumulation of human and social capital through farmer groups and cooperatives

(McElwee, 2005; LEISA Magazine, 2009; Tahmas, Hekmat and Davodi, 2012). Farmer organisations need to stimulate entrepreneurship through availing systems that allow free information flow and sharing, organised extension trainings and advisory services, promotion of collective marketing and improved coordination among producers, shared production and management costs/risks, and always presenting farmers' interests in policy negotiations.

Furthermore, producers, business associations (other rural entrepreneurs investing in market intelligence, technologies, products and services, and organisation reforms) and government need to agree and put in place rules, norms and regulation, and institutional environment that enhance coordination of rural businesses. This reduces business risks, transaction costs, improves market accessibility and entrepreneurship growth (LEISA Magazine, 2009). Rural smallholder farmers need government support to stimulate entrepreneurship growth. Support like provision of information on quality standards, and input and output markets in the agricultural sector and may provision of capacity building services such as business planning, marketing and book/record keeping, quality control and post-harvest handling of agricultural goods may be of great importance in promoting entrepreneurship. Other support may include demonstration sites and farmer learning and interaction centres, and other infrastructures should be put in place to help farmers solve their technical problems, promote social cohesion, reliable information flow and increased social networks (McElwee, 2005; Einstein College of Engineering, 2011; Tahmas, Hekmat and Davodi, 2012).

Agricultural credit/loans at low interest rates for long payback periods need to be availed to farmers to speed up the entrepreneurial drive. Conditions needed to boost entrepreneurial growth, may call for more agricultural linked activities such as agro-processing produce units (maize mills, decorticating mills); agro-produce manufacturing units; and agro-input manufacturing. Access to improved seed and fertilizer and agro-service and workshop centres are also essential for entrepreneurial growth (Sudharani, 2010).

Entrepreneurship is an inevitable ingredient of rural economic development especially in Sub-Saharan Africa (McElwee, 2005; Masaviru, 2011; and Ndou, 2012). A few studies carried out in Western and Central Europe indicates the importance of smallholder farm enterprises in economic growth (McElwee, 2005). During the periods of high levels of

underemployment and unemployment in India and other Asian countries, many people resorted to innovation and created new businesses including smallholder farming. The government rendered support to the small-scale enterprises through farmers, traders and manufacturing industries linkages, and provided extension services and market oriented technologies. Government efforts stimulated economic growth in these economies (Sudharani, 2010; Einstein College of Engineering, 2011). In Sub-Saharan Africa, there are pockets of successful smallholder farmer entrepreneurs along value chains of high value crops and horticulture products (Africa Human Development Report, 2012). Using a Cobb-Douglas production function, Masaviru (2011) reported a positive and significant relationship between entrepreneurship and Kenya's economic growth.

According to Global Entrepreneurship Monitor (GEM) (2011), entrepreneurial spirit can be enhanced through improved infrastructure development, quality of the population in terms of skill building, research and development, and technology advancement. Entrepreneurship can also be enhanced through availability of flexible labour markets and inputs/output markets, and financial market flexibilities within the location of operations. For someone to be identified as a successful entrepreneur, one has to be more efficient in utilising the available resources and ensure product quality enough to fetch more profits. However, entrepreneurs are faced with increasing challenges in input/output prices, changes in trade policies and stiff environmental regulatory policies. These challenges call for innovativeness, taking risks and recognise opportunities, and strike a balance between people, policies and natural environment for a sustainable farm business (Modiba, 2009).

3.5.6 Entrepreneurship and Innovation in communal Agriculture

Schumpeter and other members of the Austrian School spearheaded the bulk of the theoretical work on the subject relate to entrepreneurship and innovation. In his *Theory of Economic Development*, Schumpeter (1949) viewed the entrepreneur as an agent of change who approaches the creative process through destruction of existing myths and stereotypes (so-called "creative destruction"). The concept of creative destruction has been widely used in the theory of economic innovation and the business cycle. Creative destruction is instrumental to the founding of new product lines, new markets and new forms of organization but ultimately leading to growth in the economy (Schumpeter, 1949). For example, farm mechanization through innovation of tractors and combining harvesters is thought to reduce farm costs thereby increasing farmers' profits and reduces consumer

food prices. Despite its positive contributions, creative destruction exhibits negative impact like farm job losses. In 1790s in the United States of America, over 90% of the population was employed in agriculture, and by 1990s, only 2.6% of the population was engaged in farming due to innovation of labour-saving technologies (Bellis, n.d.). This implies that over 87% of farm jobs were lost. Innovation was defined by Schumpeter (1937) as the setting up of a new production functions (Hagedoorn, 1996). Based on the notion of new production functions, Hagedoorn (1996) cited Schumpeter (1937) reporting that entrepreneurship can be considered as a third basic factors of production in addition to land and labour.

Using the Schumpeterian entrepreneurship theory, Braguinsky, Klepper and Ohyama (2009) established the impact of individual talent coupled with working experience and education level in job creation (self-employment). Findings of this study indicated that individual's talent, hands on experience (both technical and managerial), human capital (level of education) and age of an individual had a positive relationship with entrepreneurial spirit. Wealth (incomes) and access to credit or financial resources are also crucial in advancing the entrepreneurial spirit (Braguinsky *et al.*, 2009; Hagedoorn, 1996). To achieve the new production functions, someone has to be bold and willing to get rid of the old myths or beliefs (Swedberg, 2007). According to Swedberg (2007), the obstacles that prevent individual's entrepreneurship progress can be both sociological and psychological in nature. Sociological obstacles are those related to social norms and beliefs which resist development while psychological are those related to individual's negative attitude towards development (Endres and Woods, n.d; Swedberg, 2007).

In the agriculture sector, Lwakuba (2011) perceives the term 'farmer entrepreneurship' as related to 'treating farming as a business'. This suggests a business-like approach to farming activities quite apart from its importance as a source of food for subsistence. Farmers' positive psychological capital/positive thinking is a driver to innovativeness important for increased production. Therefore, the focus is on changing the mindset of farmers from subsistence to a more commercial farming operations' orientation. A number of agricultural innovations have been introduced as an effort to improve resilience and livelihoods within the community, primarily through the Smallholder System Innovation (SSI) and Land Care projects (Sturdy, 2008). Furthermore, in Uganda and the world over, farmers' and nations' options for survival and for sustainably ensuring success in changing

their respective economic environments has become increasingly critical due to the changing socio, economic, political, environmental and cultural dimensions (Lwakuba, 2011). It is also worth noting that the emergence of the free market economies globally has resulted in the development of a new spirit of enterprise and the increased individual need for responsibility for running their own businesses (Lwakuba, 2011).

Apart from land reform programmes to develop agriculture, South African government, in particular, initiated a number of irrigation schemes soon after the 1994 elections with the aim of developing small-scale agricultural production (Riddell, Westlake and Burke, 2006). These low-cost micro-irrigation technologies are largely promoted to poor farmers because of their competitive pricing and compatibility with smallholder farming systems. It is one of government's responses to low agricultural productivity and the 'absence of commercial agriculture' in the homelands to what was attributed to be perceived lack of entrepreneurial and managerial ability among black farmers (Sishuta, 2005). Farmers become more entrepreneurial as economies grow, and this trend is triggered by rapid technological change, improved rural infrastructure, and diversification in the patterns of food demand (Von Braun, 1995). McElwee (2005) agreed that farmers are becoming more entrepreneurial and developing new skills and functional capabilities to enhance their competitiveness. This phenomenon was particularly visible in Poland where it was noted that entrepreneurship is a relatively recent.

3.5.7 South Africa's Entrepreneurial Performance

Global Entrepreneurship Monitor (GEM) used the World Economic Forum's (WEF) classifications to categories South Africa among the efficient-driven economies, however, South African second economy dominated by resource-poor households can be classified among the factor-driven economies (GEM, 2011). The factor-driven economy is characterised by mainly subsistence agriculture and extraction businesses with a heavy reliance on unskilled labour and natural resources (GEM, 2011). Further, the economy is faced with poor entrepreneurial environment. To improve on the entrepreneurial environment, the government of South Africa has developed policies that emphasise promotion of entrepreneurial activity especially in the informal sector. This has been implemented through allocation of vast financial resources to catalyse the establishment of self-owned or joint ventures businesses (Modiba, 2009; GEM, 2011). A vast body of

literature confirm the huge support rendered by South African government to improve on the entrepreneurial activities among smallholder agriculture. The support entailed establishment of small-scale irrigation schemes, subsidization of farm inputs, and provision of credit facilities and enacting a number of land reform policies (Ramaila *et al.*, 2011).

Notwithstanding the support from government, South Africa's level of entrepreneurial spirit is reported to be the lowest and lagging behind many countries globally (Modiba, 2009; GEM, 2011). In South Africa, only 1.7% of businesses started do survive after a period beyond three years and six months, and the Total early-stage Entrepreneurial Activity (TEA) rate was reported at 9.1% (GEM, 2011). The prevalence rates for established self-employed business in South Africa were reported at 2.3% (GEM, 2011). Moreover, the country's agribusiness sector is the most underdeveloped yet considered being the most important for economic growth of the second economy (Modiba, 2009). Low entrepreneurial spirit indicates a worrying situation for smallholder's agribusiness sector in contributing towards meaningful job creation, and growth of the rural economy (Modiba, 2009).

3.6 Smallholder Farmer's Goals and Aspiration

Availability of physical assets like land and water without proper management, organisation and co-ordination is believed to be non-productive. Therefore, there is need to set goals and objectives in order to utilize and manage such assets more optimally and efficiently. According to Gasson (1973), farmers express values through implementing a range of farming goals. Goals and objectives can be defined as aspirations for which a person has decided to undertake for improved well-being (Padilla-Fernandez and Nuthall, 2001). The purpose and direction to decision-making, and performance of the farm depend on the set goals (Maskey, Lawler and Batey, 2010). Thus, goals need to be defined because they determine the farmer's success or failure. For the farmer to achieve his goals there should be minimised management gaps. Fairweather and Keating (1994) indicated that farmer's goals are known to be related to their styles of management. However, management and decision-making among smallholder farmers are based on the values and attitude of a given farmer and society (Padilla-Fernandez and Nuthall, 2001; Vimalra, Singh and Vijayaragavan, 2012). Goals of the smallholder farmer may not only be

maximisation of output and profits, but also satisfaction of beliefs, values, cultural and other sociological endeavours (Harwood, 1979; Padilla-Fernandez and Nuthall, 2001).

According to Appadurai (2002), the capacity to aspire plays a great role in participating in the economic system and to alter the conditions in which individuals live. A related view is put forward by Ray (2002), who asserts that poverty may be linked somehow to aspirations to the extent that individual desires and standards of behaviour are conditioned by what they experience around them. In their publication, Eagly and Chaiken (1993) reported that farmer's goals have been used to predict their behaviour. It is therefore only possible to understand why people act the way they do by understanding their behaviours and the value systems (which influence goals and aspirations) they are coming from. Identification of farmers' goals may be reflected in their needs, and thus, many international development agencies use the Quality Assessment Framework (QAF) to collect the relevant information (FAO, 2011). Organizations like the International Organization for Migration (IOM) and the World Food Programme (WFP) make use of needs assessment to plan and implement emergency programmes during disasters (WFP, 2005). However, most farmers' needs assessments carried by WFP have not dwelt much on the actual farmers' goals related to agricultural production but rather focus on mainly food availability and its quality for food security reasons.

Literature dated back to the 1960s and 1970s reported that measurement of farmers' operations was mainly based on a single-objective decision models, such as profit maximization and the expected utility models (Lichtenstein and Slovic, 1973). However, the approach was criticized by Baumol (1965) for being unrealistic. Baumol (1965) urged that individual goals may not only rely on a single-objective of profits maximization but rather strive to attain satisfactory levels of different objectives. Several studies have attempted to measure farmers goals using different approaches like paired comparisons, magnitude estimation, and multidimensional structures (Van Kooten *et al.*, 1986, Padilla-Fernandez and Nuthall, 2001). Some of the common goal statements used in analysis included growth goals, risks, personal goals, farm business and family goals, quality of life goals, and profit goals. These goals are thought to be influenced by individual characteristics like age, education, farming experience, and household incomes, and farm characteristics such as, farm size, access to irrigation water, and other agricultural inputs (Van Kooten *et al.*, 1986; Padilla-Fernandez and Nuthall, 2001). Van Kooten *et al.* (1986)

they indicated that measuring of farmers' goals is important for predicting economic behaviour, and the multiple goals can be incorporated into farm simulation models to support farmers in making decisions.

Therefore, there is need to understand the roles of human dimensions in production efficiency for sustainable policies that are within farmers' socio-cultural, economic and development goals. In their study to determine the impact of farmers' goals and attitudes on production efficiency, Padilla-Fernandez and Nuthall (2001) found that, intrinsic independence goal; the instrumental aspects of farming, leisure orientation, optimistic attitude, and risk consciousness were among goals and attitudes of farmers with a positive and significant influence on production efficiency.

3.7 Commercialisation of Agriculture

There is no definite definition of commercialization of agricultural production but can be described based on the farmers' aims/goals and aspirations. Smallholder commercialization of agriculture production can be defined as; small scale farmers that are more integrated into available local, national and international markets (Doward and Kydd, 2002). Farmer's goals and aspirations that shape the definition of commercialization of agricultural production include production aimed mainly for sale, oriented towards profit maximization while satisfying the different needs and interests of the consumer. Such production calls for effective business management and entrepreneurial skills to achieve farmer's set market oriented objectives (Mahaliyanaarachchi and Bandara, 2006). According to Mahaliyanaarachchi and Bandara (2006), commercial farmers can be classified based on the marketable surplus produced and these include; subsistence farmers who produce marketable surplus of under 25% of the total production. The second group comprises the emerging farmers who produce a marketable surplus ranging between 25-50% of total production. The third group is made up of commercial farmers who produce marketable surplus of more than 50% of the total production.

Commercialization of agricultural production in many developed and developing countries has proved efficient in catalysing industrial and economic growth (Eicher and Staatz, 1985, von Braun, 1995; Jaleta *et al.*, 2009; Kofi Annan Foundation, 2011). Large-scale commercialised agriculture using modern machinery and sophisticated technologies has

largely contributed to economic and industrial growth in developed countries like North America, and European countries, Israel in the Middle East, and Southern American countries like Brazil and Argentina; Asian economies like China and India (Eicher and Staatz, 1985). In developing countries especially in Sub Saharan Africa, Asia and South America, commercial farming was mainly introduced by European colonial masters for purposes of feeding their industries in Europe (Eicher and Staatz, 1985). Despite its positive contributions, commercialization of agricultural production should be promoted with caution due to its mixed effects (Jaleta *et al.*, 2009; Jedwab and Moradi, 2012).

3.7.1 Positive Attributes of Agricultural Commercialisation in Developing Countries

According to Chandra (1992), Robbins and Ferris (2002), Jedwab and Moradi (2012), some positive attributes of commercialization of agricultural production in developing countries during and after colonial periods included:

- (i) Improved communication systems established through construction of infrastructures like roads and railway lines from crop fields to the exiting point for export. Infrastructure development made agricultural trade feasible especially over long distances.
- (ii) Agro-industries were established in developing countries to add value to the produce before they are exported. Established agro-industries promoted industrial growth in these countries.
- (iii) Commercialisation of agriculture in former European colonies also offered an opportunity to identify regional specialization of crop production based on topography, climatic conditions, soil conditions among other factors
- (iv) Further, commercialization of agricultural production led to changes in land tenure systems, improving on land markets in some countries.
- (v) A few indigenous middle men and traders benefited from high profits earned in the venture.

- (vi) Europeans introduced commercial field crops like, cotton, jute, tea, tobacco, coffee among others in developing countries. To-date these crops, are known to be the major contributors to export earnings and national GDP especially in developing countries whose economies are still depending on primary agriculture.
- (vii) Also, commercial farms were a source of employment for most peasant farmers in these colonies. Commercialized agricultural production during this period enjoyed high economies of scale.

3.7.2 The Negative attributes of Agricultural Commercialisation in Developing Countries

Colonial led commercialisation of agricultural production is condemned for its unimaginable negative impact in developing countries (Chandra, 1992; Robbins and Ferris, 2002; Jedwab and Moradi, 2012). The negative impacts included;

- (i) The oppression of the peasants in the hands of Europeans masters and huge exploitation of natural resources
- (ii) Limited transfer of productive technical and managerial farming knowledge and skills to peasant farmers led to stagnant, subsistence and low agricultural productivity.
- (iii) Large commercial farming put less emphasis on sustainable agricultural production practices, and hence resulting into soil fertility exhaustion and thus, denying a sustainable development of future generations.
- (iv) Land was mostly devoted to cash crops and less apportioned to food production leading to famines in some rural peasant communities.
- (v) Also, the system led to distortion in the land acquisition, hold, control and use traditionally established before colonial periods, leading to social conflicts among communities, and nations. Further, due to low and fluctuating prices of cash crops, farmers were earning less incomes and sometimes not sure of the

output markets. Such resulted in high level of poverty and high dependence of developing countries on donations and food aid from developed countries.

Though, commercialization of agriculture is normally anticipated to act as a catalyst in increasing agricultural productivity for increased household incomes and improved general livelihood of rural farmers as reported by von Braun (1995) and Timmer (1997), it was not the case for most European colonies in developing countries. Evidence reveals that most commercial farms failed during the early post-national independence of most developing countries due to poor human capital, agricultural organization and lack of external social capital, out-dated technologies, lack of access to physical and financial resources, and lack of entrepreneurship drive to manage these large farms (Romer, 1994). Consequently, the peasant farmers resorted to small scale farming mainly for subsistence farming. Despite its ability to bring food at the table, subsistence farming in the long run, may not result in sustainable food security and improved general livelihood (Pingali, 1997).

3.7.3 Commercialisation of Agriculture in South Africa

In South Africa, smallholder commercialization of agriculture production started as early as 2,500 years ago by (Khoisan) people who traded in livestock with people from North and Bantu group who settled along Limpopo river banks (Byrnes, 1996). Bantu group were practicing subsistence food crop production mainly for household consumption. In year 1658, European settlers introduced large scale commercial agricultural farming (Seneque, 1982; Thwala, 2003; Kodua-Agyekum, 2009; McAllister, 2010). To date, the white farmers are the major contributors to commercial agriculture in South Africa. Thus, most rural farmers especially in former homelands in Eastern Cape Province of South Africa are still locked in low agriculture production with no or less marketable surplus extremely below threshold to uplift them out of widespread increasing poverty (Seneque, 1982; Thwala, 2003; Kodua-Agyekum, 2009; McAllister, 2010; Zuma, 2011).

Evidence displayed in literature report a decline in the number of commercial farms in South Africa, exposing the country to food insecurity and increased poverty levels among rural communities especially in former homelands like Transkei and Ciskei. Therefore, this may call for potential and policies that promote investment incentives in the sector. Also, the development of entrepreneurial skills across the agricultural sector especially among

small-scale farmers may be of great importance to catalyze the transition from subsistence to commercial farming. According to AgriSETA (2010), there has been a decline in the number of commercial farming businesses of -10.97% in the Eastern Cape Province.

Table 3.1: Growth/Decline in Commercial farming enterprises: 2002 and 2007

PROVINCE	2002	2007	Growth/decline (%)
Eastern Cape	4 376	3 896	- 10.97
Free State	8 531	7 515	- 11.91
Gauteng	2 206	2 378	7.80
KwaZulu-Natal	4 038	3 560	- 11.84
Limpopo	2 915	2 657	- 8.85
Mpumalanga	5 104	3 376	- 33.86
North West	5 349	4 692	- 12.28
Northern Cape	6 114	5 226	- 14.52
Western Cape	7 187	6 682	- 7.03
Total	45 818	39 982	- 12.74

Source: AgriSETA (2010)

The number of active commercial farms is declining in South Africa. Results in Table 3.1 indicate that overall active commercial farming enterprises declined by 12.74% from 45 818 active commercial farming units in 2002 to 39 982 active commercial farm units by 2007. Between 1993 and 2002, the number of active commercial farms reduced by as much as 12 162 farming units (AgriSETA, 2010).

The slow rate of land redistribution and restitution programmes, limited of government support and reduced government support to smallholder irrigation schemes are among the factors blamed for the decline in active commercial farming units in the Eastern Cape Province. A dominant view is that the slow progress in the transfer of land from white farmer owners to the black farmers is said to be the major cause of the decline. Between 1994 and 2009 only 6.9 of agriculture land had been transferred to beneficiaries through redistribution and restitution programmes (AgriSETA, 2010). This rate obviously falls far too short of the rate required to achieve the government's goal of transferring 30% of previously white owned farms to black ownership by 2014. Other programmes like land tenure system are also failing to address the current the inequalities created by the

apartheid government (Tshuma, 2009). Moreover, South African smallholder irrigation schemes offer individual plots of only less than 5 ha in size, too small to accommodate reasonable commercial production.

Government programmes like Comprehensive Agriculture Support Programme have benefited a few farmers and failed to support a large number of black farmers who benefited from land reforms programmes (Aliber and Hall, 2009). This is rendering the transferred land unproductive. Aliber and Hall (2009) reported that it is a matter for concern that in the Eastern Cape, most black farmers cannot access production loans meant for small farmers as a result of the disbursement practices of the main channel for farmer infrastructure support, namely the Comprehensive Agricultural Support Programme (CASP). The study by Aliber and Hall (2009) reviewed data from 322 projects which revealed that about 80% of the CASP funds go to a mere 20% of the beneficiaries as a result of the eligibility criteria that include the presence of fixed infrastructure and that the beneficiary owns the land in question (Aliber and Hall, 2009). Thus, the terms and conditions applying in this case effectively excludes the majority of farmers in the former Ciskei and Transkei regions.

The effect of the withdrawal of government from the management of the existing small-scale irrigation schemes might have led to the decline of agricultural production in the Eastern Cape Province. As the history of the schemes will show, after the establishment of the small-scale irrigation schemes, they were run and managed by government through its agencies on behalf of small-scale farmers. Tshuma (2009) revealed that all the schemes under the Agriculture and Rural Development Corporation (ARDC) were fully subsidized, meaning that the government was majority owner of the schemes' capital resources such as the machinery, water through the Department of Water Affairs and Forestry (DWAF) and even the working capital used in the schemes. This left the farmers to play only the role of casual labour for weeding and harvesting. The scope for the farmers to acquire skills in management of these schemes was therefore limited. This is probably why, despite huge investments on them by the government, the performance of most of these small-scale irrigation schemes has been poor and falls far short of the expectations of all stakeholders, be they engineers, development agencies and the participants themselves.

3.7.4 Factors for Improved Smallholder Agricultural Commercialisation

Therefore, promotion of smallholder commercialization in the rural Sub Saharan Africa including South Africa is inevitable for improved livelihood of the rural population (Jaleta *et al.*, 2009; Doward and Kydd, 2002). The essential components for a sustainable and feasible smallholder commercialization of agricultural production especially in rural areas in Sub Saharan Africa include improved physical infrastructure such as roads, railways and ICT facilities (Sibale, 2010). Increased adoption of new technologies, research and development (R&D), level of specialization in fewer staple food and cash crops coupled with availability of assured markets through contracts and legal agreements are vital in promoting increased commercialisation of smallholder farmers (Sibale, 2010). Other factors that may be of great importance for increased commercialisation of subsistence farmers include internal and external social capital accumulation through group/cooperative union formation (Jaleta *et al.*, 2009). Development of agro-industries, development of the rural financial institutions and farmers capacity building in entrepreneurship, and farmer's participation in planning and management of rural development programmes may be considered (Eicher and Staatz, 1985; Romer, 1994; Sibale, 2010; Jaleta *et al.*, 2009; and Jedwab and Moradi, 2012).

3.8.1 Summary of the effects of Human dimension on Agricultural production

Agricultural production can simply be defined as the process of transforming inputs (factors of production) into outputs (Doll and Orazem, 1984). Among factors of production needed in the transformation process of inputs to outputs include natural resources (mainly land and water), labour and capital (mainly physical and financial capital) (Doll and Orazem, 1984; Djomo and Sikod, 2012). The accessibility and use of these factors of production is crucial in achieving the desired output (Djomo and Sikod, 2012). The level of accessibility and use of these factors of production is thought to be influenced by the individual's human dimensions (Padilla-Fernandez and Nuthall, 2001). For example, the human capital that includes skill and knowledge avails information needed to apply fertilizers, pesticides, and herbicides and adopt resource-saving and enhancement productive technologies (CIMMYT, 2000).

Production can be enhanced by social capital through farmer groups and cooperatives which pool resources together for large- scale operations (Ostrom, 1998; FAO, 2000). Further, social capital is viewed as a buffer to farmer's risks and shocks especially those related to crop failure and general production. In the presence of more accumulated social capital, one can easily access farm implements, inputs and group labour at no or low cost (Tshikolomo, 1996; McAllister, 2010). Farmers' goals and aspiration are also key in determining the level of farm production since they influence farmers' decisions related to how much and what to grow and for what reason (Padilla-Fernandez and Nuthallhall, 2001; Maskey, Lawler and Batey, 2010). Robert (2012) indicated that individuals' level of entrepreneurship is crucial in accumulating productive assets and financial assets for maximizing output and profits.

3.8.2 Summary of the effects of Human dimension on Technical Efficiency

Technical efficiency is crucial in maximizing output given that available factors of production are utilized in the best combination (Battese and Coelli, 1995). Factors of production like land, labour and capital need to be used more efficiently in order to maximize production (Battese and Coelli, 1995; Djomo and Sikod, 2012). In terms of human capital, more skilled and more educated farmers are thought to have knowledge of utilizing farm inputs to achieve higher efficiency than their counter parts with low literacy and poorly skilled (Djomo and Sikod, 2012). This is an indication that human capital is important in enhancing farmers' production efficiency.

Social capital is also thought to have an effect on technical efficiency through exchange of skills, availing group labour, and easing access to farm inputs and implements which are combined in a manner that maximises output. Several studies including Kelemework (2007), Haji (2008), Kibirige (2008), Tshilambilu (2011), Djomo and Sikod (2012) have reported that human capital (farmers' formal education level, access to extension services and trainings) and social capital (mainly farmer group membership) have a significant impact on technical efficiency. Entrepreneurial spirit and positive psychological capital are also key in promoting improved technical efficiency through innovation, and availing financial capital and time. Innovation and adoption of new technologies like use of fertilizers, pesticides and improved seeds have been found to significantly affect the level of technical efficiency (Kibirige, 2008; Tshilambilu, 2011). Technical efficiency is also

affected by farmer's goal and aspiration through farmer's decisions on whether to invest more inputs to produce output enough to meet his/her goals (Padilla-Fernandez and Nuthall, 2011).

3.8.3 Summary of the effects of Human dimension on smallholder agricultural commercialization

Jaleta *et al.* (2009) indicated that human capital is essential in smallholder commercialization of agriculture. The contribution of human capital to smallholder commercialization of agriculture can be viewed in terms of farmer's skills and capabilities to adapt to and exploit new opportunities for profit maximization. More literature availed by Jaleta *et al.* (2009) revealed that institutions and institutional arrangements which form part of the social capital significantly affected commercialisation of subsistence agriculture. Formal institutions including property rights, constitution, rules and regulation play a key role in commercialization of agriculture (Jaleta *et al.*, 2009). For example, in the Eastern Cape, unclear land ownership, may lead to low investment in agriculture resulting in production and low market participation (Sishuta, 2005; Kodua-Agyekum, 2009). Farmer's goals and aspiration differ from one to another. Whereas some farmer's goals target increased production for market surplus, others produce for home consumption (Padilla-Fernandez and Nuthall, 2001; Aliber *et al.*, 2009). The major objective of entrepreneurs is to maximize profits and thus, the more the farmers' entrepreneurial spirit, the more level of commercialization attained (Modiba, 2009; GEM, 2011). Smallholder farmers with high entrepreneurial spirit are thought to produce more marketable surplus and this becomes a driving force towards commercialization (Modiba, 2009).

3.9 Chapter Summary

This chapter was devoted to the discussion of the possible human dimensions that need more attention when formulating programmes aimed at improving farmers' productivity, self-Sustenance, increased food security and household incomes. Among others, farmers' human dimensions include human capital, social capital, entrepreneurial spirit and positive psychology, and goals and aspiration. Farmers with more human capital like education and training adopt and use new technologies more efficiently. For example they can read and measure the recommended quantities of fertilizer, pesticide and herbicide which results in better yields. The positive attributes of social capital towards production efficiency include

enhancing sharing of skills, knowledge and information, mobilisation and coordination of resources, and eases access to farm inputs and implements. Motivational aspects of social capital include improved access to markets, improved access to services like trainings, and spreading of risks among group members. Working towards achieving goals and aspiration with confidence, optimism, hope and resilience attitude coupled with innovations and risk taking contribute greatly in enhancing the entrepreneurial capital and positive psychological capital,, needed for farmers' efficient use of resources.

Another aspect explained in this chapter is the role of commercialisation of agriculture in economic development in developing countries. Large scale commercial agricultural crop production was introduced by European during the colonial era in most developing countries. Literatures indicate that commercialisation of agriculture led to the development of infrastructure and introduction of cash crops of which up-to-date are still a major contributor to the national GDP in most developing countries (like coffee export from Uganda and tea export from Kenya). During post-independence, most of these large-scale commercial farms have not been sustained because of insufficient management and operational skills, lack of resources and fluctuating prices of especially non-consumable products. Most African farmers resorted to smallholder subsistence farming which yields less marketable surplus not enough to lift them out of poverty. The question still stands to whether famers' human dimensions necessarily contribute to a sustainable and efficient use of the state provided inputs subsidies and other support for increased productivity and smallholder commercialisation level.

CHAPTER 4

AGRICULTURAL PRODUCTIVITY AND PRODUCTION EFFICIENCY

4.1 Introduction

Since the aim of this study is to assess the performance of smallholder farmers' production and factors influencing their productivity, it will be useful if some light is thrown at the outset on the production theory and the recent studies that used the concepts of total factor productivity, marginal factor productivity and partial factor productivity. The chapter presents reviews of these concepts, namely production efficiency, allocative efficiency and technical efficiency theories and their measurement as a platform for a better understanding of the analytical methods of this study. Further, the study describes the two methods used in estimating technical efficiency and these include the Stochastic Production Frontier (SPF) and the Data Envelopment Analysis (DEA) approaches. Recent studies estimating production efficiency using SPF and DEA are also explained in this chapter. The chapter concludes with the theoretical framework and conceptual framework relevant for the study.

4.2 Production Theory

In developing countries, most agricultural related policies are strived to increase production enough to avail more marketable surplus to boost rural economic growth and alleviate poverty (Eicher and Staatz, 1985). Agricultural production can be defined as the economic process of converting inputs into outputs or broadly as, all economic activity other than consumption (Doll and Orazem, 1984) Agricultural production uses resources (tangible and intangible) or inputs to create goods or services needed for use, or exchange in the agricultural market economy. The action of creating can be termed as production process. Production process can be defined as any activity driven by increased demand for goods and services, and the quantity, form, shape, size and distribution of these items available to the market place. Production is a process, and as such it occurs through time and space, and thus measured as a rate of output per period of time and this process includes manufacturing, storing, packaging and transporting of goods and services (Doll and Orazem, 1984).

According to Doll and Orazem (1984), the resources and inputs are referred to as factors of production in the production theory and the traditional factors of production include raw materials, machinery or implements, labour services (includes the human dimensions), capital goods (includes finances) and land (Soils and Water). Further, these factors are divided into fixed and variable factors. Fixed factors include land, machinery/implements and sometimes managerial personnel whose quantity cannot readily be changed. The variable factors of production are those whose usage rate can be changed easily and they include energy consumption like fuel and electricity, and most raw material inputs. The labour services and management are much dependent on the human and social capital, goals and aspirations, positive psychological capital and market related activities like entrepreneurship. Human dimensions are embedded in the inputs used in production processes and through management enhance the way inputs are combined and utilized (Padilla-Fernandez and Nuthall, 2001; Bailey, 2007). The major objective of most farmers/producers is to use resources/ raw materials/input in the most optimal way that maximizes the number of outputs produced.

The mathematical presentation of input-output relationship include total product (T.P) (or total physical product (TPP)), average product (A.P) (or average physical product (APP)) and marginal product (M.P) (or marginal physical product (MPP)) of a variable input. The T.P mainly identifies amount of outputs that are possibly produced using various levels of the variable input. The average physical product is estimated as total production divided by the number of units of variable used $APP = f(Y/X)$ (or ratio of output to variable input). Marginal physical productivity of a variable input is the change in total output due to a one unit change in the particular variable input while holding all other inputs constant ($MPP = dy/dx$ (the derivative of the production function)).

4.3 Graphical Presentation of the Production Function/T.P, APP and MPP

Total physical product (TPP), average physical productivity (APP) and marginal physical productivity (MPP) can be presented in form of charts that lists the output level corresponding to various levels of input, or a graph that summarizes the data into a total physical product curve sometimes referred to as the production function, APP curve and MPP curve respectively. Other assumptions of the curves include, all points above the production function are unobtainable with current technology, all points below are technically feasible, and all points on the function show the maximum quantity of output

obtainable at the specified level of input usage (Doll and Orazem, 1984). Using a single variable input the curves can be presented graphically as shown in Figure 4.1.

The production function is presented by the curve that passes through the origin, points A, B, and C. The rising of the curve, indicates increasing quantity of output for any additional units of inputs used and beyond point C, when the total output starts to decline, employment of additional units of inputs produces no additional output and it is an indication that the variable input is being used too intensively. The use of too much variable input relative to the available fixed inputs, results into negative marginal returns to variable inputs, and diminishing total returns as experienced by the farm/firm. Beyond point Z and C, the farm experiences the negative marginal physical product curve (-MPP) and the declining production function as illustrated in Figure 4.1.

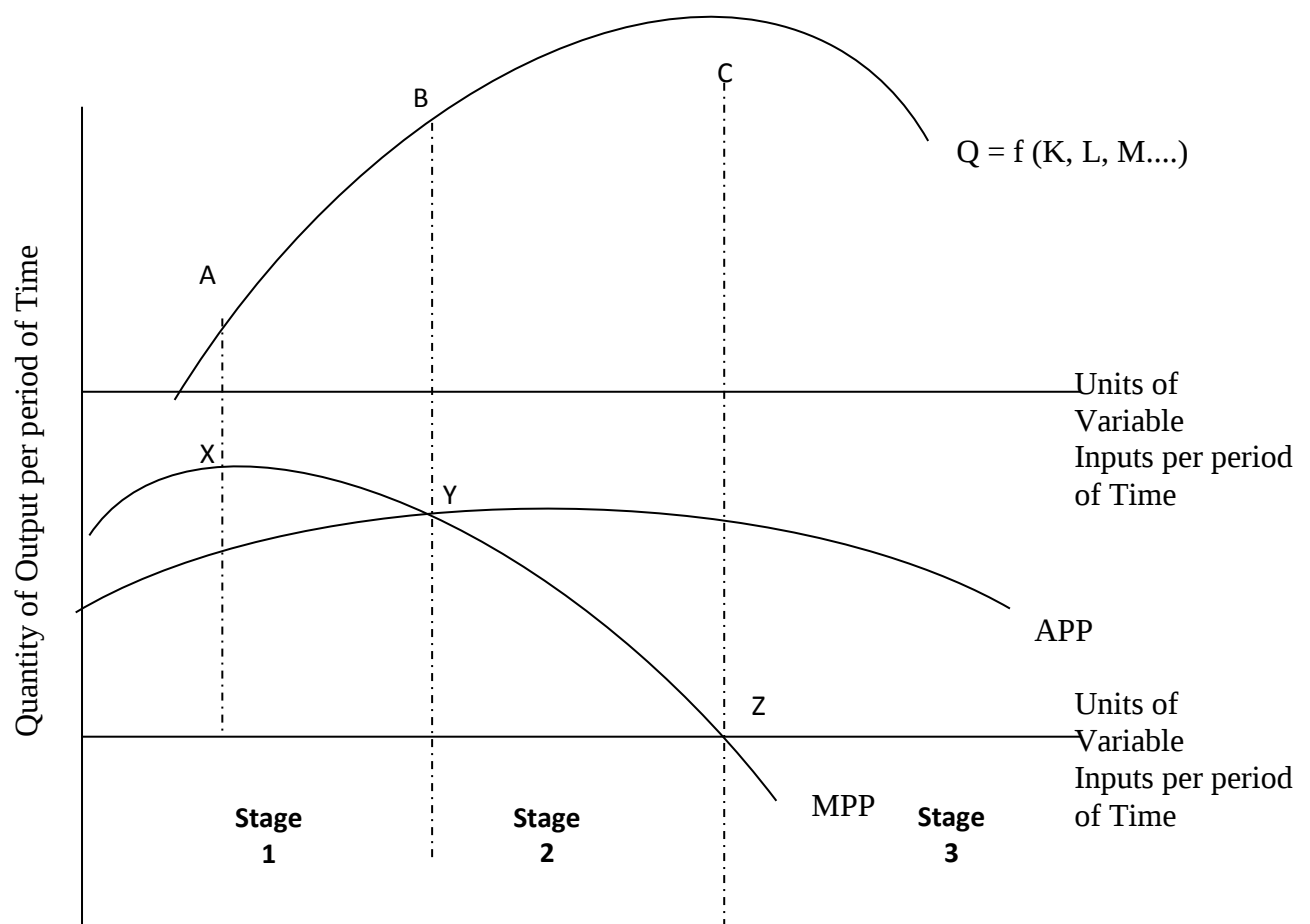


Figure 4.1 Typical Production Function, APP and MPP Curves
Source: Doll and Orazem (1984)

Based on Figure 4.1, part of the curve between the origin and point A, the firm experiences increasing returns to variable inputs and thus, as more inputs are employed, output increases at an increasing rate. Also, between the same points, both marginal physical product (MPP) and average physical product (APP) are rising. Point A on the production function curve and point X on the MPP curve they define the points beyond which there is diminishing marginal returns. Between point A and C, the firm experiences positive but decreasing marginal returns to the variable input. Thus, as additional units of the input are employed, output increases but at a decreasing rate and beyond points B on the production function curve and point Y on the APP curve, the farm/firm experiences diminishing average returns. At point B the farm/firm experiences maximum average physical product because it is just tangent to the steepest ray from the origin.

Based on the illustration, therefore, the production function can be divided into three stages. The first stage is characterised by, output increases at an increasing rate with additional unit of input employed (from the origin to point B), thus small quantities inputs results in more than double output production. Unfortunately, the price taking farms/firms like rural poor smallholder farmers normally operate beyond this point yet the farms/firms faced with declining/low demand of its goods would prefer operating within stage 1. The second stage is characterised by output increases at a decreasing rate and the average physical product are declining. Further, in this stage, employment of additional unit of variable inputs increases output per additional unit of fixed inputs employed and in this stage; price-taking farms/firms like most rural poor smallholder farmers will achieve optimal input/output combination in stage 2. Stage 3 can be described as the diminishing returns stage where excess use of variable input with available fixed inputs results into declining output throughout the production function and the MPP curves as shown in Figure 4.1.

Following the production theory, agricultural productivity is measured as the ratio of agricultural outputs to agricultural inputs. It can be measured in different ways that include partial, multifactor and total productivity. Partial factor productivity is the amount of output per unit of a particular input, and multifactor productivity (MFP) and Total factor productivity (TFP) are ratios of total agricultural output to a subset of agricultural inputs. MFP and TFP measurements consider aggregated factors such as, new technologies, economies of scale, managerial skill, and changes in the organization of production in

agriculture. Although, TFP is most preferred to MFP to estimate productivity because of its ability to encompass all factors involved in producing an output, it is more complex and therefore, MFP is used as an approximation of TFP. However, direct computation of MFP in most cases is faced with difficulties of aggregating different physical forms of output and input quantities (Mass or Volume) and this can lead to distortion of results if deflations in actual measurements are engineered (Ramaila *et al.*, 2011). Therefore, to overcome this, different studies have employed indices to generate results. Such indices include the Laspeyres, Tornqvist-Theil, Paasche, Malmquist and Fisher indexing methods. However, each index estimation method has its own advantages over the other (Ramaila *et al.*, 2011).

Ramaila *et al.* (2011) cited Liebenberg *et al.* (2010) indicating that the most used indexing method by OECD countries was the Fisher indexing method because it does not require logarithmic conversions and aggregation of underlying data when inputs are used in the later stage of the base year. However, most recent studies in South Africa have been employing the Tornqvist-Theil indexing method which requires compound price and quantity indices of Laspeyres type as a proxy for prices (Ramaila *et al.*, 2011). This method is said to be unrealistic because it uses natural log estimates, and it becomes impossible when the values turn negative generated during inventory changes. Further, the method calls for aggregated data when inputs/outputs are used in the later stage than the base year. Most studies employing these methods mainly concentrate on the use of tangible/material inputs like land, capital and labour and less attention is given to the intangible human dimensions that play a greater role in agricultural productivity.

4.4 Studies that Used the Concepts of TFP, MFP and Partial Factor Productivity

Ramaila *et al.* (2011) cited Chang *et al.* (2001) who reported to have used the TFP and the partial factor productivity functions to estimate the impact of increased agricultural productivity through increased investment in physical and human capital for more efficient and improved sustainable food security in Asia and the Pacific. According to the study results, agricultural output growth had remained positive from 1961 to 1994 and labour productivity growth was the only sure way to increase agricultural productivity. Also, Kiani *et al.* (2008) used total factor productivity to estimate the relationship between productivity and agricultural research expenditures of Pakistan between years 1970 and 2004. For easy aggregation of inputs and outputs of different forms and prices, a

Tornqvist-Theil index method was used for measuring total factor productivity of horticulture crops. Generated results indicated a positive trend of agricultural average output growth rate of 2.2% over time.

Using available data sourced from previous studies, Wiebe *et al.* (2001) analysed the impact of agricultural policies and investment on productivity in Southern Africa and in particular Zimbabwe and South Africa. Generated results from this study indicated an increase in land productivity in the two countries. This may be partly attributed to land reforms (Ramaila *et al.*, 2011). Furthermore, results indicated increasing labour productivity in South Africa and decrease labour productivity in Zimbabwe. The study recommended that more investment in infrastructure, human capital and research should be considered for a more vibrant commercial agriculture in South Africa. TFP studies in South Africa have been carried by different groups of researchers which include Kirsten and Vink (2003) who used South Africa commercial agricultural aggregated data ranging from year 1947 to 1996, Thirtle, Piesse and Gouse in 2005, and Conradie, Piesse and Thirtle (2009) who used commercial agricultural aggregated data ranging from year 1952 to 2002. Results from all these studies indicated a general agricultural output growth and productivity. Further, all TFP studies reported an increase in the labour input use due to increased import taxes imposed on machinery and credit policies that made human labour input more cheap to use than sophisticated farm mechanization.

Although TFP studies consider labour's productivity contribution to agricultural output growth, these studies lacked in-depth or embodied attributes of human dimensions in stimulating labour efficiency for improved agricultural productivity. These studies only considered the numerical numbers of people as a measure of labour productivity. Since labour productivity has been identified as one of the crucial factors for improved commercialization of agriculture in South Africa there is a need to understand the intrinsic human dimensions that can result to the best functioning of this input for increased agricultural output growth (Wiebe *et al.*, 2001). Increased agricultural output growth is vital for most agro-based industries whose raw materials are primary agricultural products. Thus, a decline in agricultural growth may result into a decline in agro-based industrial growth and other economic activities that are linked to agriculture (Poonyth, Hassaan, Kirsten and Calcaterra 2001).

4.5 The Most Used Types of Production Function

The basic generalised production function can be presented mathematically as follows:

$$Q = f(X_1, X_2, X_3 \dots X_n) \dots \dots \dots (1)$$

Where Q = Quantity of output produced by a given farm/firm

$X_1, X_2, X_3 \dots X_n$ = Quantity of factor inputs (e.g. land, labour, capital, water, fertilizers, herbicides, and pesticides etc.)

1) One formulation, unlikely to be relevant in practice, is as a linear function:

$$Q = a + bX_1 + cX_2 + dX_3 + \dots \dots \dots (2)$$

Where, a, b, c, and d are parameters estimated empirically.

Constant Elasticity of Substitution (CES)

$$Q = A [\alpha X_1^\gamma + (1-\alpha)X_2^\gamma]^{1/\gamma} \dots \dots \dots (3)$$

Where: Q = Quantity of output, A = Constant, α = Random error term, γ = Elasticity coefficient, and X = quantities of inputs.

A Cobb-Douglas production function: (imperfect Substitution of inputs)

$$Q = AX_1^\alpha X_2^{1-\alpha} \dots \dots \dots (4)$$

Where: Q = Quantity of output, A = Constant, α = Random error term and X = quantities of inputs.

2) Translog (generalised linear Cobb Douglas production function)

$$\ln(Q) = \ln(A) + aX_2 * \ln(X_2) + aX_1 * \ln(X_1) + bX_2 X_2 * \ln(X_2) * \ln(X_2) + bX_1 X_1 * \ln(X_1) * \ln(X_1) + bX_2 X_1 * \ln(X_2) * \ln(X_1). \dots \dots \dots (5)$$

Where: ln = natural log, Q = Quantities of output, X = quantities of inputs, a and b are parameters to be measured.

3) The Leontief production function

$$Q = \text{Minimise } (aX_1, bX_2 \dots) \dots\dots\dots(6)$$

This production function applies to situations in which inputs must be used in fixed proportions; starting from those proportions, if usage of one input is increased without another being increased, and the output is held constant.

4.6 Production Efficiency

Padilla-Fernandez and Nuthall (2001) cited Farrell (1957) defining efficiency as the ability to produce a given level of output at the lowest cost. Efficiency can be divided into two concepts, the technical and allocative efficiency. Technical efficiency is the ability of the farm to produce a maximum level of output given a similar level of production inputs. Allocative efficiency literally can be defined as generating of output with the least cost of production to obtain maximum profits. Economic efficiency is a product of both allocative and technical efficiency and it is achieved when the producer combines resources in the least combination to generate maximum output as well as ensuring least cost to obtain maximum revenue (Chukwuji, *et al.*, 2006). In order to promote commercialization of agriculture from subsistence farming, farmers therefore, need to be both technically and allocatively efficient (Kibirige, 2008).

4.6.1 Allocative Efficiency

Farrell (1957) defined allocative efficiency as the ability of a firm to choose the optimal combination of inputs given input prices. According to Inoni (2007) allocative efficiency can be defined as a measure of how an enterprise uses production inputs optimally in the right combination to maximize profits. Thus, the allocatively efficient level of production is where the farm operates at the least-cost combination of inputs. Based on current researches there are several new methods that can be used to estimate allocative efficiency. The most employed method of estimating allocative efficiency has been dependent on the input and output prices. Due to the significant importance of the input and out prices in the estimation of allocative efficiency, Farrell (1957) called it price efficiency (Badunenko *et al.*, 2006). The output-oriented distance to the frontier in a profit-technical efficiency space is among the new methods that can be used to estimate the allocative efficiency without using the input price. Badunenko *et al.* (2006) used the method using the Data

Envelopment Analysis (DEA) for the new output-oriented distance to the frontier in profit-technical efficiency space and compared results with frontier analysis that uses the input prices (traditional method), and both methods yielded highly correlated results.

Although allocative efficiency was among the top listed issues on the main agenda of many economists, most studies were devoted to technical efficiency estimation and gave less attention to allocative efficiency (Badunenko *et al.*, 2006). The less concentration on allocative efficiency was mainly attributed to the hardships of accessing information that contain input prices yet they were the major drivers of the traditional allocative efficiency estimations. This called for an alternative method that did not require input prices which gave birth to the output-oriented distance to a frontier in a profit-technical efficiency space method which exclusively depends on quantities and profits (Badunenko *et al.*, 2006). In the output-oriented distance to a frontier in a profit-technical efficiency space methods, evidently results indicates that as output increases also profits and technical efficiency increase. Thus, if farmers are allocatively and technically efficient then they can use the available resources to achieve high yields coupled with increased profits and hence transit from subsistence to commercial farming.

Chukwuji *et al.* (2006) stated the assumptions used by farmers to allocate resources for profit maximization and these include; farmers choose the best combination (low costs) of inputs to produce profit maximizing output level; there is perfect competition in input and output markets; producers are price takers and assumed to have perfect market information; and all inputs are of the same quality from all producers in the market. Under a perfectly competitive market, an extra revenue (Marginal Value Product) generated from the employment of an extra unit of resource must be equal to its unit cost (Marginal Cost = Unit price of Input) (Chukwuji *et al.*, 2006). Hence, $MVP = MC$ relationship should be achieved. When $MVP > MC$, then the resource is said to be underutilized, and thus more of that resource/input units should be used to maximise profits and if $MVP < MC$ then the resource is said to be over utilized and hence calling for reduction in use of that resource in order to maximise profits (Chukwuji *et al.*, 2006).

Some examples of studies that estimated allocative efficiency among farmers include a study carried out by Inoni (2007) who estimated the efficient resource allocation in pond fish production in Delta State of Nigeria. Results revealed that farmers' allocative

efficiency of pond size, fish feeds, fingerlings, labour and fixed costs used was 3.22, 0.0025, 0.00064, -0.00017, and 0.00025, respectively. Based on these results, fish farmers in Delta State of Nigeria were said to be allocatively inefficient in all resources because 3.22 efficiency of the pond size is greater than one and above the optimal ($MVP > MC$), indicating that it was being under-utilized. Other resources used in fish farming were said to be over-utilize. This called for the reduction on the use of fish feeds, fingerlings, labour and fixed costs in order to achieve optimal resource allocation for increased revenues and net returns.

In 1997, Bravo-Ureta *et al.* carried out a research to estimate the economic, technical and allocative efficiencies of peasant farming in the Dominican Republic. Their findings indicated that farmers were 0.44 allocatively efficient. These results were compared with Pakistan wheat and maize farmers and Paraguay peasant farmers, respectively. Results regarding Paraguay peasant farmers indicated that they were more allocatively efficient with 0.70 and 0.88 efficiency in wheat and maize production respectively compared to their counterparts in Dominican Republic. Pakistan wheat and maize farmers were found to be 0.43 allocatively efficient which is closer to Dominican Republic peasant farmers. In a study carried out by Chukwuji *et al.* (2006) to determine allocative efficiency of broiler production in Delta state of Nigeria, results indicated that farmers were under-utilizing resources since marginal value product was greater than marginal costs or unit price of inputs ($MVP > MC$). Stock size scored the highest allocative efficiency value of 24.9, followed by feed expenses (24.8), fixed capital (11.9) and variable expenses (-4.6), respectively. Therefore, these farmers needed to increase on the quantity of these inputs in the least cost combination in order to maximize profits.

4.6.2 Technical Efficiency

Technical efficiency is the process of using available resource in the best combination with an objective of maximizing output (Battese and Coelli, 1995). Esparon and Sturgess (1989) described technical efficiency as efficiency in relation to factor-product transformation. For a farm to be technically efficient, it has to produce at the production frontier level. However, this is not always the case due to random factors such as bad weather, animal destruction and/ or farm specific factors, which lead to producing below the expected output frontier (Battese and Coelli, 1995). Although it is related to productivity where

inputs are transformed into outputs, technical efficiency estimation provides better results in identifying the best performing firm among a given set of firms compared to the average productivity estimates (Battese and Coelli, 1995). Furthermore, efficiency measurement provides an opportunity to separate production effects from managerial weakness (Ogundari and Ojoo, 2005).

4.6.3 Technical Efficiency Measurement

Technical efficiency can be measured using both, parametric (stochastic frontier estimation) and non-parametric (Data Envelopment Analysis (DEA)) methods. The stochastic frontier is where the deviation from the frontier is attributed to the random component reflecting measurement error and statistical noise, and an inefficiency component (Ogundele and Okoruwa, 2006). The stochastic frontier method can be a good measurement of performance because of its advantage of incorporating the random error of the regression. The random error therefore captures the effect of unimportant left out variables and errors of dependent variables as well as the farm specific inefficiencies. It provides the farm efficiency estimates with much lower variability than any other method due to the error term decomposition (Neff *et al.*, 1994). Because of its ability to decompose errors, this method of estimation is reported to be superior to others. A widely used Cobb-Douglas production is linearized and used to estimate the technical efficiency (Stochastic frontier) and allocative efficiency (Ogundele and Okoruwa, 2006).

4.6.3.1 The Stochastic Frontier Analysis

The stochastic frontier is a linearized Cob-Douglas production function and can be expressed mathematically as;

$$\ln(Y_i) = \beta_0 + \sum_i \beta_i \ln X_{ij} + \varepsilon_i \dots \dots \dots (7)$$

Where $\ln$ is natural logarithm, Y_i is output of the i farmers, β_0 is a Constant, β_i is a Coefficient, X_{ij} is the j input used by farmer i , ε_i = a “composed” error term.

The “composed” error term (ε_i) is the essential component that distinguishes the stochastic frontier model from other models (Sharma and Leung, 2000; Bravo-Ureta and Pinheiro 1997; Rahman, 2003; Chavas *et al.*, 2005). The Composite error term (ε_i) can be rewritten as;

$$\varepsilon_i = v_i - u_i \dots\dots\dots(8)$$

but $I = 1, \dots, n, n=158$

When ε_i is substituted by $v_i - u_i$, then equation (7) is rewritten as;

$$\ln(Y_i) = \beta_0 + \sum_i \beta_i \ln X_{ij} + v_i - u_i \dots\dots\dots(9)$$

Where the efficient component v_i is a two-sided ($-\infty < v < \infty$) normally distributed random error ($v \sim N[0, \sigma_v^2]$) that captures the stochastic effects outside the farmer's control (e.g., weather, natural disasters, and luck), measurement errors, and other statistical noise. The efficiency component u_i is a one-sided ($u > 0$) and measures the shortfall in output Y from its maximum value given by the stochastic frontier $f(X_i; \beta_i) + v$. We assume u has an exponential distribution [$U \approx N(0, \sigma_u^2)$]. The two components v and u are also assumed independent of each other. The parameters are estimated by the maximum likelihood method following Bravo-Ureta and Pinheiro (1997) and Bi (2004). If the efficient component u_i takes on a half-normal distribution then equation (7) above can be rewritten as;

$$\ln(Y_i) = \beta_0 + \sum_i \beta_i \ln X_{ij} + v_i \dots\dots\dots(10)$$

Following Jondrow *et al.* (1982), in addition to the half-normal distribution, the assumption of conditional distributional error term coupled with the assumed independence of efficient components v_i and u_i should be satisfied when using a stochastic frontier. If all assumptions are satisfied, then the conditional mean of u_i given ε_i is defined as;

$$E(u_i | \varepsilon_i) = \delta_* \left[\frac{f^*(\varepsilon_i \lambda / \delta)}{1 - F^*[\varepsilon_i \lambda / \delta]} - \frac{\varepsilon_i \lambda}{\delta} \right] \dots\dots\dots(11)$$

Where $\sigma^{*2} = \sigma_u^2 \sigma_v^2 / \sigma^2$, f^* = the standard normal density function, F^* = the distribution function, and $f^* = F^* = \lambda \varepsilon / \sigma$

Technical efficiency of a single farm is specifically defined as;

$$TE_i = \exp(-\hat{u}_i / \sum_i \beta_i) = \exp(-E(u_i | \varepsilon_i) / \sum_i \beta_i) \dots\dots\dots(12)$$

The estimates for v and u are derived by replacing ε , σ^* , and λ in equations (7) and (10). Then the stochastic frontier is estimated by subtracting v_i from both sides of equation (9).

$$\ln(Y_i^*) = \beta_0 + \sum_i \beta_i \ln X_{ij} - u_i = \ln(Y_i) - v_i \dots\dots\dots(13)$$

$$\text{Thus, } \ln(Y_i^*) = \beta_0 + \sum_i \beta_i \ln X_{ij} + v_i - u_i = \ln(Y_i)$$

Where $\ln(Y_i^*)$ is the observed output of the farm i which regulates the statistical noise contained in v_i , and Y_i is the corresponding frontier output. Explicitly, for an individual firm, technical efficiency is defined in terms of the ratio of the observed output to the corresponding frontier output and it can be expressed as;

$$TE = \frac{Y_i}{Y_i^*} \dots\dots\dots (14)$$

4.6.3.2 The Data Envelopment Analysis (DEA) Modelling

The non-parametric method of estimating efficiency includes the Data Envelopment Analysis and the Free Disposal Hull (FDH) (Kibaara, 2005). The DEA is based on the notion that a production unit employing less input than another to produce the same amount of output is more profitable. The DEA approach applies the linear programming method where a series of equations is used to construct linear production frontiers (Lemba *et al.*, 2012). Thus, production frontier functional assumptions play less or no roles when using this method. The first DEA models were deterministic but have been modernized by including the stochastic characteristics (Khai *et al.*, 2008).

The DEA has some advantages over the parametric approaches (Speelman *et al.*, 2007). Firstly, since it uses linear programming and constructed series of equation there is no need for assumptions set for a DEA production function. The method also gives an allowance for comparing different production frontiers in terms of a performance index. Also, efficiency estimate is not affected significantly when using small sample size. Finally, the DEA gives the freedom of determining efficiencies of the sub-vectors, for example specifying a target resource use, unlike the stochastic production frontier (Speelman *et al.*, 2007).

4.6.4 Recent Studies Estimating Production Efficiency using DEA and SFA

According to Khai *et al.* (2008), most smallholder farmers in developing countries have failed to optimise fully the potential of technology. This may be due to inefficient

decisions made when using these technologies leading to low productivity. These technical inefficiencies may be attributed to several factors that include socioeconomic, institutional and management. Further, these factors can be split into household education, farming experience, age of the farmer, farm size, non-farm employment, and access to extension service, credit constraint, institutional constraint, farm assets and membership of farmer associations, among others. Several studies have been carried out to estimate technical efficiency and its determinants.

On estimating a trans-log production function to determine technical efficiency differential between small and medium scale tobacco farmers in Uganda, Obwona (2000) found out that credit accessibility, extension service access and farm assets contributed positively to technical efficiency. The differences in efficiency between farmer groups were explained with only socio-economic and demographic factors. Mubarik *et al.* (1989) used profit efficiency and Ordinary Least Squares (OLS) models estimations to establish the inefficiency and factors causing inefficiency among Basmati rice growers in Pakistan. Results indicated that, generally these farmers were inefficient between 5 and 87%. Socio-economic factors like household education, non-farm employment and credit constraint and institutional constraint were found to have an impact on the farmer's efficiency. Institutional constraints identified were late delivery of fertilizers and thus late planting which impacted on the technical efficiency of farmers. Studies carried out by different researchers like Ogundari and Ojoo (2005), Padilla-Fernandez and Nuthall (2001), and Obwona (2000) indicated that age, farming experience, extension service access and farm assets contributed to farmer's inefficiency.

In year 2005, Kibaara estimated the technical efficiency in Kenya's maize production using a stochastic frontier approach and reported that the mean technical efficiency of Kenya's maize production was 49%. The research further estimated the determinants of technical efficiency and these included the farmer's years spent in school (formal education), age of the household head, health of the household head, gender of the household, use or none use of tractors and off-farm income.

In their study to estimate production efficiency of soybean production in the Mekong River Delta of Viet Nam, Khai *et al.* (2008) found out that governmental policies like fertilizer, pesticides, and seed subsidies had a positive and significant influence on TE and EE

function at 20% level. Also, farmer's experience was found to have a positive and significant influence on AE and EE at 20% level. Land size had a positive and significant influence on TE, and a negative and significant influence on AE and EE at 1% level, respectively. The geographical location of farms also had a positive and significant influence on TE at 10% level. However, government policies and farmer's experience significant impact were not considered important because of the assumed large error estimation (20% level or confidence interval of 80%). These results were generated using a stochastic frontier function.

A study carried out by Kelemework (2007) compared farmers' technical efficiency of irrigators and non-irrigators in two selected areas in Ethiopia. Although many studies have attributed access to irrigation water as a major contributor to improved farmer's production efficiency, the inverse was found to be true for Doni and Godino irrigation scheme community. Results indicated that the mean efficiency of farmers of Doni and Godino irrigation schemes was 0.556 whereas dry-land farmers in the same locality had a mean technical efficiency of 0.798. However, Batu Degaga irrigators were more technically efficient at 0.76 compared to the dry-land farmers whose mean efficiency was estimated at 0.656. The determinants of farmer's technical efficiency included gender, agricultural advices/extension services, off-farm income and the location of farms on the watercourse.

Haji (2008) carried out a research to establish the economic efficiency and marketing performance of vegetable production in the eastern and central parts of Ethiopia. The study employed the data envelopment analysis (DEA) and Tobit regression models to estimate the technical, allocative and economic efficiency and factors affecting thereof. Results of the study indicated that farmers were technically efficiency (0.91), but allocatively and economically inefficient at 60% and 56% level, respectively. Determinants of farmers' technical efficiency included household size, value of asset owned, farm size, extension services and off-farm incomes. Extension services exhibited a negative relationship with technical efficiency. Allocative and economic efficiency were found to be significantly influenced by asset owned, farm size, consumption expenditures, and crop diversification. Consumption expenditure and crop diversification were found to have a negative and significant relationship with both allocative and economic efficiency of vegetable farmers in the selected study areas.

According to the study carried out by Bifarin *et al.* (2010), results indicated that plantain farmers in Ondo State of Nigeria averagely were 61% technically efficient, 57% allocatively efficient and 35% economically efficient. The factors responsible for technical, allocative and economic efficiency included, age which had a positive and significant impact on technical and economic efficiency. Access to extension service was found to have a positive and significant impact on technical efficiencies. Farmer's experience and extension services had a positive and significant influence on efficiency of plantain farmers in Ondo State of Nigeria. Bifarin *et al.* (2010) used the stochastic frontier to execute their results.

Kibirige (2008) carried out a study aimed at analysing the impact of Agricultural Productivity Enhancement Programme (APEP-USAID) on technical and allocative efficiency of maize farmers in Uganda. The study used a stochastic frontier to estimate technical efficiency and robust standard error OLS model to estimate the determinants of technical efficiency. Results generated from this study indicated that, on average, 57% of these farmers were operating above 60% technical efficiency. Positively and significantly related factors to technical efficiency included; group membership, household size, respondent's spouse education level in years and respondent's spouse major occupation and variety of seed planted. Selling at the farm gate had a negative and significant relationship with technical efficiency. Also, farmers who belonged to APEP groups were reported to be allocatively more efficient than non-APEP members, especially in utilizing improved seed (allocative efficiency scores for seeds were 0.92). .

Using a Cobb-Douglas production stochastic frontier and logistic regression model, Tshilambilu (2011) found out that small-scale maize farmers in Ga-Mothiba in Limpopo of South Africa were technically inefficient due to several socio-economic factors. The socio-economic factors that significantly affected technical efficiency of maize farmers in Ga-Mothiba included household size, level of education, farming experience, household monthly incomes, farm size, cost of hiring a tractor, fertiliser use, use of hybrid maize seeds, and membership to farmer groups, and farmer's perception on maize profitability. Household size, tractor hiring costs, use of hybrid maize seed, and farmer's perception on maize profitability had a negative influence on technical efficiency of smallholder maize farmers in the study area.

In their study to establish the technical efficiency of water use and its determinants among small-scale irrigation schemes in North-West Province of South Africa, Speelman *et al.* (2008) reported that farmers generally were technically efficient at 49% under Constant Returns to Scale (CRS) and 16% efficient water use under Variable Returns to Scale (VRS), respectively. Thus, farmers were operating at low technical efficiency and had a potential of improving their water use efficiency by 84% for increased productivity when using the same available technology. Determinates of water use efficiency included farm size, landownership, fragmentation, the type of irrigation scheme, crop choice and the irrigation methods applied.

Most studies mentioned (Kelemework, 2007; Haji, 2008; Kibirige, 2008; Tshilambilu, 2011) have some elements of human capital (Education, experience, training/extension services accessibility) and social capital which was mainly presented in form of group membership. Thus, human capital and social capital are crucial intangible factors needed for improved production efficiency which in turn result into increased productivity. Ramaila *et al.* (2011) acknowledged that, there are few studies carried in South Africa to estimate production efficiency especially among smallholder farmers. This was mainly attributed to the scarce information in the national statistics related to smallholder farmers' operations. This has created a knowledge gap which needs to be closed for a meaningful policy formulation and implementation to save the stagnant and declining smallholder agricultural production and productivity in South Africa (Aliber and Hart, 2009; Ramaila *et al.*, 2011).

4.6.5 Graphical Explanation of Allocative and Technical Efficiency

Following Kumbhaker and Lovell (2000) the concepts of technical efficiency and allocative efficiency can be presented graphically as shown in Figure 4.2. The graphical explanation in this case used a simplified example of two input (x_1, x_2)-two output (y_1, y_2) production process as shown in Figures 4.2 & 4.3. Figures 4.2, illustrates efficiency estimation in terms of the optimal combination of inputs employed to achieve a given level of output, and this type of approach is called the input-orientation. Figure 4.3, illustrates the second approach of explaining efficiency based on the optimal output that could be produced from a given set of inputs and it is known as the output-orientation.

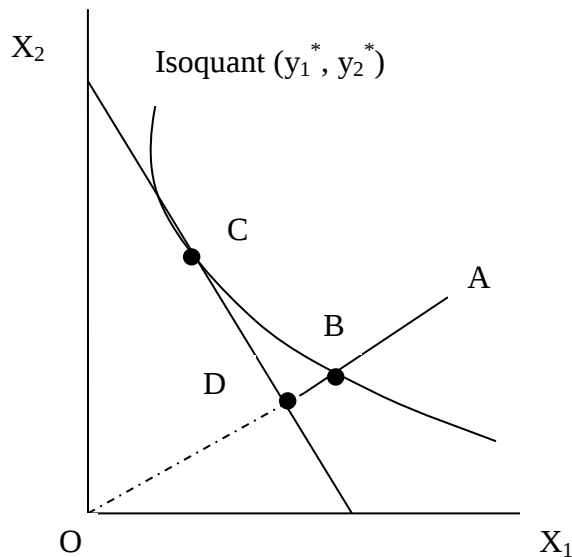


Figure 4.2: Input Oriented Efficiency Measures

Source: Kumbhaker and Lovell (2000)

According to Figure 4.2, Using an input combination defined at point A, the firm produces a given level of output (y_1^*, y_2^*) . The input-oriented level of technical efficiency ($TEI(y, x)$) is defined by OB/OA and can be achieved by radially reducing on (contraction) both inputs (X_1, X_2) used from point A back to point B, when producing the same level of output. Point B lies on the isoquant associated with the minimum level of inputs required to produce (y_1^*, y_2^*) (Isoquant (y_1^*, y_2^*)). The least-cost combination of inputs that produces (y_1^*, y_2^*) is given by point C. At Point C, the marginal rate of technical substitution (MRTS) is equal to the input-input price ratio P_{x2}/P_{x1} . For the farmer to be cost efficient (CE), both inputs use can further be reduced (contracted) to point D when maintaining the same level of input cost. Cost efficiency ($CE(y, x, P_x)$) can therefore be defined by the ratio OD/OA . According to Coelli (1996), resource/input allocative efficiency ($AEI(y, P_{x1}, P_{x2})$) is subsequently given by $CE(y, x, P_x)/TEI(y, x)$, or OD/OB

Summary of Figure 4.1 illustrations;

OB/OA = Input Oriented Technical Efficiency ($TEI(y, x)$) (At point B)

P_{x2}/P_{x1} = Marginal Rate of Technical Substitution (MRTS) (least cost combination of inputs to produce a given output (y_1^*, y_2^*) (At Point C)

OD/OA = Cost Efficiency ($CE(y, x, P_x)$) (At Point D)

OD/OB = Resource/Input oriented Allocative Efficiency ($OD/OA \div OB/OA$) = ($CE(y, x, P_x)/TEI(y, x)$) (At Point D)

Figure 4.3 illustrates the production possibility frontier for a given set of inputs. The output oriented measure of technical efficiency ($TEO(Y, X)$) given by OA/OB can be achieved if the inputs employed by the firm were used efficiently, and when the output (Y_1^*, Y_2^*) produced by the firm at point A, increases (expands) radially to point B. At point B the farm/firm is said to be technically efficient because it is located on the production possibility frontier. Also, higher revenue could be achieved by producing at point C the point where the marginal rate of transformation (MRT) is equal to the output price ratio (P_{Y2}/P_{Y1}). In order to maximize revenue, therefore, there is need to produce more of Y_1 and less of Y_2 . Revenue efficiency ($RE(Y, X, P)$) is represented by point D and can be attained when output at point C is expanded to point D when maintaining the same input and output combination, and $RE(Y, X, P) = OA/OD$. According to Coelli (1996), output allocative efficiency ($AEO(Y, P_{Y1}, P_{Y2})$) can be estimated as $RE(Y, X, P_Y)/TEI(y, x)$, or OB/OD in Figure 4.3.

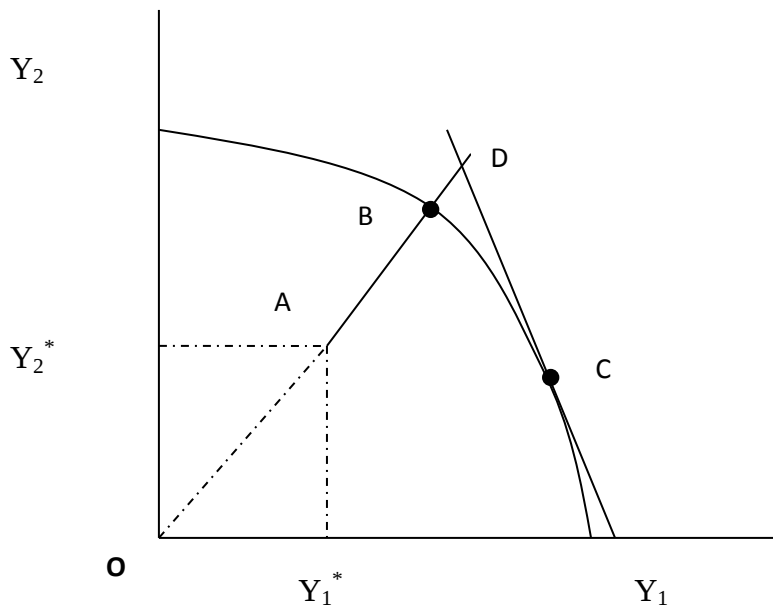


Figure 4.3 Output Oriented Efficiency Measure

Source: Kumbhaker and Lovell (2000)

Summary of figure 4.3 illustration

OA/OB = Output oriented measure of technical efficiency ($TEO(Y, X)$) (At point B)

P_{Y2}/P_{Y1} = Marginal Rate of Transformation (MRT) (Higher revenues achieved at point C)

OA/OD = Revenue efficiency ($RE(Y, X, P)$) (At Point D)

OB/OD = Output allocative efficiency ($AEO(Y, P_{Y1}, P_{Y2})$) = $RE(Y, X, P_Y)/TEI(y, x)$
 $= OA/OD \div OA/OB$.

4.6.6 Graphical Presentation of the CRS and VRS Frontiers

Coelli (1996) provides an explanation of methods for determining returns to scale. In essence, the researcher examines the technical efficiency given different returns to scale, and determines whether or not the observed levels are along the frontier corresponding to a particular returns to scale (Coelli, 1996). The Data envelopment Analysis produces different results depending on the scale assumptions that considered when modelling (Coelli, 1996). There are two scale assumptions generally employed and these are constant returns to scale (CRS), and variable returns to scale (VRS). A variable return to scale includes both increasing and decreasing returns to scale (Coelli, 1996). The CRS reflects the fact that output will change by the same proportion as inputs are changed while the VRS appreciates the fact that production technology varies and exhibit increasing, constant and decreasing returns to scale.

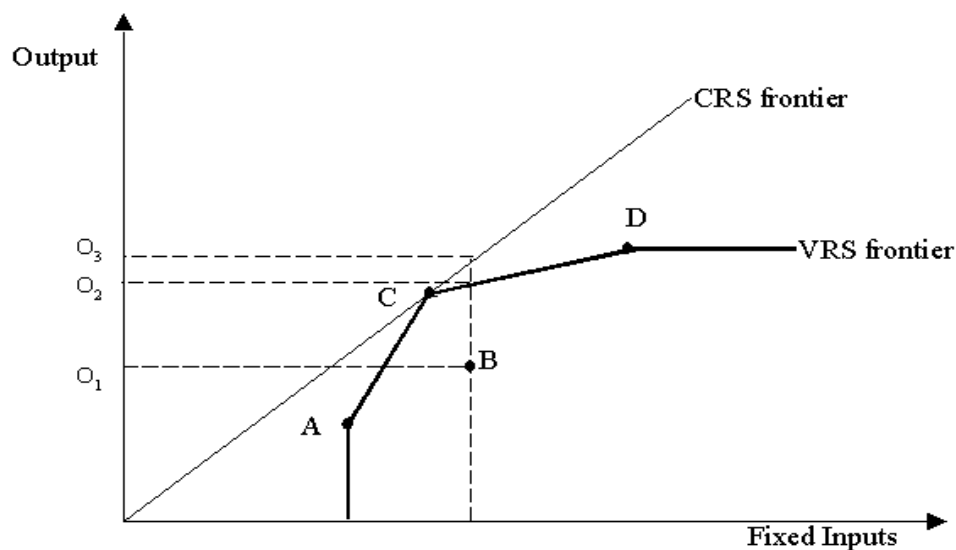


Figure 4.4: CRS and VRS Frontier
Source: Coelli (1996)

Figure 4.4 presents the effect of the scale assumption on the measure of capacity utilization. Four data points namely A, B, C, and D are used to estimate the efficient frontier under both scale assumptions, thus, constant returns to scale (CRS) and variable returns to scale (VRS). Figure 4.4 above considers inputs fixed inputs. The frontier defines the full capacity output given the level of fixed inputs. Considering constant returns to scale (CRS), the frontier is defined by point C for all points along the frontier, with all other points falling below the frontier (hence indicating underutilization). Considering

variable returns to scale (VRS), the frontier is defined by points A, C and D, and only point B lies below the frontier, that is to say, exhibits underutilization. According to Figure 4.4, the variable returns to scale frontier curve is lower than the constant returns to scale frontier curve.

4.7 The Gross Margins

Profit can be defined operationally as the total revenue less total production costs and it is the basic economic measurement of profitability (Doll and Orazem, 1984, Tweeten, 1979). Profitability can be measured using net income, Internal Rate of Return (IRR) to investments and gross margin analysis. Gross margin can be estimated as the return over variable costs, and it is an appropriate measure to compare enterprises that place similar demands for limited resources like farmers. Gross margin is a good measure for short run and annual planning decisions (Castle *et al.*, 1987). According to Norman *et al.* (2002), gross margin refers to the gross income minus the variable costs associated with an enterprise/activity. Gross margin is a simple but a realistic measure of the performance of enterprises.

4.8 Theoretical Framework

Livelihood vulnerabilities for sub-Saharan Africa have been established incontestably. The World Bank suggests that overall, extreme poverty has fallen from 42% of the population in 1990 to about 22% in 2008, but for sub-Saharan Africa, it has risen to about 51% (United Nations, 2008). Hunger is also increasing in Africa and this is worsened by recent food price increases alongside conflicts and poor economic management and corruption among others (Bruinsma, 2010). Evidence exists in the literature that the application of improved technology is one sure way to lift people quickly out of poverty and restore livelihoods to acceptable levels (Eicher & Staatz, 1985). One of the improved technologies particularly relevant for semi-arid settings such as South Africa is irrigation and several authors have confirmed its efficacy (Steduto *et al.*, 2007). However, literature indicates sub-optimal use of smallholder irrigation schemes in South Africa due to farmer poor skills needed to utilize the available technologies (Muchara, 2011). Thus, the existence of these technologies does not guarantee that local people can access them or use them to improve production and productivity (Machethe, 2004).

Most studies have largely used the neo-classical traditions and rational choice models to identify constraints faced by farmers but have been proven inadequate in explaining the large number of uncertainties. The notions of bounded rationality as promoted by the NIE allow for more flexible modelling. Thus, a mix of traditional approaches of technical and allocative efficiencies is used within those frameworks, to come up with more policy relevant conclusions that contribute to sustainable improvement in livelihood.

4.9 Conceptual Framework

The conceptual framework illustrates how government policies can influence availability and farmer's accessibility to productive assets like land and water which in turn are utilized given a favourable environment for agricultural commercial production. Such environment is thought to entail appropriate education and training, efficient financial and product markets, availability of appropriate technologies, research and development transfer, and efficient and flexible labour markets. The high quality human dimensions for increased agricultural productivity, production efficiency and smallholder commercialization include human capital, entrepreneurial spirit and positive psychological capital, farmers' goals and social capital. Increased yields and commercialization of smallholder agriculture is anticipated to improve household wealth and livelihood, improved food security and health, provision of employment and reduce poverty levels among rural communities.

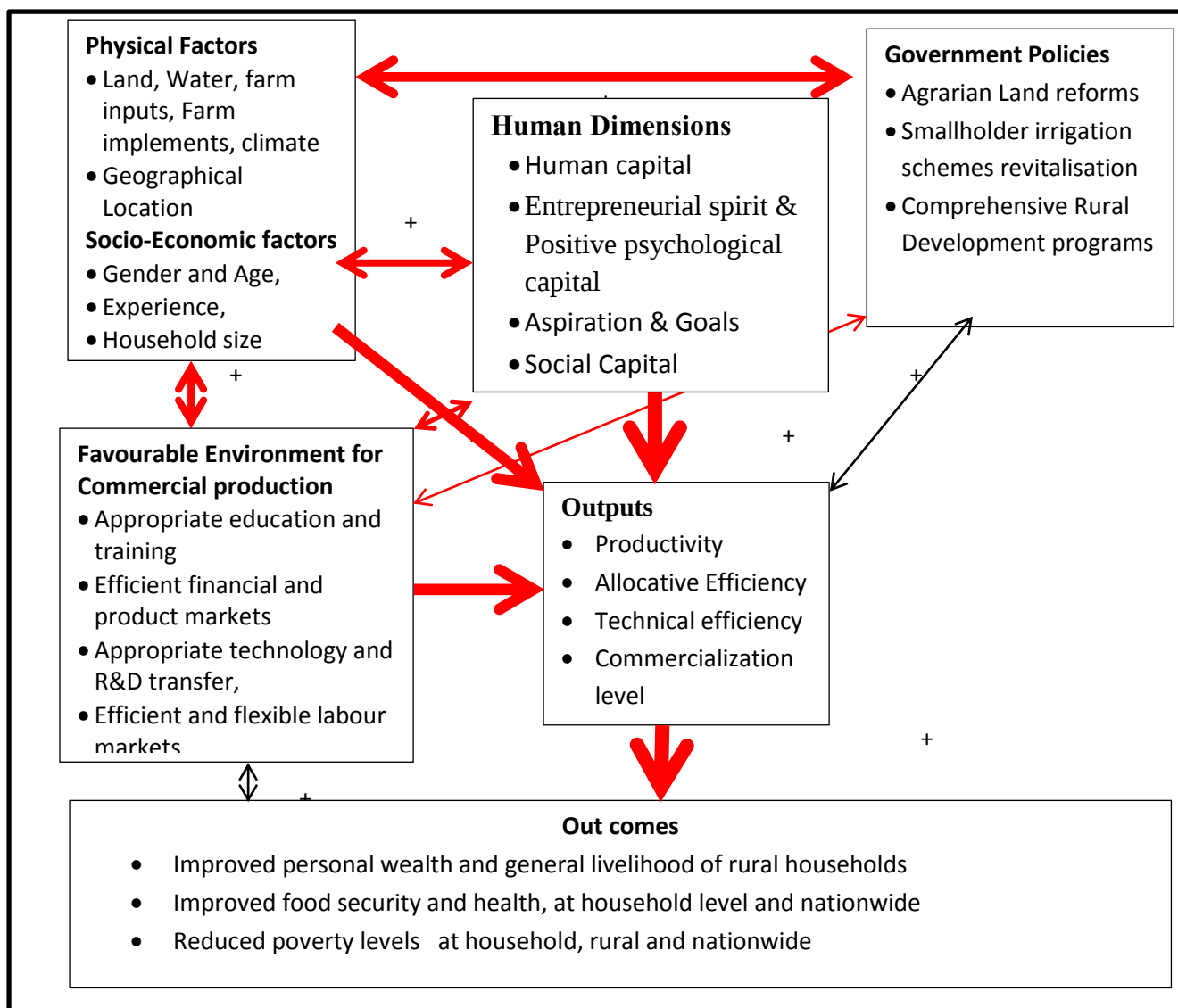


Figure 4.5: Conceptual framework

CHAPTER 5

DESCRIPTION OF THE STUDY AREAS

5.1 Introduction

The purpose of this chapter is to describe the study area. The study was carried out in selected small-scale irrigation schemes in the Eastern Cape Province of South Africa. Purposively, two irrigation schemes one in former Transkei (Qamata irrigation scheme) and another in former Ciskei (Tyefu irrigation scheme) homelands in the Eastern Cape Province of South Africa were selected. Two communities surrounding these small scale irrigation schemes were selected. This chapter starts with a broad spectrum of describing the status-quo of Eastern Cape Province where both schemes are located. Further, the chapter continues to describe the Intsika-Yethu Municipality where Qamata irrigation scheme is located including the demographic composition, biophysical characteristics, location and a brief history of Qamata irrigation scheme. Using the same logical flow, Ngqushwa local municipality where Tyefu irrigation scheme is located was briefly described followed by the biophysical factors at Tyefu irrigation scheme, a brief history and the current status of the irrigation scheme, respectively.

5.2 The Eastern Cape Province

The Eastern Cape Province occupies approximately 169 580 square kilometres, thus, about 13, 9% of the South Africa's total area and it is divided into two regions, the Western and the Eastern region (ECDRAR, 2011). The province is endowed with mountains, rivers, and savannah grass land with short shrubs and forests. It derives its incomes from eco-tourisms, agro-industries, livestock and crop production. According to 2011 South African census, the Eastern Cape Province's population was estimated to be 6 562 053 out of 51 770 560 of South African total population (Statistics South Africa, 2012). Of the 6 562 053 people, 60% live in rural areas. The population quality is generally poor characterised by low literacy levels with high levels of poverty, unemployment, poor infrastructure and lack of other socio basic needs. The Province's average poverty level was estimated as 74.9% in four Districts which include O.R Tambo, Alfred Nzo, Joe Gqabi and Chris Hani. Unemployment rate was estimated at 35% and a large number of people (2.5Million) earn a living through social grants. These social grants are mainly received by elderly, retired civil servants, disabled and children (ECDRAR, 2011).

Like most African countries and governments, the Eastern Cape Province is sharing the goal of reducing poverty by half in 2014 (ECDRAR, 2011). Poverty reduction is thought to reduce if there is excess agricultural growth of 6%. Although the strategy of this province is to boost Agro-processing as a way of creating more employment opportunities, most people are smallholder subsistence farmers who produce less surplus for markets to feed these industries (ECDRAR, 2011). The province has few commercially organised large farms that majorly contribute to its rural economy and are mainly owned by white people. According to ECDRAR (2011) and ECSECC (2011), there is a decline in agricultural production and its contribution to GDP of the Eastern Cape Province. This decline may be attributed to migration of most youth to big cities in search for greener pastures leaving old people with less energy to cultivate the big chunks of land (ECDRAR, 2011). In addition, the provincial atmospheric temperature has increased and it receives low rainfall, resulting in water shortage and low agricultural output (ECDRAR, 2011).



Figure 5.1: The Eastern Cape Province Map Showing the Study Areas

5.3 Intsika Yethu Municipality

Qamata irrigation scheme is located in Intsika Yethu Municipality part of Chris Hani district in the Eastern Cape Province. The municipality is composed of two major towns, namely Cofimvaba and Tsomo. Further, the municipality comprises 213 villages scattered throughout. Topographically, the municipality is located in the Grassland Biome with hilltops of the same altitude and Valley Rivers flowing in between these hills (Kodua-Agyekum, 2009). The Lubisi, Xonxa, Ncora and Tsojana rivers form the major sources of water mainly connected to valley water dams for irrigation farming (Kodua-Agyekum, 2009). The municipality experiences both hot summer and cool dry winters with some snowing mainly on hilltops. Further, the area experiences low summer rainfall ranging between 700mm and 800mm annually. Sometimes it rains heavily during the beginning of summer resulting into gully soil erosion (Intsika Yethu Municipality, 2008).



Plate 5.2 Land Degradation and Gully Soil Erosion in Qamata Area

According to Intsika Yethu Municipality (2008), due to its rocky sandstone of the Clarens Group, the soils in the area are categorized as shallow to moderately deep and highly weathered. Beyond the shallow soils are red and purple mudstones together with shale. The shale soils can be described as fine-grained, clastic sedimentary rock composed of mud made-up of flakes of clay minerals and silt-sized particles of other minerals, especially quartz and calcite (Blatt and Tracy, 1996). The dry winter periods, high water evaporation due to high temperature, low rain falls, gully soil erosion and unpredicted weather patterns, they are a threat to agricultural productivity and profitability (Intsika Yethu Municipality, 2008). The major economic activities carried out on land include livestock grazing and smallholder farming. Most land near the homesteads is heavily degraded due to

overstocking, poor veld management and farming techniques. Villages in Intsika Yethu Municipality still have huge tracts of uncultivated arable land (Intsika Yethu Municipality, 2008).

By 2011, South African population census, there were 145 372 persons and 40 448 households living in Intsika Yethu municipality with an average household size of 3.5 persons per household (Statistics South Africa, 2012). Thus, this indicates increased population migration to more urbanized towns outside the Intsika Yethu Municipality. Based on the gender ratio, women constitute 53% of municipality's population. Further, the population is composed of 60% young pupil aged between 0 and 19 years of age. The 7% municipal population fall under the pension age and 33% are under the working age between 20 and 64 years old (Intsika Yethu Municipality, 2008). The 33% working group are faced with high unemployment rate and most families are highly dependent on government social grants received by pensioners, disabled and children (Intsika Yethu Municipality, 2008).

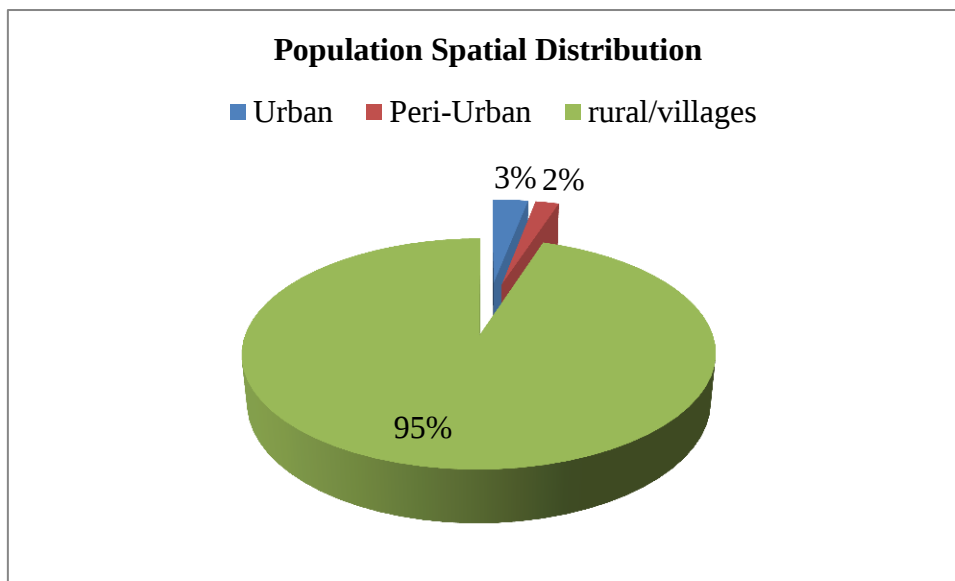


Figure 5.2 Population Spatial Distribution of Intsika Yethu Municipality

According to Intsika Yethu Municipality housing sector plan report of 2008, 76% of households in the area can be regarded as poor with gross monthly incomes of less than R1500. Furthermore, 87.1% of its population is unemployed (Intsika Yethu Municipality,

2008). The municipality is faced with low public and private investment in trade, tourism and agriculture, low literacy levels and lack of economically viable productive skills in agricultural production, and poor natural resource management. Also, the municipality has insufficient entrepreneurial innovations, and lack access to credit facilities. Poor and worn-out infrastructures like irrigation facilities, feeder roads, housing and markets are also contributing towards the poor performance of the municipality's economic growth. Unclear land tenure system in the municipality acts as a hindrance to potential investments (Intsika Yethu Municipality, 2008). The Intsika Yethu Municipality report recommended revisiting the rehabilitation of the Qamata irrigation scheme as a successful strategy for improved livelihoods among the smallholder households (Intsika Yethu Municipality, 2008).

5.4 The Biophysical Description of Qamata Area

Precisely, Qamata is located in the subtropical high-pressure belt, at latitudes ranging between 31° 45' 30"S and 32° 00' 15"S and longitudes 27° 15' 00"E and 27° 30' 00"E (Kodua-Agyekum, 2009). Qamata area is in the rain shadow of the Drakensberg Range and thus, rain deficient and too dry for agricultural production without irrigation. As described, Qamata area is endowed with mountains and wide valleys that permit mechanised agricultural production. Also, this type of topography facilitates gravitational flow of water from rivers through canals to dams and crop fields without energy costs incurred. This makes the canal-furrow irrigation more appropriate and suitable for the resource-poor farmers who cannot afford fuel costs to pump water to their fields.

Despite its significant contribution to energy saving, the sloppy nature of this land results into huge amounts of eroded soils from the mountains into farms causing a threat of crop destruction and high silting of dams. Qamata Community is endowed with a major river called Indwe River that supplies water to Lubisi Dam which in turn serves a series of small dams connected to farmer fields (Kodua-Agyekum, 2009). Other sources of water include Spring Rivers like, Qamata River and the White Kei River. However, these spring rivers are susceptible to drying especially during winter and severe droughts. Water scarcity and soil erosion faced by smallholders in Qamata area call for more appropriate environmental conservation methods and sustainable agricultural production systems (Kodua-Agyekum, 2009). These sustainable conservation methods may require improved farmers' skills in

natural resource management and low external input sustainable agricultural (LEISA) (SSI, 2009).

5.5 Climate, Vegetation and Soils in Qamata Area

As mentioned in the general description of Intsika Yethu Municipality biophysical characteristics, Qamata area experiences an average annual rainfall of about 500mm, too low to sustain agricultural production (Kodua-Agyekum, 2009). The situation is worsened by high run-off of rain water from hills into river valleys and high temperatures that cause high rates of evaporation. The average temperature during winter is approximately 12⁰C, and 24⁰C to 29⁰C during summer (Kodua-Agyekum, 2009). The *Cymbopogon-Themeda* veld and the thorn-bush form the natural vegetation of Qamata (Kodua-Agyekum, 2009). The *Cymbopogon-Themeda* type of grass is lowly palatable to livestock and has a tendency of suppressing other types of grasses. Vegetation in Qamata area takes long to establish and hence less regeneration of nutritious grasses for livestock. This is mainly attributed to poor farming practices, bush burning, soil erosion and moderate wind blow (Kodua-Agyekum, 2009). Scarce grass and poor vegetation has resulted in apportioning more irrigated land to pastures production like lucerne for livestock.

Topsoil in Qamata are mainly sandy loam (alluvium) and relatively more fertile compare to other areas that receive moderate temperatures favourable for crop production in South Africa (Kodua-Agyekum, 2009 cited Republic of Transkei, 1991). The fertility attribute may be due to low rainfalls and high temperatures that hardly result into leaching. Low leaching means that soil nutrients cannot easily be drained deeper into the ground by rain water and thus, plants roots can easily reach these nutrients needed for proper growth.

5.6 Qamata Irrigation Scheme

Qamata Irrigation Scheme is served by two main dams, thus the Lubisi and the Xonxa, which draw water from Indwe River and Great White Kei River, respectively. The scheme is categorised as a smallholder canal and it uses gravity-fed surface irrigation technology to supply water in dams and crop fields. The water canal that supplies the irrigation scheme is about 15km long from the main Lubisi Dam. The Xonxa Dam supplies the western portion of the scheme. The scheme covers 2 601 ha of total surface irrigated area (Kodua-Agyekum, 2009). Figure 5.4 and 5.6 show the location and layout of Qamata Irrigation Scheme.

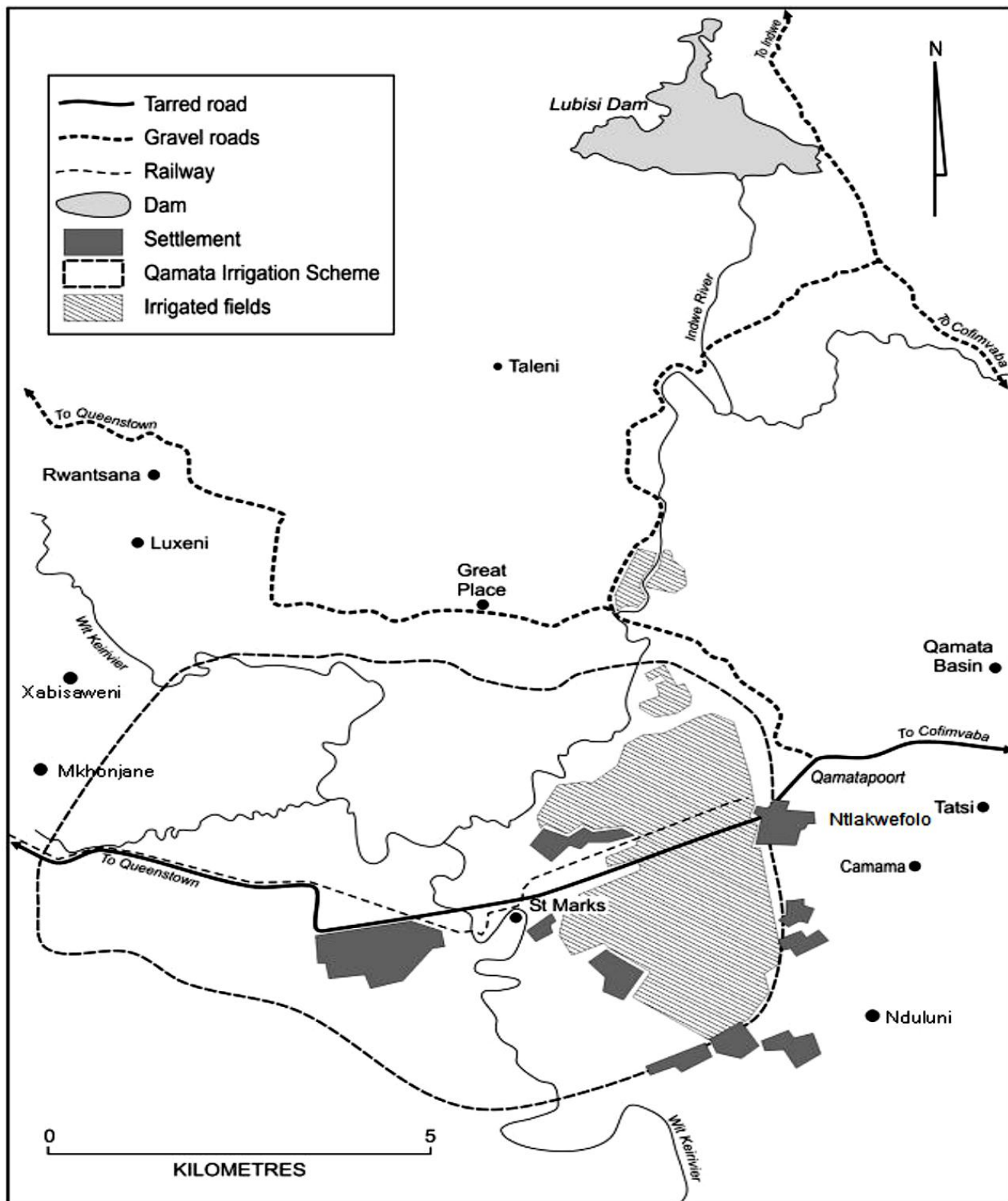


Figure 5.3: Map Showing the Qamata Irrigation Scheme Community
Source: Kodua-Agyekum (2009)

5.7 A Brief Historical Background of Qamata Irrigation Scheme

According to Kodua-Agyekum (2009), the idea of establishing Qamata irrigation scheme started way back in 1940s by the District Magistrate of St. Marks and was welcomed by the Paramount Chief of Western Thembuland, Chief K. D. Matanzima. Following their idea, in 1968 the construction of Lubisi dam was completed to serve Qamata irrigation scheme. The construction of the dam was mainly financed by the former republic of South African Government (Kodua-Agyekum, 2009). The Qamata irrigation scheme management, planning and implementation were generally centralized (top-bottom management approach) with less participation of the beneficiaries (farmers). Among the organisations that participated in the management of the scheme included the Xhosa Development Corporation under the department of Bantu Development of former republic of South Africa, Department of Agriculture and Forestry under the former Transkei government, the Transkei Agricultural Corporation (TRACOR), and the Inter-Science (Pty) Ltd., under Loxton, Venn and Associates enterprise, respectively (Kodua-Agyekum, 2009).

Initially the scheme was divided into two portions namely, the individual food plots of 0.25ha to 2,5ha based on the size of land owned by the household before the establishment of the irrigation scheme. For each household that joined the scheme, their land tenure had to be converted into communal land tenure system administered by traditional leaders (Kodua-Agyekum, 2009). The second category of farmers was regarded as commercial farmers who owned land of more than 5ha. Also, a highly mechanised Lanti commercial farm was established on over 225ha of land to create employment and generate incomes used to subsidize inputs for household food plots. The major crops grown on the Lanti commercial farm included maize, lucerne and Cabbage. Lanti farm used a vertical integration approach, where most produce harvested was sorted, graded and carefully packed ready to be sold in formal markets (Kodua-Agyekum, 2009). However, the scheme failed to realise its objectives of reducing poverty, increasing employment and improving the general livelihoods of farmers at the scheme (Kodua-Agyekum, 2009).

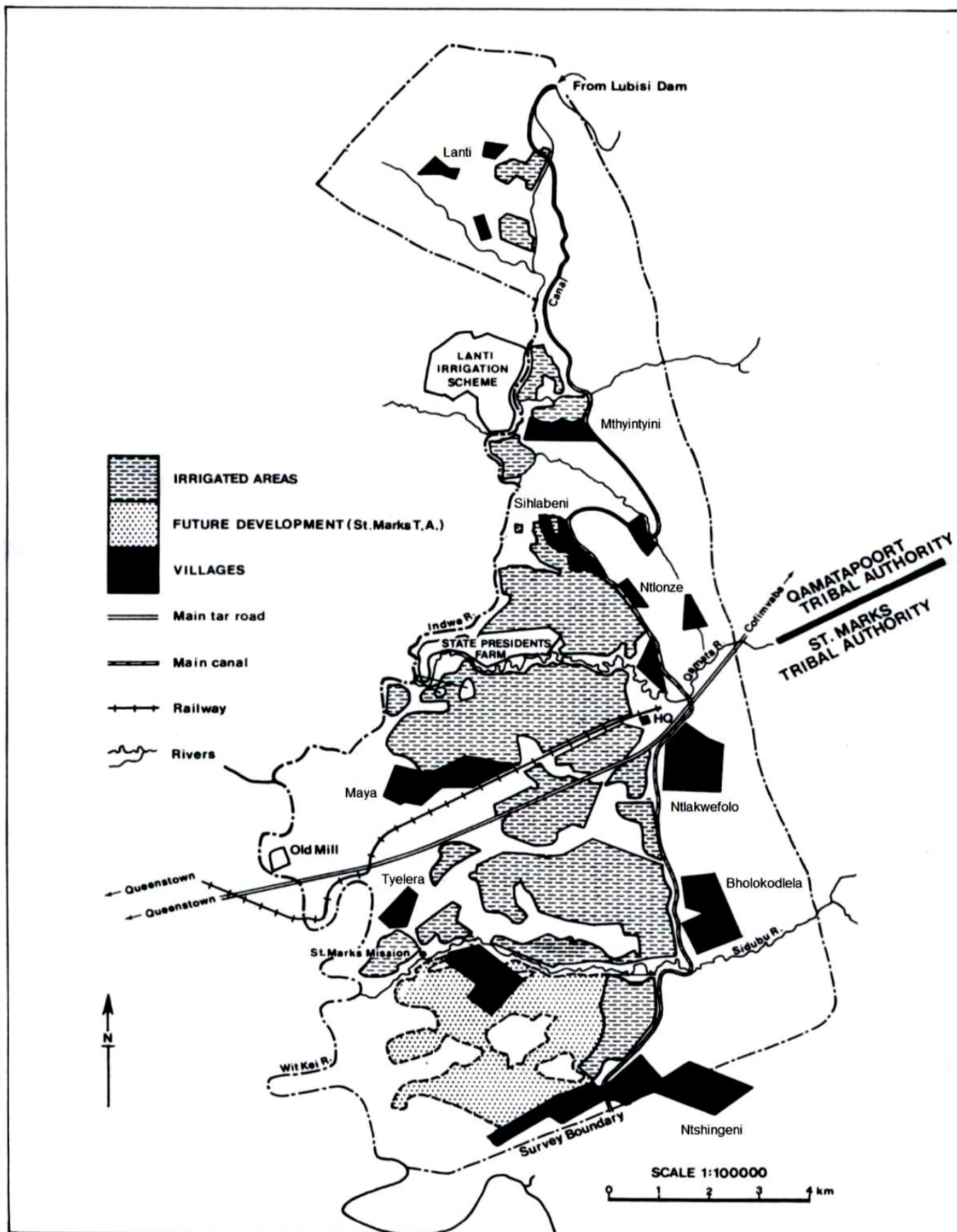


Figure 5.4: Qamata Irrigation Scheme Layout (Kodua-Agyekum, 2009)

Kodua-Agyekum (2009) identified the major causal of unrealised objectives of the Qamata irrigation scheme for improved rural livelihood and these included:

- i) Distribution of plots was based on tribal lines rather than focusing on the economic viability and sustainability of the scheme for community development and improved livelihoods.
- ii) Land allocation excluded community members who had other alternative sources of livelihood like wages, salaries and old age pension, and thus limiting investment of these non-farm incomes in farming for increased productivity.
- iv) Generally, the plots were too small to yield marketable surplus especially among the resource poor who could not afford purchase of farm inputs or meet production costs such as tractors hiring. This led to farmers' abandonment of over 40% of irrigated plots in search for better livelihood opportunities elsewhere.
- v) Other major factors that led to low farmers' participation and low productivity on the irrigation scheme included political unrest in the former Transkei in the late 1980s, and the withdraw of government management and operational support under TRACOR in 1994. After government withdrawal, the Irrigation Management Transfer (IMT) was introduced to technically unskilled farmers to manage and operate the irrigation scheme through water users associations.

5.8 Ngqushwa Local Municipality/Peddie Area

Tyefu irrigation scheme is located in Peddie area of Ngqushwa local municipality. Ngqushwa local municipality is located in the Amathole District Municipality of the Eastern Cape Province (Ngqushwa Municipality, 2007). The local municipality is bordered by the Great Fish River to the West, and the Keiskamma River to the East and the coastline of the Indian Ocean in the South (Ngqushwa Municipality, 2007). Over 95% of Ngqushwa local municipality's population reside in rural areas and only 5% reside in urban area (Ngqushwa Municipality, 2007). Although there is some development observed in the municipality, the rural areas still lack the basic services such as water, sewerage, electricity, and inadequate community facilities. About 40% of the population still depend

on natural sources of water like rivers and rainfall (Ngqushwa Municipality, 2007). Most adults (52%) are illiterate with education level of less than grade 7 (primary school dropouts). About 91% of the population of the municipality fall under the poverty line and 78% are unemployed (Ngqushwa Municipality, 2007).

The major sources of livelihood among people in this municipality include agriculture, small and micro enterprises, wage labour, pensions and disability grants, remittances, work parties, savings clubs, unpaid domestic labour and non-monetized activities such as barter and exchange of gifts (Ngqushwa Municipality, 2007). The municipality has a potential of improving its incomes through exploration of the livestock, horticulture and field crops, fisheries and tourism recreation beaches especially in the Hamburg area on the coastline (Ngqushwa Municipality, 2007).

5.8.1 Topology and drainage in Tyefu Communal Villages

Tyefu villages are endowed with two major rivers, namely, the Keiskamma River and the Great Fish River which acts as boundaries in the North and South of the villages respectively (Sishuta, 2005; Mamfengu, 2007; Nondumiso, 2009). There are numerous small rivers flowing from the inland areas into the Indian Ocean. The land scape is made-up of relatively high and gentle slopes with steep river valleys (Mamfengu, 2007). Areas near Keiskamma River form the lowest altitude of about 300m above sea level and areas around Peddie town form the highest altitude of approximately 460m above sea level, respectively (Mamfengu, 2007). Most homesteads are situated on gentle slopes and the farm land is located near river valleys for easy access to irrigation water. Despite its presence, the Great Fish River water was reported to be not suitable for crop farming and hence compromising farmer's productivity (Sishuta, 2005). The river valleys are relatively wide and flat enabling the use of farm machinery.

5.8.2 Climate in Tyefu Area

Tyefu communal villages are located in the semi-arid plateau of the Eastern Cape and the climate is mainly influenced by the warm Agulhas Current and the advections of dry Karoo air that blow towards the interior. The warm Agulhas Current was reported to be responsible for the low rainfall inland (Mamfengu, 2007). According to Mamfengu (2007),

the elevation and the coastline tend to create variations in climate that ranges from cool humid sub-tropical at the coast to hot and sub-arid inland. According to Ngqushwa IDP (2005/06) cited by Mamfengu (2007) indicated that the Tyefu communal villages experience two major wind directions namely, the South-westerly winds in winter and North-westerly in the summer, respectively.

5.8.3 Precipitation and Temperature at Tyefu Area

Since the area is located in the semi-arid type of climate, it experiences low average rainfall ranging between 700 mm at the coast and 400 mm inland annually. Most rainfall is experienced during summer between the months of November and March (Mamfengu, 2007). Also, the area experiences maximum average temperatures of 28°C during summer between months of December and February, and minimal average temperature of 9°C during winter in the month of July (Mamfengu, 2007). The warm temperatures are mainly attributed to the inward flow of off-shore Berg winds. The abrupt cold temperatures at Tyefu are mainly attributed to the cold fronts and the ridging of the South Atlantic high pressure system that bring in very cold air of Antarctica inland (Mamfengu, 2007). Other factors responsible for temperature variation at Tyefu include the elevation and the slopes of the area (Mamfengu, 2007). The erratic rainfalls in this area may contribute to low agricultural productivity forcing many out of farming as their source of livelihood and hence resulting into increased hunger and poverty (Nondumiso, 2009). This further qualifies the purposes by which Tyefu irrigation scheme was established. The scheme was established to increase food productivity enough for household and marketable surplus, and provides employment with an overall goal of reducing poverty (Sishuta, 2005; Nondumiso, 2009; Van Averbeké *et al.*, 2011).

5.8.4 Soil Type of Tyefu Area

According to Barnes (1988), Lewis (1995), Kakembo (1997) Birch (2000) cited in Mamfengu (2007), the Soil type of Tyefu area is mainly composed of sedimentary rocks such as sandstone, shale and grey/red mudstones of the Beaufort groups and generally fall under the Karoo sequence. Soil geological formation processes include several phases of uplifting, erosion and deposition. Further, Mamfengu cited Loxton, Hunting and Associates (1979), Kakembo (1997), and Birch (2000) describing the soils derived from

Beaufort and Ecca sediments as eutrophic, grayish brown, shallow and litholic soils. The segmentally rocks further decompose to form mudstones, and sandstones that are super Karoo in type and such give rise to formation of the shallow aridosols, with a calcareous hardpan layer which is shallow and fertile in nature (Mamfengu, 2007). The shallowness of these soils exposes it to soil erosion and this is evident in some parts of villages where land has been over grazed (Mamfengu, 2007). This may calls for better farming practices, appropriate and sustainable technologies intended for soil conservation and increased productivity.

Like most communal areas and place in South Africa, Peddie and Tyefu communal villages have received measurable support from the South African government directed towards improving smallholder agricultural for increased employment, increased incomes and poverty alleviation (Nondumiso, 2009). This support is seemingly failing to counteract the declining subsistence agricultural production and wide spread poverty (Nondumiso, 2009). The insufficient support has resulted into most smallholders' abandonment of their farm fields. Agricultural's failure in Tyefu area is mainly attributed to lack of farmers' participation, low management capabilities and exclusion of farmers' experience and knowledge in rural development programmes (Sishuta, 2005).

5.9 Tyefu Irrigation Scheme

Tyefu Irrigation scheme is located 30Km in the western part of Peddi along banks of the lower Great Fish River in the Eastern Cape Province of South Africa (Sishuta, 2005). The Scheme was using approximately 25km of the Great Fish River waters that served five sections. These sections include Ndlambe, Pikoli, Ndwayana, Kaliken and Glenmore, respectively. In 1997 the scheme was reported to cover approximately 694 hectares with a future potential of expansion to 1000 hectares of irrigated land. The area is faced with multiple agricultural challenges which include intensive droughts, low soil fertility, irregular rain fall, poor water quality, high rates of evaporation, and extreme temperatures (Sishuta, 2005). Communities surrounding Tyefu irrigation scheme lack access to credit/finance support and extension services, and poor infrastructures that limit movement of produce from farms to markets. Soil erosion and veld degradation makes land unsuitable for farming. Sishuta (2005) reported that Tyefu area has a potential of commercial crop production though more suitable for extensive and semi-intensive livestock production.

Large blocks of uncultivated farm land can be observed in Tyefu communities, and this may be due to the above mentioned challenges that are beyond farmers' control (Sishuta, 2005).

5.9.1 Brief history of the Tyefu Irrigation Scheme Operations

Suggestions and ideas to establish Tyefu irrigation scheme started in 1930's and preliminary studies were carried. Results from these studies exposed its low potentiality for crop production due to poor water quality (Sishuta, 2005). During the late 1970s after the establishment of the Ciskei government autonomy, Tyefu irrigation scheme pilot project was established and was fully run by the former Ciskei government (Sishuta, 2005). During the period of its establishment, socio-political ambitions of the former republic of South Africa and Ciskei governments' policies towards rural infrastructure development overrode the development and economic growth of rural communities. Based on these ambitions, Tyefu irrigation scheme was established without considering the financial and economic benefits for improved rural livelihood (Sishuta, 2005). Each household in the community was assigned 0.5ha of food plot and 4ha for smallholder commercial farmers.

According to the scheme plan, a top-down management style was used to control individual farmers' activities on food plots (Sishuta, 2005). Large scale mechanised farming like use of tractors and harvesters was considered to be more appropriate and economically efficient (Sishuta, 2005). Thus, the commercially oriented section employed capital intensive (mechanised farm production) and sophisticated agronomic techniques for increased agricultural production and value addition. Most farm operations, right from production to marketing were mainly controlled by top management with less involvement of farmers (Sishuta, 2005). Exclusion of farmers' participation in these process resulted into a lack of sense of ownership and no skills were transferred in respect to management and farm operations.

Thus, farmers' goals and aspirations were not considered in the planning and implementation, and this led to low human capital acquisition, lack of entrepreneurial spirit and low social networks created within and outside the scheme (Sishuta, 2005). The system also failed to establish sustainable institutions, and the management was non-accountable for all operations (Sishuta, 2005). Moreover, the scheme was faced with high cost of electricity used in pumping water. The mentioned challenges led to low agricultural

productivity and negative net cash flows of the scheme (Hill, 1984; Vink and Kirsten, 2000).

The situation was worsened by government withdrawal of support during the post-apartheid (Sishuta, 2005). The scheme was left to be run by farmers with less government direct interference. Farmers lacked management and operational skills to run the scheme. Water User Associations (WUA) under IMT programme was formed for more efficient water use and improved agricultural production (Manona *et al.*, 2010). Since most farmers were illiterates with low technical skills, the irrigation plots were abandoned, and in 1997 almost all the developed irrigation land was left uncultivated (Sishuta, 2005). The non-functioning and poor maintenance of the scheme resulted into deterioration of the infrastructure, and attracted theft and vandalism for some parts of the equipment (Sishuta, 2005). Despite its failures, the community still called for support from the government to revive the scheme for purposes of improving food security and providing employment. The physical rehabilitation of the scheme started in 2002 and was supposed to end in 2004 (Sishuta, 2005).

5.9.2 Current Status of the Irrigation Scheme

According to Mr Nbaba Cakwe¹, the GoSA embarked on revitalisation of Tyefu irrigation Scheme between 2002 and 2009. The scheme retained the four communities of Glenmore, Ndwayana, Ndlambe and Pikoli. Investigations were carried out to establish the viability of investing in revitalisation of the scheme. Among factors of great concern during investigations included mechanical related and ecological factors like water quality. Results from the investigations revealed that irrigation water drawn from Great Fish River was of poor quality and reports recommended that water should be drawn from Orange River by constructing a water pipe line that runs from the river to the scheme. The water pipe line was constructed and ended at Ndlambe, and the second phase of the construction was expected to continue up to Pikoli community. From the Orange River, water flows through the pipe into the control unit and later released by gravity through sprinkler pipes and drip pipes to irrigate the food plots and commercial plots, respectively.

¹ Mr. Nbaba Cakwe is the manager of Tyefu Irrigation scheme, and he provided all the information concerning the current status of Tyefu irrigation scheme in an exclusive face to face interview with the researcher.

Each of the four communities has been allocated different sizes of total irrigated land both under general commercial production and a 0.25ha individual household food plot. For Glenmore, the total commercial area planned for pomegranate fruit production is 100ha, of which 90ha is already under production. The total size of community food plots at Glenmore is 75ha. At Ndlambe, the total area allocated to commercial pomegranate fruit production is 230ha and so far 120ha is under production. In this community, 50ha is allocated to food plots. There are 260ha of undeveloped commercial land and a total of 56ha of food plots in Ndwayana. Pikoli has 197ha of undeveloped commercial land and a total of 75ha of food plots. The commercial fruit production on Tyefu irrigation scheme is mainly targeted for export markets.

5.9.3 Institutional Arrangements at Tyefu Irrigation Scheme

In 2005, a Producer Assembly (PA) for the scheme was established and the PA was also established for each of the four communities benefiting from the scheme. Although the PA is not a membership based organisation, each individual community elected their representative at the community meeting. The community based PA are referred to as primary cooperatives which merged to form a secondary cooperative society that form the Tyefu irrigation scheme farmers' management committee. The cooperative was reported to be in the processes of acquiring a registration certificate. At a lower level, the scheme is composed of 40 Producer Assembly members and each community is represented by 10 members. From each 10 representatives, 2 members are chosen to form the 8 members' management committee. The roles of the PA includes identifying and act on the development needs of the scheme, to coordinate all activities of the scheme in conjunction with the relevant authorities, to manage and control assets of the scheme, to avail employment opportunities to local community members, and settle disputes and conflicts among its members.

During revitalization of Tyefu irrigation scheme, the government of South Africa through the provincial Agricultural Department requested farmers to source for private companies that can partner with them especially in meeting the running costs needed for commercial production. Farmers out-sourced Bonifruit (Pty) Ltd Company and some level of agreement was reached awaiting approval by the Department of Rural Development and

Agrarian Reforms. The deal was a 50/50 joint venture partnership between the farmers and Bonifruit (Pty) Ltd. Bonifruit took the responsibility of providing technical, marketing and business management expertise, and use of its brand names for marketing. The government covered all capital expenditures like installing the drip irrigation pipes and farm machinery needed for the establishment the commercial pomegranate fruit farms in Glenmore and Ndlambe. Community members decide on how to spend the profits accrued to the commercial section of the irrigation scheme based on their general needs.

Progress on the commercial farms has been greatly affected by disputes between the Tribal Authority and community member regarding the redistribution of irrigated land to cater for the increased population. Due to failed conflict resolution, this has slowed process of acquiring a legal agreement between Bonifruit (Pty) Ltd Company and the scheme. Other challenges include lack of fencing materials, storage facilities, training centres, poor roads, theft of produce and equipment, and destruction of crops by wild animals.

CHAPTER 6

METHODOLOGY AND MODEL SPECIFICATIONS

6.1 Introduction

The purpose of this chapter is to develop the outline of the models for the analysis, type of data used in modelling, sampling frame and sample size, and data collection methods. The chapter is divided into two main sections, namely the analytical methods and empirical modelling, and the field methods. The field method section comprises sampling frame and sample size, and data collection. The sequence of the analytical section follows the arrangement of the specific objectives as outlined in Chapter 1, Section 1.3. The first objective seeks to establish the performance of smallholder farmers in Qamata and Tyefu using the gross margin analysis and commercialisation level, and also estimating the production efficiency and its determinants for the same category of farmers. The second objective is attained by using the factor analysis approach and more specifically employing the Principal Components Analysis model. The third objective is addressed by using factor analysis results and multiple regression. Objective four was achieved by regressing the technical efficiency scores and household agricultural commercialisation indices of maize and cabbage production,, against the average scores derived from Likert scale of responses of each principal component .. Both STATA and SPSS statistical software were used in data analysis.

6.2 Analytical Methods and Empirical Modelling

This analytical methods section presents the non-parametric and parametric methods used to estimate the performance of smallholder farmers. The non-parametric methods presented include estimation of gross margins as a proxy for profitability, household agricultural commercialization level and the Data Envelopment Analysis (DEA). The Stochastic Frontier Analysis (SFA), Ordinary Least Square (OLS) model and factor analysis are some of the parametric methods used to estimate farmers' performance and determinants of their performance in the selected enterprises.

6.2.1 Estimating the Gross Margins of Maize and Cabbage Enterprises

Gross margins were evaluated by identifying and quantifying the Total Variable Costs (TVC) incurred by the farmers, and the Total Revenues (TR) realized in the production of

maize and cabbage enterprises per season. The *TR* is estimated as the prevailing market price of a given output (P_y) multiplied by quantity of output sold (Q_{ys}) ($P_y * Q_{ys}$). Total variable costs is a summation of all input variable costs incurred by a given firm, and the input variable cost is estimated as the prevailing market price of a given input (P_{xi}) multiplied by quantity of the input used (Q_{xi}) ($P_{xi} * Q_{xi}$). Thus, $TVC = \sum_{i=1}^n (P_{xi} * Q_{xi})$. Gross margin for each enterprise is calculated as:

$$GM = (P_y * Q_{ys}) - \sum_{i=1}^n (P_{xi} * Q_{xi}) \dots \dots \dots (15)$$

6.2.2 Estimating the Commercialization Level of Smallholder Farmers

There are several methods of measuring household commercialisation level among smallholder farmers (Jaleta *et al.*, 2009). Some studies like de Janvry *et al.* (1991) and Fafchamps (1992) cited by Jaleta *et al.* (2009) used dichotomy between food and cash crops and examine household decision on resource allocation to these crops as a proxy for smallholder commercialisation . However, this study used the ratio of marketed output to the total value of agricultural production. Estimation of commerciality levels help to establish the farmer’s entrepreneurial ability for different enterprises.

Agriculture of Commercialization (Output-Side)

$$= \frac{\text{Value of agricultural sales in markets}}{\text{Agricultural product value}} \dots \dots \dots (16)$$

Following Govereh *et al.* (1999); Strasberg *et al.* (1999) as cited by Jaleta *et al.* (2009) the Household Commercialization Index (HCI) can be estimated as follows;

$$HCI_i = \left[\frac{\text{Gross value of crop sales}_{hhi'seasonj}}{\text{Gross value of all crop production}_{hhi'seasonj}} \right] * 100 \dots \dots \dots (17)$$

6.2.3 Estimation of Allocative Efficiency (A.E)

Allocative efficiency is where the farm operates at the least-cost combination of inputs to maximize profits. Allocative efficiency can be estimated using a Cobb Douglas production function. This study assumes that crop production is dependent on human labour, fertilizers

applied, amount of seed planted, pesticides, herbicides, size of land, the number of times a farmer irrigates her/his garden per season and the human dimensions (human and social capital, farmers' goals, entrepreneurial spirit and positive psychological capital). Therefore, allocative efficiency is estimated following physical production relationships derived from the modified Cobb – Douglas production function of Equation (11). Thus, the specific model estimated is given by:

$$Y = AX_1^{\alpha_1} X_2^{\alpha_2} \dots \dots \dots X_n^{\alpha_n} \gamma \dots \dots \dots (18)$$

Where:

Y = Amount of crop produced per farm

X₁= Land allocated to crop production

X₂= Amount of fertilizers used

X₃= Amount of seed planted

X₄= Amount of pesticide

X₅= Amount of herbicides

X₆ = Total number of times a farmer irrigates his/her plot per season

X₇ = Education

X₈= Farm Experience

X₉ = Number of training received on use of inputs per year

X₁₀ – X₁₂ = Entrepreneurial spirit/drives

X₁₃ – X₁₆ = Farmers' goals and behaviour factors

X₁₇ – X₁₉ = Farmers social capital factors

A = Constant and α = Random error term

From (18) the linear production function can be re-written as:

$$\ln Y = \ln A + \sum_{i=1}^n \beta_i \ln X_i + \varepsilon \dots \dots \dots (19)$$

Where A, α and β_i are parameters to be estimated. Following Chukwuji *et al.* (2006), allocative efficiency analysis is done by estimating a Cobb-Douglas function using OLS. It is followed by computing the value of marginal product (VMP_i) for each factor of production, which then is compared with the marginal input cost (MIC_i). Beta sometimes is used as a proxy for estimating elasticities. Results from equation (19) yield the Beta (β_i).

$$\frac{\partial \ln Y}{\partial \ln X} = \left[\frac{\frac{1}{Y} * \partial Y}{\frac{1}{X} * \partial X} \right] = \left[\frac{X}{Y} * \frac{\partial Y}{\partial X} \right] = \beta_i \dots\dots\dots(20)$$

Using the coefficient estimates from (20), MP_i the marginal product of the i^{th} factor X is calculated as:

$$MP_i = \frac{\partial Y}{\partial X_i} = \beta_i \frac{Y}{X_i} \dots\dots\dots(21)$$

$$\text{But } AP = \frac{Y}{X_i}$$

Where Y is the geometrical mean of maize output (mean of natural logarithm); X_i is the geometrical mean of input i ; β is the OLS estimated coefficient of input X_i . The marginal value product of input i (MVP_i) can be obtained by multiplying marginal physical product (MP_i) by the price of output (P_y). Thus,

$$MVP_i = MP_i * P_y \dots\dots\dots(22)$$

$$\text{Allocative Efficiency (A.E)} = \frac{MVP_i}{P_i} \dots\dots\dots(23)$$

But, P_i = Marginal cost of the i^{th} input

Following, the steps described above, this study determined allocative efficiency by comparing the value of marginal product of input (MVP_i) with the marginal factor cost (P_{xi}). Since farmers are price takers in the input market, the marginal cost of input approximates the price of the factor i , P_{xi} (Grazhdaninova and Lerman, 2004; Kibirige, 2008). Hence, if $MVP_i > P_{xi}$, then the input is underused and farm profit can be raised by increasing the use of this input. Conversely, if $MVP_i < P_{xi}$, the input is overused and to raise farm profits its use should be reduced. The point of allocative efficiency (maximum profit) is reached when $MVP_i = P_{xi}$ (Chavas *et al.*, 2005).

6.2.4 Estimation of Technical Efficiency (T.E)

Technical efficiency is the process of using available resource in the best combination with an objective of maximizing output (Battese and Coelli, 1995). Technical efficiency involves the transformation of inputs into outputs and it is achieved when a given farm produces at the production frontier level/optimal scale (Esparon and Sturgess, 1989). Technical efficiency aims at identifying means of optimal utilisation of inputs to maximise output while allocative efficiency aims at utilising the same input in a least-combination to maximise profits (Padilla-Fernandez and Nuthall, 2001). There are two common methods

of estimating technical efficiency, namely the Data Envelopment Analysis (DEA) and the Stochastic Frontier Analysis (SFA). The DEA mainly employs constructed linear programming set of equations to estimate production technical efficiency scores while the SFA uses a log-linear Cobb-Douglas production function to generate the technical efficiency scores (Speelman *et al.*, 2007; Lemba *et al.*, 2012). Both methods have been used and yielded results.

Both the SFA and DEA models each have limitations and their functions depend mainly on the category of data used to generate results (Lemba *et al.*, 2012). According to Lemba *et al.* (2012), the SFA employs the parametric production function to execute efficiency scores but the imposed assumptions expose the model to more misspecification errors. Thus, this renders SFA model insufficient to explain the differences especially between efficiency scores of different individual farm. The limitations of the DEA model include its inability to incorporate the statistical noise caused by stochastic elements resulting in biased efficiency estimates (Lemba *et al.*, 2012). Further, the DEA model loose its discrimination power in the absence of the inputs and outputs relationship as a result of treating individual farms unique and regarded efficient. Nevertheless, Thiam *et al.* (2001) and Alene and Zeller (2005) cited by Lemba *et al.* (2012) indicated that both SFA and DEA models yield highly correlated results. Therefore, this study used both models to limit errors in the efficiency estimates which may result from differences among individual farm operations.

6.2.4.1 Data Envelopment Analysis Approach

The model presented in this study assumed that each of the N farms use K inputs to produce a given output M . For the i^{th} farm, input and output data are represented by the column vectors X_i and Y_i , respectively. The $K \times N$ input matrix or X_{ij} (where X_{ij} = Land acreage, number of irrigations/ha/season, amount of seeds planted, fertilizer, pesticide, herbicides, capital) and the $M \times N$ output matrix, or Y_{ij} (value of output of i^{th} farm & j^{th} crop enterprise) represent the data for all N farms in the sample.

Following Speelman *et al.* (2007) and Lemba *et al.* (2012) the DEA model was estimated to generate technical efficiency (TE) using linear programing equation as shown below.

$$Min_{\theta, \lambda} \theta \dots\dots\dots(24)$$

$$\begin{aligned}
\text{Subject to:} \quad & -Y_{ij} + Y\lambda \geq 0, \\
& \theta X_{ij} - X\lambda \geq 0, \\
& N1'\lambda = 1, \\
& \lambda \geq 0
\end{aligned}$$

Where θ is a scalar, $N1$ is a $N \times 1$ vector of ones, and λ is an $N \times 1$ vector of constants. The value of θ obtained is the technical efficiency score for the i^{th} farm and these scores normally lie between zero and one. If $\theta = 1$ then the farm is said to be efficient and lies on the frontier, thus, the more θ tends to zero the more less efficient the farm becomes. The $(N1'\lambda = 1)$ is referred to as Variable Returns to Scale (VRS) with some specification as a convexity constraint. Without that constraint $(N1'\lambda = 1)$, then efficiency estimates are calculated under Constant Returns to Scale specifications (CRS). Further, Färe *et al.* (1994) used the sub-vector efficiency to estimate the technical sub-vector efficiency for the variable input k like irrigation water for each i^{th} farm by solving the linear programme problem as shown below.

$$Min_{\theta_k} \theta_k \dots \dots \dots (25)$$

$$\begin{aligned}
\text{Subject to} \quad & -Y_i + Y\lambda \geq 0, \\
& \theta_k X_i^k - X^k \lambda \geq 0, \\
& X_i^{n-k} - X^{n-k} \lambda \geq 0, \\
& N1'\lambda = 1, \\
& \lambda \geq 0,
\end{aligned}$$

Where θ_k is the input k sub-vector technical efficiency scores for farm i . The second constraint with terms X_i^k and X^k includes only the K^{th} input and in the third constraint which contains terms X_i^{n-k} and X^{n-k} it excludes (thus, $n - k$) the K^{th} input. Other variables in this equation are defined in equation 24.

6.2.4.2 Stochastic Frontier Analysis

The Stochastic Frontier Analysis was also employed to estimate the technical efficiency of smallholder farmers for maize and cabbage enterprises. Results were used to establish resource use efficiency of farmers as a platform to suggest the best enterprises to capitalize on for a more efficient, profitable and sustainable farming business among smallholder irrigation schemes in the Eastern Cape Province. Following Battese (1992) and Rahman

(2003), technical efficiency of a given crop production was estimated using a stochastic production frontier, which is specified as:

$$Y = f(X_i; \beta) + \ell \dots\dots\dots(26)$$

Technical efficiency levels are predicted from the stochastic frontier estimation. Following Ojo (2003), this study specified the stochastic frontier production function using the flexible log linear Cobb- Douglas production function as stated in equation (19).

6.2.4.3 Estimation of Factors Affecting Technical Efficiency

Determinants of the level of technical efficiency were estimated by establishing the relationship between farm/farmer characteristics and the computed technical efficiency indices. Following Bravo-Ureta and Rieger (1990), Bravo-Ureta and Pinheiro (1997) second step estimation adapted from the relationship between technical efficiency and the different farm/farmer characteristics are determined. To estimate these factors, a linear model is used with estimates. An OLS regression is performed and Durbin-Watson statistic is estimated to determine the extent of autocorrelation problem (Obi and Chisango, 2011). The linear model is estimated as shown below for each farmer.

$$T.E = \beta X + e \dots\dots\dots(27)$$

Where TE = level of technical efficiency; β = coefficient parameters to be measured; e = error term; and X is a vector of explanatory variables that include farm/farmer characteristics like X_1 = Household size, X_2 = Age, X_3 = Education level (years), X_4 = Farming experience, X_5 = Amount of land owned, X_6 = Training on input use, X_7 = Use agro-chemicals, X_8 = Use of tractor, X_9 = Location of irrigation scheme, X_{10} = Gross margins, X_{11} = Commercialization level, X_{12} = crop incomes, X_{13} = Off-farm incomes.

6.2.5 Estimating the Principal Components for the Farmers’ Human Dimensions

In order to achieve the second and third objectives of the study, the factor analysis method was employed. The purpose of using the factor analysis is to reduce the large number of variables (i.e. human dimensional/attitudinal statements) to a smaller set of new composite

factors (WIDCORP, 2008; Kisaka-Lwayo and Obi, 2012). This process also ensures limited loss of information contained in the large number of attitudinal statements. The underlying factors that explain variance among the human dimensional or attitudinal statements were extracted using the factor analysis approach. The extracted factors were then clustered around related attributes such as farmer's entrepreneurial skills, social capital and socio-cultural attitudes towards farming. Another reason for using the Principal Components Analysis (PCA) is its ability to yield convincing results (Padilla-Fernandez and Nuthall, 2001; Rao, 1964 cited by Kisaka-Lwayo and Obi, 2012).

The variable to be retained in the model had to satisfy the condition that, the coefficients of variables should be equal to eigenvalues that are greater than one. Thus, such factor explains more variance than any of the original set of variables. To ensure greater factoring ability and sampling adequacy, the Kaiser-Meyer-Oklun (KMO) and the Bartlett's Test of Sphericity tests were used (WIDCORP, 2008). According to WIDCORP (2008), the tests are part of the minimum requirements needed before the data set qualifies for PCA. The KMO uses partial correlations to identify the correlations between pairs of variables, and the recommended minimum value of KMO is 0.6. The Bartlett's test of sphericity verifies the suitability of data for PCA by either accepting or rejecting the hypothesis based on the relationship between the correlation matrix and identity matrix.

Following Kisaka-Lwayo and Obi (2012), the principal component (PC) of a given dataset of P numeric variables can be presented mathematically as:

$$PC_n = f(a_{ni}X_i, \dots, a_{1j}X_j) \dots \dots \dots (28)$$

Where *PC* is the principal component, *n* represents a number greater than one. The *PC* can take different forms of measurement and these include continuous variables, quantity of related products of values that make up a component, and weighted values or generated values from the component loading. a_{1j} is the regression coefficient for the j^{th} variable and it is known as the eigenvector of the covariance matrix between variables. X_j is the value of the j^{th} variable. Explicitly the equation can be written as:

$$PC_1 = a_{11}X_1 + a_{12}X_2 + \dots a_{1j}X_j \dots \dots \dots (29)$$

Where PC_1 = the first principal component. X_1 and X_2 are the first and second independent variables of PC_1 in the linear additive model needed to derive the principal component, and the a_{11} and a_{12} are coefficient (component loadings) associated with the X_1 and X_2 variables. Thus, if the study considers multiple principal components, a series of these additive linear combinations of component loadings and variable values can be presented as:

$$\begin{aligned}
 PC_1 &= a_{11}X_1 + a_{12}X_2 + \dots + a_{1j}X_j \\
 PC_2 &= a_{21}X_1 + a_{22}X_2 + \dots + a_{2j}X_j \\
 &\cdot \quad \cdot \quad \cdot \quad \cdot \quad \dots \dots \dots (30) \\
 &\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\
 PC_n &= a_{n1}X_1 + a_{n2}X_2 + \dots + a_{nj}X_j
 \end{aligned}$$

Where

$$n = 1 \dots 5$$

$$j = 1 \dots 45$$

$a_{n1} \dots a_{nj}$ = the component loading

$X_1 \dots X_j$ = the human dimensions/farmers attitudes towards farming

6.2.5.1 Relationship between Human Dimensions and Farmer/Farm Characteristics

The impact of socioeconomic characteristics on the farmer's human dimensions was estimated using factor analysis and multiple regression analysis. The multiple regression analysis used standard factor scores generated after the factor analyses was performed, and these scores were regressed on farm and farmers' socioeconomic characteristics. Thus,

$$\begin{aligned}
 FS_{ij} = & \beta_0 + \beta_3HHSZE + \beta_1AGE + \beta_2EDUC + \beta_4MJOCUP + \beta_5 EXPE + \beta_6LANDSIZE + \\
 & \beta_7CRPINCOM + \beta_8LVTINCOM + \beta_9RMGP + \beta_{10}SOURCWAT + \beta_{11}IRSLOC \\
 & + e \dots \dots \dots (31)
 \end{aligned}$$

Where FS_{ij} (dependent variable) = generated regression factor analysis scores; β = coefficient parameters to be measured; e = error term; explanatory variable include $HHSZE$ = household size, AGE = Age of the farmer (years), $EDUC$ = education level of the farmer (years in school), $MJOCUP$ = major occupation of the farmer, $EXPE$ = farming experience (years) of the farmer, $LANDSIZE$ = size of land farmer owns (hectares), $CRPINCOM$ =crop incomes (Rand), $LVTINCOM$ =livestock incomes (Rand) , $RMGP$ =

remittances, social grants and pension amount received by the farm household (Rand),
SOURWAT = Source of water for crop production (Rain, tap, dam, river, or spring) and
IRSLOC = Location of the irrigation scheme (1 = Qamata and 2 =Tyefu irrigation scheme)

6.2.5.2 Estimating the Impact of Human Dimensions on T. E., and HCI

The impact of human dimensions on the level of technical efficiency and household commercialization index (HCI) can be determined by establishing the relationship between the estimated average scores derived from Likert scaling of responses for each human dimensions principal component and the computed technical efficiency scores, and household commercialisation indices. Following Bravo-Ureta and Rieger (1990), Bravo-Ureta, and Pinheiro (1997) and Padilla-Fernandez and Nuthall (2001), the second step estimates the relationship between the dependent variables (technical efficiency and household commercialisation index), and the different farm/farmer characteristics. To estimate this relationship, the multiple regression models are employed. The model in this section incorporated the total average scores (i.e., the item scores or the human dimensions measured using the Likert scale) of human dimensions that passed the factor analysis test along with the other explanatory variables. The linear model is estimated as shown below for each farmer.

$$\Theta = \beta X + e \dots\dots\dots (32)$$

$$\begin{aligned} \Theta = & \beta_0 + \beta_1 HHSZE + \beta_2 SEX + \beta_3 AGE + \beta_4 LANDSIZE + \beta_5 MJOCUP + \\ & \beta_6 CRPINCOM + \beta_7 RMGP + \beta_8 OFFINCOM + \beta_9 IMPSEED + \\ & \beta_{10} SOUCWAT + \beta_{11} IRRLOC + \beta_{12} EDUC + \beta_{13} EXPE + \beta_{14} ENTPPC_1 + \\ & \beta_{15} ENTPPC_2 + \beta_{16} ENTPPC_3 + \beta_{17} GOAL_1 + \beta_{18} GOAL_2 + \beta_{19} GOAL_3 \\ & \beta_{20} GOAL_4 + \beta_{21} SOCAP_1 + \beta_{22} SOCAP_2 + \beta_{23} SOCAP_3 \\ & + e \dots\dots\dots (34) \end{aligned}$$

Where Θ = Technical efficiency scores and Commercialisation level index

e = Error term

β_0 = Constant (intercept)

$\beta_1 \dots \beta_{25}$ = Regression coefficients

$HHSZE$ = Household size

SEX = Sex of the household head

AGE	=	Age of the household head
LANDSIZE	=	Amount of land owned
MJOCUP	=	Major occupation
CRPINCOM	=	Crop incomes
RMGP	=	Remittances, social grants & pension
OFFINCOM	=	Off-farm incomes
IMPSEED	=	Use of improved seeds
SOUCWAT	=	Source of water for crop production
IRRLOC	=	Location of the Irrigation Scheme
EDUC	=	Education level (years) (Human Capital)
EXPE	=	Farming Experience (years) (Human Capital)
ENTPPC ₁	=	Risk taking (1 st Principal Component for entrepreneurial/positive psychological capital)
ENTPPC ₂	=	Innovativeness (2 nd Principal Component for entrepreneurial/positive psychological capital)
ENTPPC ₃	=	Responding to opportunities (3 rd Principal Component Entrepreneurial/positive psychological capital)
GOAL ₁	=	Farm status (1 st principal component for Farmers' goals)
GOAL ₂	=	Business (2 nd principal component for farmers' goals)
GOAL ₃	=	Social (3 rd principal component for farmers' goals)
GOAL ₄	=	Independence (4 th principal component for farmers' goals)
SOCAP ₁	=	Bonding (1 st principal component of farmers' social capital)
SOCAP ₂	=	External (2 nd principal component of farmers' social capital)
SOCAP ₃	=	Social values (3 rd principal component of farmers' social capital)

6.2.6 Type of Data Used

The data used in this thesis were extracted from the primary survey of individual farm using a structured questionnaire. In the analysis, farmers' and farm characteristics were

used and these are explained in Table 6.1 based on the hypothesised impact on the extracted on the principal components of human dimensional, maize and cabbage production, technical efficiency and commercialisation level index of smallholder farmers.

Table 6.1: Definition of Empirical Model Variables and their Hypothesis

Dependent variables include; Total amount of crop produced, Technical Efficiency, and Commercialization Level of Smallholder Farmers			
Independent Variable	Description	Unit	Hypothesized sign
HHSIZE	Number of people in a household	number	+
SEX	Gender of Household head (Male = 1, Female = 0)	Dummy variable	+
AGE	Age of respondent	Years	+
LANDSIZE	Size of farm land accessed	hectares	+
MJOCUP	Major occupation of respondent a (Farming =1 Otherwise =0)	Dummy Variable	+/-
EDUC	Education level of respondent	years	+
EXPE	Farming experience of respondent	years	+
CRPINCOM	Crop incomes	Rand	+
RMGP	Remittances social grants, pension	Rand	+
OFFINCOM	Off-farm income	Rand	+/-
IMPSEED	Where farmer plants improved seeds (yes =1 and no = 0)	Dummy	+
AGROCHEM	Use of agrochemicals (Yes =1, No =0)	Dummy	+
ENTPPC1	Risk taking (hope)	scores	+
ENTPPC2	Innovativeness (confidence)	scores	+
ENTPPC3	Response to business opportunities	scores	+
GOAL1	Farm-status oriented goal (confidence)	scores	+
GOAL2	Business oriented goal	scores	+
GOAL3	Social oriented goal	scores	+
GOAL ₄	Independence oriented goal	scores	+
SOCAP ₁	Bonding social capital	scores	+
SOCAP ₂	External social capital	scores	+/-
SOCAP ₃	Social values	scores	+/-
Group Membership	Respondent belong to group (Y/N)	Dummy	+

6.3 Field Methods

The field methods are presented in this section and they include sampling procedure and sample size, and data collection procedure. A brief explanation is given in this section about the reasons why the study selected Qamata and Tyefu irrigation schemes. Further,

the section describes steps taken to ensure that research ethics were followed during data collection. Description of how the sample size was obtained is also presented. The section concluded with a description on how interviews were conducted to obtain the raw data.

6.3.1 Sampling Procedure and Sample Size

Qamata and Tyefu irrigation schemes were purposively chosen because they are considered to be among the largest small-scale irrigation schemes in the former Transkei and Ciskei homelands respectively, currently located in the Eastern Cape Province of South Africa (Kodua-Agyekum, 2009). The schemes were established to improve on the agricultural productivity of smallholder farmers to combat food insecurity, unemployment and wide-spread poverty levels in these communities. Thus, it was worth establishing the impact of these irrigation schemes on smallholder farmers' profitability, commercialisation level and production efficiency of the major crops like maize and cabbage. Therefore, the research objectives and hypothesis were set to suit the rural farming population cultivating on the irrigation scheme, and homestead food gardeners in the vicinity of these schemes. A sample was drawn from the total population of smallholder farmers in the study areas.

The information regarding the operational status of irrigation schemes in Eastern Cape Province was accessed through stakeholder meetings with the department of agriculture, and government extension officers. Based on the information gathered, the two smallholder irrigation schemes and the surrounding communities were identified. The research team sought support from extension officers and community authorities who assisted in identifying both the homestead gardeners and smallholder irrigators in the same locality. Based on the extension worker's guidance, farmers were randomly selected and interviewed. Forty six homestead food gardeners and 56 smallholder irrigators were interviewed in Qamata area while only 4 homestead food gardeners and 52 smallholder irrigators were interviewed in Tyefu area. Based on observations and inquiries from the community development officer, there are very few homestead food gardeners close to Tyefu irrigation scheme unlike at Qamata irrigation scheme. Thus, a total of 102 farmers were interviewed in Qamata and 56 farmers at Tyefu irrigation scheme, respectively. This resulted in an overall sample size of 158 farmers.

Table 6.2: Distribution of Sample size

Category	Qamata Area			Tyefu (Ndlambe) Area		
	Population (N)	Sample size (n)	Sample Fraction (%) (n/N)	Population (N)	Sample size (n)	Sample Fraction (%) (n/N)
Active Participants on small-scale Irrigation schemes	675	56	8.3	246	52	21.1
Homestead food Gardeners	450	46	10.2	-	4	-
Total	1125	102	9.3		56	-

All the 158 filled questionnaires were used to address the first objective of this study. Both smallholder irrigators and homestead food gardeners availed the necessary information needed to describe the smallholder farming systems that exist in Qamata and Tyefu areas. The information required to address the first objective included the social demographic characteristic, production and marketing information.

To achieve the second, third and fourth objectives, data from 108 respondents for both Qamata and Tyefu areas were used. These respondents included 75 smallholder irrigators and 33 homestead food gardeners. During field interviews, some smallholder farmers in Qamata area indicated that they were operating as farmer groups and most of the production activities were carried out as a group although these farmers owned individual plots. Further, agricultural extension officers were directly involved in farmers' field activities especially during planting and application of fertilizers and other agro-chemicals. Thus, individual decision making would be greatly influenced by the group members and extension officers. Also, farmers belonging to cooperatives have less control over purchased agro-inputs and it is the cooperative management committee and irrigation management office who take decisions on how to use these inputs. Group decision making, direct involvement of extension officers in farmers' field activities and lack of control over purchased agro-inputs were thought to produce biased results especially the intrinsic values related to farmers' human dimensions. Therefore, of the 158 smallholder farmers, 108 respondents were considered to be relatively more independent in decision making, especially on activities related to individual farm production and marketing.

6.3.2 The Agricultural Research for Development (ARD) Approach for Study Site Identification, Selection, and Data Collection

Several studies have employed the Agricultural Research for Development (ARD) concept to generate more participatory, inclusive, and meaningful research outcomes (Hawkins *et al.*, 2009). The ARD aims at innovations for improved agricultural productivity through engagement of multiple actors in contextualizing the problem, identifying strategies, formulating and implementing joint action plans (Hawkins *et al.*, 2009). The ARD innovations evolve where interaction among players, response to feedbacks, analysis and generated solutions from the feedbacks are incorporated in the different processes (Hawkins *et al.*, 2009). According to Hawkins *et al.* (2009), the ARD approach accommodates the technical, social, and institutional constraints, with all their inherent complexities, in an environment that facilitates learning and not mere research products. A brief background on its origin and antecedents is necessary at this juncture.

In a recent review for the Forum for Agricultural Research in Africa (FARA), Obi, Ajayi and Mugabo (2013) have observed that a dominant image of the research and farmer support environment of continent is its linear and top-down orientation. Their views are in line with the findings of the International Centre for development-oriented Research in Agriculture (ICRA) which suggest that the research élite and the local levels they are intended to serve are widely separated (ICRA, 2009). This has grown out of a research and support tradition that is long-standing. For instance, according to Eicher (2001), most of the research systems and extension services in the immediate post-colonial era in Africa were immersed within the Ministry of Agriculture. Figure 6.1 illustrates the typical format encountered in almost all the existing research systems on the continent prior to the emergence of the participatory thinking.

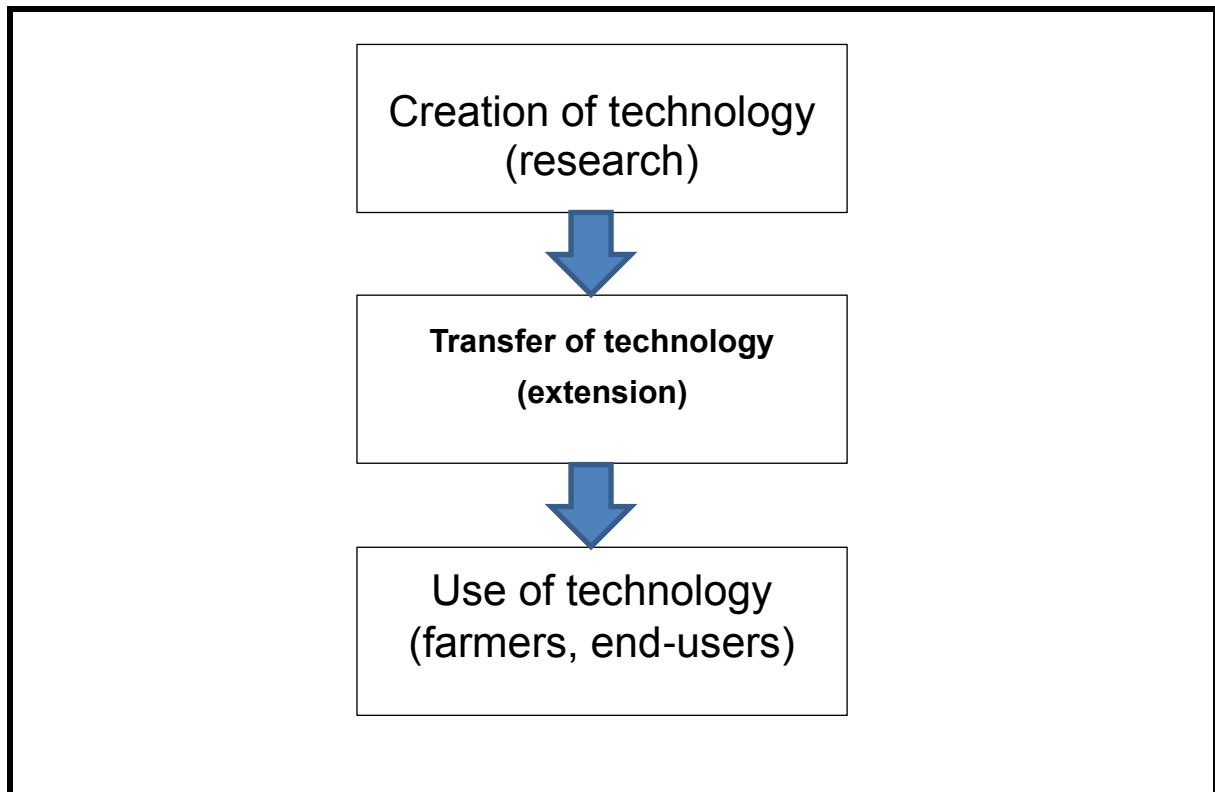


Figure 6.1: Linear format of the conventional research and extension systems

The top-down orientation has been widely seen as removing elements of feedback and ensuring that research priorities incorporate the perspectives of the grassroots (ICRA, 2009). Some of the arguments against the linear model, often referred to as “vertical one-way communication model” (Asiabaka, 1994 and Asiabaka and Mwangi, 2001), include the fact that it limits the role of extension to merely transferring information to farmers and ensures that it tended to be skewed towards research interests instead of reflecting farmers’ problems and circumstances. In an earlier international review incorporated in a training manual for people associated with various national agricultural research systems (NARS) in sub-Saharan Africa, the International Livestock Centre for Africa (ILCA), the precursor of the International Livestock Research Institute (ILRI), noted that the format of the agricultural research and extension systems on the continent has led to failures in technology development (ILCA, 1988). According to ILCA (1988), these failures were traceable to a wide range of factors, notably:

- i. The weak links between research establishments and entities operating at the level of the traditional farm sector which skews technologies towards the priorities of the research confraternity rather than those who actually use them;

- ii. Emphasizing performance criteria developed and applied to high-income, industrialized countries and that are out-of-touch with situations in developing countries;
- iii. Insufficient knowledge of small farmer conditions and circumstances.

ILCA was naturally one of the first institutions to call for the application of farming systems research approach to take care of the afore-mentioned deficiencies. In its view (ILCA, 1988), a well-designed and applied FSR should have the following features:

- i. Be neutral with respect to the nature of the system by beginning without pre-conditions, that is having an open-mind about the existing situations and the eventual outcome of any programming efforts;
- ii. Focus on improvements
- iii. Exhaustively examine interactions and relationships and linkages among the various units and entities making up the system under investigation;
- iv. Put the farmer at the centre of the entire process, from the conception, description and diagnosis of the system to the development of solutions; and
- v. Emphasize the evaluation of the identified solutions in terms of their broader effects on a wide range of indices of welfare, including productivity, equity, stability, and sustainability.

It is apparent that the sector has been the victim of gross mis-diagnosis of the core problem. According to Asiabaka (1994), one attempt to address the top-down orientation of the extension and research system has been the focus on constraints research and interventions to address identified constraints, culminating in the introduction of the farming systems research (FSR) programmes. But this approach has failed to produce the desired changes in adoption behaviour of smallholders and improve livelihoods of African resource-poor farmers, with new insights now showing that this was because the central role of farmers in adoption of improved practices was not recognized by the FSR approach. Maxwell (1986) saw the main problem with FSR as attempting to “hit a moving target” which definitely resulted in failures. According to Maxwell (1986), both the concept of FSR and the way it was implemented did not give sufficient recognition to the fact that the system itself is constantly changing and evolving and not one that can be productively engaged by ones-off methodologies or contacts.

According to Obi, Ajayi and Mugabo (2013), the wider development literature presents numerous indications of the erstwhile structure and organization of the agricultural research system on the continent. According to Taylor (1991), the structure of these systems has been influenced largely by the colonial backgrounds of these countries. Especially for the Anglophone countries, the strong influence of colonial thinking is evident (Taylor, 1991), in contrast with the situation in the Francophone countries where there has been some attempt at nationalization of the research systems to better reflect national circumstances and priorities right from the early days., although in many instances this development has been lagged up to 10-15 years after the attainment of political independence. Some of the most comprehensive studies on the origin of agricultural research in Anglophone Africa have demonstrated that there was never an intention to forge a link between the research system and the local farming system (Taylor, 1991; Eicher, 1999).

As has been made clear over the years, the first efforts at conducting research of any type into agricultural systems revolved around the botanical garden concept where the new commodities were “studied, evaluated ... (and prepared for)...distribution, dissemination and production...” (Taylor, 1991). Given this focus, it was not necessary to expect that the research system would aim to achieve “balanced and efficient development of the natural resource base or...concern for food or improved nutrition of the peoples” (Taylor, 1991). Attention to food crops only began in the late 1950s, becoming significant only around the 1970s as population pressures became a more serious problem than previously (Taylor, 1991). When all the foregoing are taken into account, the differences between the conventional research tradition and the ARD methodologies become quite glaring as shown in Table 6.3.

Table 6.3: Comparison of conventional research and agricultural research for development

Conventional Research	Agricultural Research Development
Commodity driven/disciplinary oriented	Systems-oriented, inter-disciplinary
Reductionist	Holistic, constructivist
Aims at increasing yield	Aims at multiple objectives
Simple high input technology	Complex knowledge-intensive technology
Science driven	Responding to clients' needs
Publication oriented	Development oriented
Conducted in isolation	Inter-institutional collaboration
Limited farmer involvement	Participation, empowerment

Source: ICRA, 2009

Against the foregoing background, this study employed the ARD participatory processes as a way of incorporating views of the key players in the rural agricultural sector and ensuring that the findings are policy-relevant to the maximum extent practicable. Three steps of the ARD were considered in data collection and these included organizing the research team, putting the research problem in context and identifying authentic data collection strategies. The key players that constituted the research team included technocrats from the University of Fort Hare, officials from the Department of Rural Development and Agrarian Reforms of the Eastern Cape Province, governmental irrigation scheme managers, and leaders of the farmers' cooperatives, individual farmers and university students.

Team bonding was strengthened during the process of problem contextualization. During the process of problem contextualization, the study area and specifications of the units of analysis in respect to the study objectives were identified. This was achieved through engaging personnel at the Department of Rural Development and Agrarian Reforms, government extension officers, community development officers, irrigation scheme managers, leaders of farmers' cooperatives, managers of private farms and individual farmers. Intensive consultative meetings were carried out to equip the research team with the knowledge regarding farmers' perceptions and attitudes towards farming, societal values and norms, and the best approaches needed to extract the relevant information. In addition to consultative meetings, the research team endeavoured to visit some of the

proposed study sites physically and interviewed the technocrats and community leaders to ascertain the feasibility of the study sites.

Different strategies were used to address the set objectives linked to the contextualized problem. These strategies were based on the participatory methods of data collection. There several participatory methods used in data collection and they include group and team dynamics, sampling, sensitive interviewing and dialogue as well as diagramming and visual construction (Pretty and Voudouhe, 1994; Pretty, 1995). Among the mentioned participatory methods, group and team dynamics, sampling and sensitive interviewing were used in this study. The research team established the rules, norms and working principles to create a better working environment that minimize group conflicts. Visiting the proposed study site as a team, work sharing, rapid report writing and shared presentations all these provided a better understanding and appreciation of the problem situation. Participants in the sensitive interviews included key informants, farmer groups and individual farmers.

The most common primary sources of knowledge in social research employ a combination of observable/measurable and unobservable/non-measurable factors needed to answer the research questions and hypothesis (Kodua-Agyekum, 2009). The researcher used proxies and asked questions that addressed the characteristics of the unobservable factors. This was achieved through face to face interviews with individual farmers and technocrats and responses were recorded. Some physical and physiological components of social factors can be observed and measured to qualify the unobservable/non-measurable information. Use of both, measurements and observation is thought to yield better results (Kodua-Agyekum, 2009).

The researcher used observation method to elicit information concerning the biophysical characteristics of the study area such as vegetation, topology, economic activities, social interactions, infrastructure available especially the irrigation system facilities, and farm layout on the irrigation schemes and homestead gardens. Also the method was used to carefully study individual responses towards certain questions that called for understanding farmer's perception and attitudes on farming. Qualitative research uses this method to assess the accuracy of documented and oral information like the status of the irrigation scheme and farming systems present in the research area.

According to Adler and Adler (1994) cited by Kodua-Agyekum (2009), observation research has the ability to extract in-depth information regarding physical/tangible, economic and social behaviours of a given community. However, despite its efficacy, results generated by this method only represent a specific location/environment/social group and can hardly be extrapolated to other locations/environment/social settings.

The data were collected using note books and questionnaires. The majority of the interviews occurred in the communal meeting places. The only exception was in the case of Tyefu smallholder irrigators who were interviewed in their irrigation food plots. A structured questionnaire was used in the interview. The questionnaires were pre-tested on a sample of farmers in the study area. The questionnaires comprise farm management factors like agronomic practices and crop production, and four farmers' human dimensional related questions. A set of questions focused on entrepreneurial spirit and positive psychological capital, farmers' goals, and social capital. Several Likert scales and rankings were developed to address each human dimensions aspect in this study. The data regarding unobservable /non-measuring factors were collected through administering questionnaire in a face to face interview. Though the questionnaire was written in English it was presented in Xhosa local language.

CHAPTER 7

RESULTS AND DISCUSSIONS

7.1 Introduction

This chapter presents the research findings. The chapter begins with describing the demographic and socioeconomic characteristic of smallholder farmers and the farming systems used. As the chapter proceeds, the smallholder farm business performance is established through estimating gross margins and the household commercialization level of maize and cabbage. Production efficiency being another important tool for evaluating farmers' level of productivity and resource use, this chapter display results accrued to smallholders' technical and allocative efficiency and determinants of technical efficiency. Results for both non-parametric and parametric methods using the DEA and SPF approaches respectively to estimate production efficiency are displayed and discussed also in this chapter.

The chapter concludes with the main theme of this study to establish whether human dimensions have an impact on technical efficiency and household commercialization level. Thus, the human dimensions and its relationship with the farmer/farmer characteristics were identified. Further, the analysis presented in this chapter established the role of farmers' human dimensions on the technical efficiency and the household commercialization index/level for both maize and cabbage enterprises. The generated information in this chapter is thought to be useful to identify the human dimensions factors that need more attention in the transition from subsistence homestead food gardening to smallholder commercial irrigation farming in Qamata and Tyefu communities.

7.2 Description of the Socio-demographic Variables of Smallholder Farmers

Most farm households were headed by males, the proportions being significantly higher among the homestead food gardeners at a 5% level. Male's dominance among both smallholder irrigators and homestead food gardeners (59% and 78% respectively) in the study area may be attributed to loss of jobs through retrenchment policies, retirement and the high unemployment rate especially in the formal sector that requires more educated skilled labour. Secondly, over 90% farm plots on irrigation schemes and dry land were allocated to men due to the bias of the African cultural rules and norms which deny

women's legal rights to own such a crucial agricultural resource (Kodua-Agyekum, 2009). Since Qamata and Tyefu irrigation scheme areas were mainly administered by Tribal Authorities, tribal rules and cultural norms were prevalent during the distribution of farm plots. According to the results presented in Table 7.1, there are relatively more women participating in irrigation farming (41%) than in homestead food gardening (22%). The increased number of women participating in irrigation farming may be due to affirmative action programmes and policies in recent years which promote women's access and control over or inherit farm plots. Although there is an increase in women's ownership of plots, that may not be the case for women participating in homestead food gardening where the traditional norms are still prevalent (Kodua-Agyekum, 2009).

Table 7.1 Demographic Characteristics of Smallholder Farmers in the Study Area

Characteristics	Description	Smallholder Irrigator (n =108) (%)	Homestead Food Gardener (n = 50) (%)	Overall Sample (n=158) (%)	Chi-Square Test
Sex of household head	Male	59.0	78.0	69.0	5.290**
	Female	41.0	22.0	31.0	
Level of Formal Education	Non	35	20	28	5.647
	Primary	36	48	42	
	Secondary	26	32	29	
	Tertiary	3	0	1	
Major Occupation	Farmer	94	90	92	3.742
	Self-employed	4	6	5	
	Civil servant	2	4	3	
		Mean-value	Mean-value	Average Mean value	T-Test
Household size		4.537 (2.698)	4.400 (1.990)	4.469 (2.344)	0.358
Age of farmer (Years)		60.232 (12.289)	61.900 (13.117)	61.066 (12.703)	-0.777
Years spent in School		4.944 (4.574)	5.900 (4.142)	5.422 (4.358)	-1.303
Faming Experience (years)		10.833 (11.821)	15.200 (12.036)	13.017 (11.928)	2.147**

Source: Results from SPSS (version 11) generated from Field Survey, 2012. Where ** represents significance at 5% level.

In Table 7.1, the sample suggests that the largest proportion of farmers had some education, mostly up to 5 years of primary school education (42%) although a handful did

not have any education at all (28%) and very few had post-secondary education (1%). Education level is higher among the homestead food gardeners (about 6 years spent in school) and lower among the smallholder irrigators (about 5 years of schooling). This implies that most household heads depend on the local language to access farm information especially through their fellow farmers. The household size averaged about 4 persons for both smallholder irrigators and homestead food gardeners. The mean household size of the smallholder irrigators is about 4 persons and that of homestead food gardeners is about 4 persons. Results indicate that there are no statistical significant difference in the education level and household size between the smallholder irrigators and homestead food gardeners. Household size in most rural villages of Sub-Saharan Africa is known to be a source of farm and off-farm labour (Kibirige, 2008).

Both smallholder irrigators and homestead food gardeners considered farming as their major occupation (92%), an indication of the endemic unemployment situation among the Qamata and Tyefu population. The average age of the household head among smallholder irrigators and homestead food gardeners is about and about 62 years, respectively (Table 7.1). This indicates that farmers at Qamata and Tyefu irrigation scheme areas may be less productive since their age is far above the youthful productive stage as defined by Ogundele and Okoruwa (2006). Increased number of farmers within this age bracket may be a reflection of more retrenched and retired formal employees who take on farming as their source of livelihood for survival. Most youth migrate to urban areas in search of more paying employment opportunities (Obi and Pote, 2012). Although age and farm experience are considered to be interrelated, age in most cases is associated with decreasing farm output. The average farming experiences of smallholder farmers and homestead food gardeners is approximately 11 years and 13 years respectively. The Chi square test indicated that homestead food gardeners had a significantly higher farming experience than smallholder irrigators at a 5% level. Many smallholder farmers abandoned their fields during the period when government stopped providing input subsidies and meeting most of the managerial and operation costs on the irrigation schemes. The scheme collapsed especially the Tyefu irrigation scheme, and the facilities were vandalised. For example, between 1997 and 2009 smallholder irrigators had no access to Tyefu irrigation scheme (Sishuta, 2005).

7.3 Sources of Farmers' Income per Cropping Season

According to results displayed in Table 7.2, farming communities in the study area derive their livelihood from crop and livestock production, off-farm incomes, and remittances, grants and pension. However, the study did not intend to estimate household income levels of smallholder farmers but merely for purposes of establishing its contribution to general livelihood of farmers. Considering individual income sources, both smallholder irrigators and homestead food gardeners seem to earn more incomes from remittances, social grants and pension more than other sources of incomes. Smallholder irrigators approximately earn significantly higher crop incomes (about R3087.85) than homestead food gardeners (about R1530) at a 1% level. According to the independent t-test, there is a significant difference between off-farm incomes earned by smallholder irrigators and homestead food gardeners at the 1% level, where the latter benefits more (about R296.94) from this income than the former (R987.47). It is important to note that social grant as source of financial asset was not statistically significantly different among the farmer-groups probably because the grants are set at the same level for all recipients, total household receipts varying only on the basis of number of recipients.

When both crop and livestock incomes are combined in the overall sample, results indicate that farming is the most important source of income for “poor” rural households. This affirms agriculture’s major role as a source of improved household incomes and poverty reduction among rural communities. Findings of this study are consistent with a study carried out by Machethe *et al.* (2004) on estimating the impact of smallholder agriculture on rural poverty alleviation whose findings revealed that most rural households derive their incomes from farming activities, followed by remittances and less from other off-farm incomes.

Table 7.2: Sources of Farmers' Incomes per Cropping Season

Source	Smallholders Irrigators (n=108)		Homestead Food Gardeners (n =50)		Overall Sample (n=158)		T-value
	Mean	S. D	Mean	S. D	Mean	S. D	
Crop incomes (R)	3087.85	3866.88	1530.53	2001.94	2309.19	2934.41	3.331***
Livestock incomes (R)	828.37	1902.09	993.07	1284.07	910.72	1593.08	-0.556
Off-farm incomes (R)	294.94	630.27	987.47	1678.79	641.205	1154.53	-3.749***
Remittances, social grants & pension (R)	3516.9	3746.81	3710.40	2742.88	3613.65	3244.85	-0.365

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where *** represents significance at 1% level, and S.D = Standard Deviation and R = Rand

7.4 Crops Grown by Smallholder Farmers

Overall, 66% of the smallholder plots were planted to three crops only, namely maize, cabbage and potatoes and 20% to other vegetables, including carrots, onions, butternut, pumpkins, melons, beans and beet root. The overall proportion of plot size planted to maize was 34.0%, 18% of potatoes and 14.5% of cabbages, respectively. Other crops grown by smallholder farmers included spinach (9%), and lucerne (4.5%). When comparing the two groups, smallholder irrigators grew more maize, other vegetables and lucerne while homestead food gardeners grew more cabbage, spinach and potatoes. This information is presented in Table 7.3. These results match with Cousins (2013) who reported that the main crop grown on smallholder irrigation schemes was maize, and others included cabbages, tomatoes, potatoes and green peppers.

Table 7.3: Crops Grown by Smallholder Farmers

Crop Grown	Type of Farmer		Overall Sample (%)	Main Season
	Smallholder Irrigators (n=108) (%)	Homestead Food Gardeners (n =50) (%)		
Maize	39.0	29.0	34.0	Summer
Other Vegetables	26.0	14.0	20.0	Winter
potatoes	17.0	19.0	18.0	Winter
Cabbage	8.0	21.0	14.5	Winter
Spinach	4.0	14.0	9.0	winter
Lucerne	6.0	3.0	4.5	Both

Source: Results from SPSS (Version 11) generated from field survey, 2012

Although most crops are grown throughout the year especially among homestead food gardeners, most vegetable production is carried out during winter and maize production in summer (Fanadzo *et al.*, 2009). Farmers follow a common crop rotation involves growing maize from August to December during summer, and vegetable crops such as cabbages or spinach from May to August during winter season (Cousins, 2013). Considering a single crop, smallholder irrigators concentrate more on maize production as per designated purpose of food plots to supply food to the household, whereas homestead food concentrated more on cabbage and spinach production. Cabbage, spinach and other vegetables normally demand more water compared to other types of crops grown by the farmers. Thus, homestead food gardeners' find it easier to water their cabbages and spinach within their homesteads and also, they enjoy relatively more freedom on water use and control compared to the more restrictive rules faced by the smallholder irrigators on the schemes.

7.5 Reasons why Smallholder Farmers Grow Specific Crops

According to Sishuta (2005), the government considered individual household food plots at the irrigation schemes and homesteads as the social components (household food supply), and the medium mechanised and sophisticated state controlled farms as the economic component of the irrigation schemes. However, smallholder farmers at the irrigation schemes in the study area view these food plots as a potential source of food and household incomes. Findings presented in Table 7.4 indicate that overall, smallholder farmers chose to grow maize, cabbage and potatoes because they are considered to be staple food (35%), income generating (29%), easy to grow (25%) and to conform to dominant practices by growing the same crops (7%). Reasons for feeding livestock (2%), high yielding (1%), and ease of marketing (1%) did not count much as motivators of farmers' choice to grow these crops.

Table 7.4: Reasons why Smallholder Farmers Grow Specific Crops

Reason	Smallholder Irrigators (n = 108) (%)	Homestead Food Gardener (n =50) (%)	Overall Sample (n =158) (%)
Staple food	33	38	35
Income generation	29	29	29
Easy to grow	29	21	25
Community grow the crop	5	8	7
Feed livestock	2	2	2
High yields	1	1	1
Easy to market	1	0	1

Source: Results from SPSS (Version 11) generated from field survey, 2012.

7.6 Type of Agro-inputs used by Smallholder Farmers

Overall, smallholder farmers in Qamata and Tyefu area used most of the essential agro-inputs in maize and vegetable production. Improved seeds (79%), fertilizer (55%), agro-chemicals (herbicides and pesticides) (30%), and tractor hire (66%) for mainly clearing and ploughing of fields/gardens are among inputs used by smallholder farmers. The independent T-test results indicate that there is a significant difference in the use of improved seed and tractor between smallholder irrigators and homestead food gardeners at the 5% and 1% levels, respectively. Smallholders had more access to improved seeds and tractors than homestead food gardeners. This appeared to be due to the close relationship between smallholder irrigators' farming activities and the central unit of the schemes mainly managed by government staff. Some modern technology which was used formally by the state controlled commercial portions on the irrigation schemes is now extended to smallholder irrigation plots. At least 17% of smallholder irrigators indicated that they were receiving some government input support and only 2% of the homestead farmer had such a privilege. The independent T-test results indicate a significant difference between the two farmer categories on receiving government support at a 1% level.

Table 7.5: Types of Inputs used by Smallholder Farmers

Agro-input used	Description	Type of Farmer			T-Test
		Smallholder Irrigators (n=108) (%)	Homestead Food Gardeners (n=50) (%)	Overall Sample (n=158) (%)	
Improved seed	Yes	87	71	79	-2.366**
	No	13	29	21	
Inorganic Fertilizers	Yes	57	53	55	-0.458
	No	43	47	45	
Agro-Chemicals	Yes	27	33	30	0.707
	No	73	67	70	
Tractors	Yes	83	49	66	-4.736***
	No	18	53	35	
Inputs from government	Yes	17	2	9	-3.547***
	No	83	98	91	

Source: Results from SPSS (Version 11) generated from field survey, 2012: where *** and ** represents significance at 1% and 5% level.

7.7 Input Use among Smallholder Farmers

An independent sample T-test was carried out to establish the difference in input use between smallholder irrigators and homestead food gardeners. According to the results displayed in Table 7.6, there is a mean difference between average numbers of irrigation /ha/season (number of times a farmer irrigate his/her field/garden per seasons) of maize production, higher among smallholder irrigators (208.78 times/ha/season) and lower among homestead food gardeners (116.14 times/ha/season) at a 1% significant level. Smallholder irrigators devoted slightly less land (0.67ha) and amount of maize seed planted (24.99Kg/ha) compared to the homestead food gardeners maize land (0.72ha) and amount of maize seed planted (26.20Kg/ha). The amount of fertilizer applied (58.03Kg/ha), pesticide (0.74L/ha) and herbicides (0.64L/ha) per hectare used by smallholder irrigators were slightly more compared to homestead food gardeners who applied fertilizer of 50Kg/ha, 0.73L/ha of pesticide and 0.40L/ha of herbicide, respectively. Thus, control of weed using chemicals and pest control using pesticides are mainly carried out by smallholder irrigators in maize production. Overall, maize production was apportioned more land (0.70ha) than cabbage production (0.16ha).

Table 7.6 indicates that, with the exception of land allocated to cabbage production, homestead food gardeners devoted more agro-inputs in the enterprise than smallholder irrigators. Homestead food gardeners applied more fertilizer (63.4Kg/ha) and number of irrigations/ ha/season (191.79 times/ha/season) in cabbage production than smallholder irrigators' fertilizer (18.83Kg/ha) and number of irrigation/ ha/season (103.56) at a 1% and 10% significant levels, respectively. Furthermore, the amount of pesticide and cabbage seed planted by homestead food gardeners was slightly more than the same input used by smallholder irrigators. The results of this study are confirmed by Obi *et al.* (2012) who indicated that most homestead food gardeners produce more vegetables than grain foods.

Table 7.6: T-test for Mean Difference in Input Use among Smallholder Farmers

Farm Inputs	Smallholder irrigators (n=108)		Homestead Food Gardeners (n = 50)		Overall Sample (n=158)		T-Test
	Mean	SD	Mean	SD	Mean	SD	
land under maize production (ha)	0.67	0.97	0.72	1.02	0.70	1.00	-0.306
Maize seed planted per ha (Kg/ha)	24.99	28.87	26.20	23.57	25.60	26.22	-0.280
Fertilizer applied per ha of maize (Kg/ha)	58.03	85.44	50.00	87.09	54.02	86.27	0.545
Pesticide applied per ha of maize (L/ha)	0.74	3.03	0.73	3.18	0.74	3.11	0.010
Herbicide applied per ha of maize (L/ha)	0.64	1.93	0.40	1.70	0.52	1.82	0.800
Number of irrigations/season/ha (maize)	208.78	217.33	116.14	132.94	162.46	175.13	3.256***
land under cabbage production (ha)	0.16	0.29	0.16	0.16	0.16	0.23	0.085
Cabbage seeds planted per ha (Kg/ha)	0.39	1.31	0.63	0.92	0.51	1.12	-1.318
Fertilizer applied per ha of cabbage (Kg/ha)	18.83	60.59	63.4	131.03	41.12	95.81	-2.930***
Pesticide applied per ha of cabbage (L/ha)	1.00	9.62	1.76	4.55	1.38	7.09	-0.674
Number of irrigations/season/ha (cabbage)	103.56	360	191.79	256.65	147.68	308.32	-1.759*

Source: Results from SPSS (Version 11) generated from field survey, 2012: Where *** and * represents significance at 1% and 10% level respectively; SD = Standard deviation; ha = hectares, Kg = Kilograms, L = Litres.

In South Africa, the recommended planting rates for improved maize seed generally range from 20Kg/ha to 25kg/ha (Hassan *et al.*, 2001). Therefore, findings in this study indicate that both smallholder irrigators and homestead food gardeners planted maize using the recommended seed rate. The recommended fertiliser rates for irrigated maize vary depending on the yield potential, but can be as high as 220 kg N ha⁻¹ for a yield target of 10 t ha⁻¹ in South African (Fanadzo *et al.*, 2009). However, findings in this study indicate that both smallholder irrigators and homestead food gardeners apply far less fertilizer than the recommended rate and these findings are consistent with Fanadzo *et al.* (2009) study

whose results showed that on average, farmers applied only 47.6 kg N ha⁻¹ of fertilizers at Zanyokwe irrigation scheme. Although both, smallholder irrigators and homestead food gardeners' cabbage seed planting rate was within the recommended rate ranging from 0.50 to 2Kh/ha for direct seeding, they applied far less fertilizers than the recommended rate ranging between 500 and 1000Kg/ha in cabbage production (Allemann and Young, 2008).

7.8 Irrigation Water Use

Figure 7.1 presents famers' responses to questions about the sources of water for crop production. The dam (the irrigation canal) provides water for farm production for 36% of smallholder irrigators and 27% homestead food gardeners. Rainfall is the main source of water for homestead food gardeners (44%) for crop production, and also considered by smallholder irrigators (36%) as a perfect alternative source of water besides dams. Smallholder irrigators tend to save more water in the dams especially during rainy season by reducing its use for rainfall. Tyefu irrigation scheme draws irrigation water directly from pipes connected to the Orange River and thus 28% of smallholder irrigators use water from the river while only 5% of homestead food gardeners use the same source of water. Piped/Tap water is mainly used by homestead gardeners (23%) to irrigate crops in the homestead gardens using hose pipes. Only, few homestead gardeners (1%) drew water from springs (1%) and thus signifying the importance of dams (the irrigation canal), rivers and rainfall as major sources of water for agricultural production.

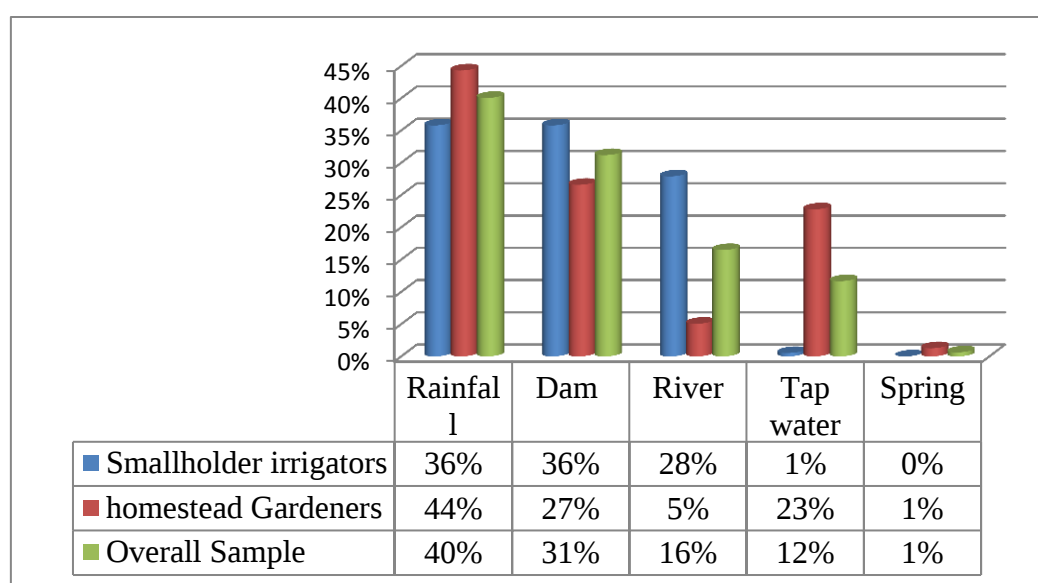


Figure 7.1: Sources of water for crop production

Source: Excel computer Software bar graph generated from field survey data, 2012.

7.8.1 Types of Irrigation Systems Used by Smallholder Farmers

There are six types of irrigation systems used by smallholder farmers in Qamata and Tyefu irrigation scheme areas, namely furrowing, sprinkler, hose pipe, bucket, and flooding and pivot irrigation systems. Sprinkler and Furrowing were the most used irrigation system among smallholder irrigators (47% and 45%, respectively) whereas homestead food gardeners irrigated their crops using mainly hose pipes (37%) connected to water taps followed by furrowing (29%). All farmers at Qamata irrigation scheme use furrowing type of irrigation with exception of some days when they are allowed to apply the flooding type of irrigation. Tyefu irrigation scheme mainly uses sprinkler type of irrigation system though water flows by gravity as in the Qamata irrigation scheme. Watering crops using buckets was mainly done by homestead food gardeners who fetched water from the canal for that purpose. The flooding type of irrigation requires larger volumes of water, hence limiting its use by homestead food gardeners. Overall, furrowing (37%) was the most used type of irrigation followed by sprinkler (30%), hose pipe (19%), buckets (11%), Flooding (2%) and pivot (2%) types of irrigations, respectively (Figure 7.2).

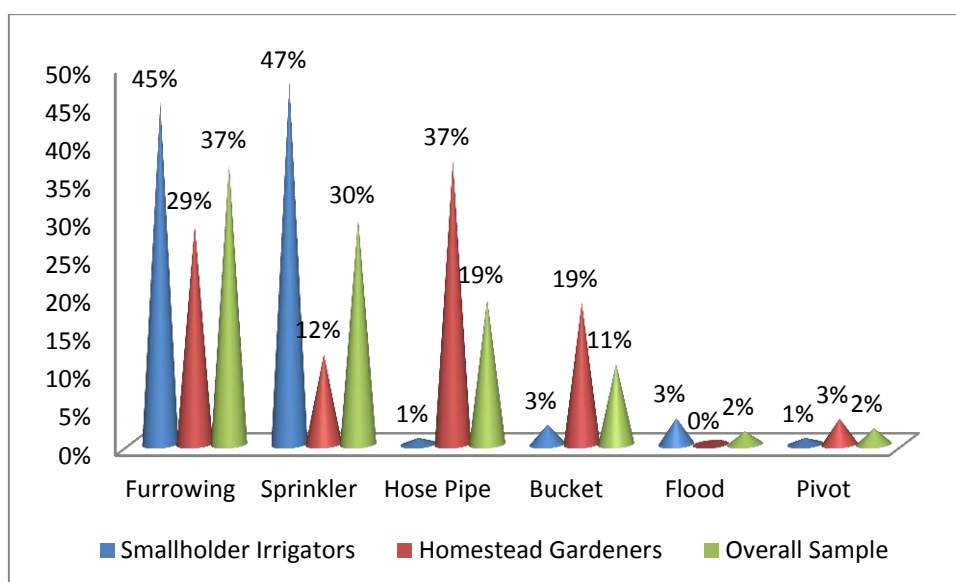


Figure 7.2: Types of Irrigation Systems used by Smallholder Farmers

Source: Excel computer Software bar graph generated from field survey data, 2012.

7.8.2 Factors Impeding Farmers' Access to Irrigation Schemes

According to the percentage distribution indicated in Figure 7.3, the major hindrance of farmers' access to Qamata and Tyefu irrigation scheme facility is lack of land on the scheme (50%). The historical land distribution criteria carried out by the Tribal Authority in Qamata and Tyefu area may have denied some families access to land and the increasing population which can hardly be accommodated by the facilities. Nevertheless, officials managing the scheme and some farmers reported incidences of large portions of uncultivated land which cannot be easily accessed by other users due to the present rigid land tenure regime and restrictions on water user's rights transfers. As indicated in Table 7.1 most farmers are old and 18% of the farmers reported to have less interest in pursuing access to irrigation plots because they are less energetic to meet the labour input required to cultivate these plots. Other impeding factors of farmers' access to irrigation plots are; lack of capital (9%), social conflicts (9%) and limited information on how to access the plots (9%), and 5% of farmers lacked interest in the irrigation scheme plots.

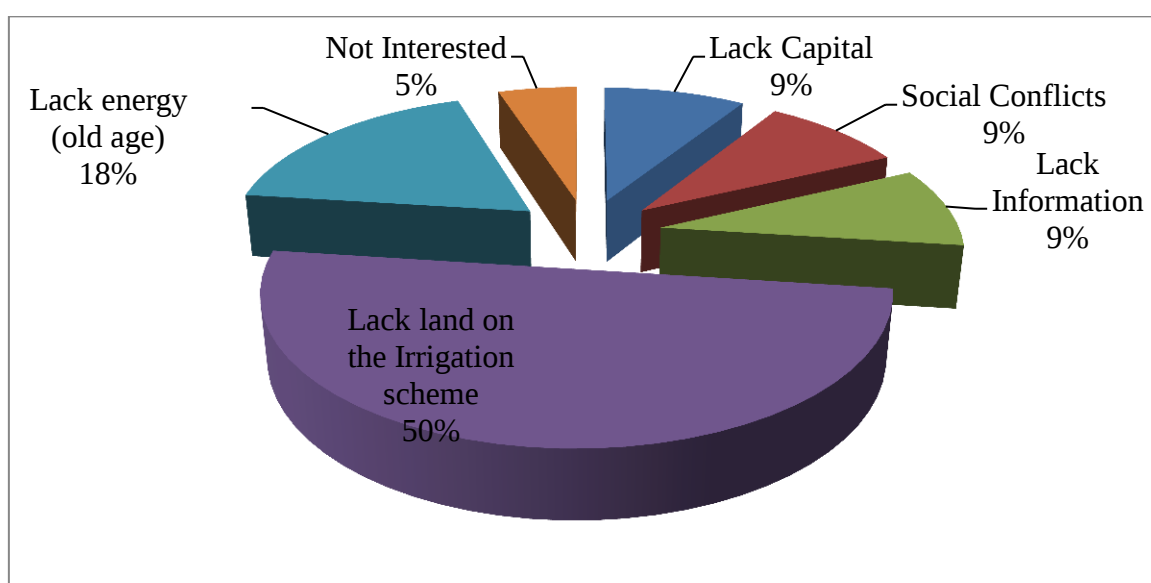


Figure 7.3: Factors Impeding Farmers' Access to Irrigation Plots

Source: Excel computer Software bar graph generated from field survey data, 2012.

7.8.3 Challenges Faced by Smallholder Irrigators at the Irrigation Schemes

Smallholder irrigators face several challenges. Results in Table 7.7 were generated using SPSS software multiple response technique where some respondents provided more than one option making total number of 221 responses. According to the results, 30% of smallholder irrigators' farmers reported inadequate supply of water by the irrigation scheme and this limits their productivity. It may be ascribed to limited number of irrigations per week directed to farmers by the irrigation scheme managers. Qamata and Tyefu irrigation schemes are among the small-scale irrigation schemes which were transferred from state management and operations to farmers' governance due to failure to meet cost recovery targets by the state. However, through the researcher's observations and explanations from the extension workers at both schemes, the scheme's operations seemed to have worsened since the transfer.

At least 30% of farmers indicated that the high costs of repairs and rehabilitation of the scheme are a major problem. Further, the government staffs who previously managed and operated the irrigation schemes failed to train the smallholder farmers on how to operate most components of the schemes creating a skills gap and this makes it hard for farmers to carry out the day to day operations of the scheme as reported by 15% of the farmers. Moreover, in an exclusive interview with some of the farmers' committee members of the scheme for Section 3 at Qamata, it was revealed that farmers did not know how to open the water valves connected to pipes from the dam that allows water to flow into their fields and lacked the technical knowledge on how the whole irrigation system operates.

Table 7.7: Challenges faced by Smallholder Irrigators on the Schemes

Challenges	Number of responses	Percentage
Inadequate water	66	30
High costs of repairs and rehabilitation	66	30
Hard to operate	34	15
Poor management	23	10
Not profitable	12	5
Not productive	6	3
Lack fencing	6	3
underutilized	4	2
Theft	2	1
Limited land and rigid land and water user rights transfers	2	1
Total Response	221	100

Source: Results from SPSS (Version 11) generated from field survey, 2012

Other challenges faced by smallholder irrigators are poor management (10%) of the scheme which is blamed on government's withdrawal of most of its management. Previously the scheme was managed by 46 managers who were reduced to only 3 managers currently managing the whole scheme activities with the help of water users' association committee members. During the interview some farmers indicated that government staff was too skeletal to manage all sections of the irrigation schemes. Irrigation plots were reported to be unprofitable (5%), less productive (3%), lacked fencing (3%), under-utilized (2%), prone to theft of produce (1%), and land was limited with rigid land and water user rights transfers (1%) as indicated in Table 7.7.

7.8.4 Smallholder Irrigators' Suggested Solutions

Although the government still provides extension services to smallholder irrigators at the Qamata irrigation scheme, farmers seem to be unsatisfied with the services, with 75% calling for more support from the government especially in respect to provision of inputs, and more extension officers skilled in technical aspects of irrigation systems. Some 15% of the farmers called for the role of NGOs (15%) to be enhanced to support farmers in different aspects of their farming business. Only 10% of respondents indicated that the community authorities should intervene to solve some of these challenges especially the problem of land access and transfer of water use rights for improved operation of the system. The 10% of farmers' response indicated that farmers are not confident that they

can manage and operate the irrigation schemes themselves. This information is presented in Table 7.8.

Table 7.8 Suggested Solutions for Improved Operations on the Irrigation Schemes

Solution	Number of responses	Percentage
Government Intervention	74	75
Non-Government Organisation support (NGOs)	15	15
Community Intervention	10	10
Total Response	93	100

Source: Results from SPSS (Version 11) generated from field survey, 2012

7.9 Extension Services

According to Kodua-Agyekum (2009), Qamata irrigation scheme is had eight permanent extension officers assigned to it to provide farmers with training services. Overall, 61% of farmers have access to training on input use and 50% of farmers indicated that they have access to training related to agronomic techniques (Table 7.9). In a discussion with a few group members, farmers attested to the high level of support received from the extension officers to the extent of involving themselves directly in planting and application of other agro-inputs in farmers' fields especially among smallholder irrigators in Qamata. In return, this has led to high dependency of farmers on extension officers' direct involvement in field activities resulting in farmers' low self-esteem especially in applying improved technologies. However, the extension officers' direct involvement in farmers' field activity may lead to increased efficient use of input and productivity.

Extension service in the Eastern Cape Province is a top-down approach rather than a participatory approach (Van Niekerk *et al.*, 2011). Although extension workers interact with farmers in the study area, they do not engage farmers in hands on practical skills training and empowerment (Van Niekerk *et al.*, 2011). The traditional agricultural extension service is a hierarchy, where the scientist is placed on top and innovate the technology, and the technology is disseminated through the extension officer to the farmer. These innovations ignore farmers' knowledge, skills and experience important for adoption of new technologies (Ton, 2005). Therefore, this called for more participatory approaches that engage farmers to gain hands on experience for sustainable food production, improved rural livelihood and natural resource management (Van Niekerk *et al.*, 2011). In this case

the Participatory Extension and Agriculture (PEA) can be of great importance for improved farmers' empowerment and skills transfer.

The PEA approach is related to the Agricultural Research for Development (ARD) approach. In the PEA the extension officers act as facilitators rather than agents that transfer agricultural knowledge to farmers (Ton, 2005). The extension officers' facilitation involves creating an environment that enables farmers to carry out an in-depth situation analysis by themselves at the beginning through the application of a Participatory Rural Appraisal (PRA). From the start, farmers are engaged in a participatory action learning process. Farmers organise themselves in groups, identify their most pressing problems and the extension officers provide technical knowledge that contributes to resolving the identified problems (Ton, 2005). With the help of the extension officer, farmers identify strategies, formulate joint action plans, and implement their joint action plans. For a success PEA, extension officers need to have strong analytical, pedagogical and facilitating skills (Ton, 2005). The PEA recognises farmers' goals, and engages farmers in planning, implementing and evaluating their development activities, and hence strengthening farmers' problem-solving capacities for self-sustenance (Ton, 2005).

Surprisingly, homestead food gardeners indicated that they receive training on input use and agronomic practice more significantly than smallholder irrigators at a 1% level respectively. However, based on group discussions, smallholder irrigators in Qamata have more access to extension services than farmers at Tyefu irrigation scheme who hardly receive any support from extension officers. Farmers' access to record keeping, financial management, marketing and working in group training is grossly inadequate. Not surprisingly, all extension workers were not qualified to hold these positions due to their limited educational qualifications, according to the South African Extension and Advisory Service policy (Kodua-Agyekum, 2009). Limited education denies them the essential skills needed to manage effective transfer of skills to farmers and this in turn leads to farmers' poor management practices. Nonetheless, 54% and 66% of smallholder irrigators and homestead food gardeners, respectively, acknowledged their regular access to extension workers. Another major source of information identified by smallholder irrigators (99%) and homestead food gardener (100%) was from fellow farmers (Table 7.9). Farmers exchanged ideas, especially smallholder farmers, who belong to water users' association groups.

Table 7.9: Farmers' Access to Trainings and Extension Services

Item	Description	Smallholder Irrigators (n =108) (%)	Homestead Food Gardeners (n=50) (%)	Overall Sample (n=158) (%)	Chi-Square Test
Trained on input use	Yes	49	72	61	-7.302***
	No	51	28	39	
Trained on agronomic practices	Yes	37	62	50	-8.607***
	No	63	38	50	
Trained on Record keeping	Yes	2	0	0	0.466
	No	98	100	99	
Trained on Financial Management	Yes	2	0	0	0.470
	No	98	100	99	
Trained on Marketing	Yes	3	0	1	1.429
	No	97	100	99	
Trained on working in groups	Yes	5	0	2	2.368
	No	95	100	98	
Access to extension services	Yes	54	66	60	1.945
	No	46	34	40	
Farmers major source of information	Radio	1	0	1	0.423
	Fellow farmers	99%	100%	99%	

Source: Results from SPSS (Version 11) generated from field survey, 2012: Where *** represents significance at 1% level

7.10 Farmers' Benefits from Group Membership

Results in Table 7.10 indicate that there are 61% of smallholder irrigators and 59% of homestead food gardeners who belong to farmer groups and there are several different benefits arising from group membership among smallholder farmers. Both smallholder irrigators (45%) and homestead food gardeners (50%) used groups as a major source of supply of farm labour. Notably, farmer groups provided relatively subsidised farm inputs and collective marketing to smallholder irrigators (26% and 25%, respectively) and homestead food gardeners (29% and 17%, respectively). Another contribution of farmer groups to homestead food gardeners were access to farm related information and credit access through group loans from microfinances and banks.

Table 7.10: Farmers' Benefits from Group Membership

Farmer benefits	Smallholder Irrigators (n = 108) (%)	Homestead Food Gardener (n =50) (%)	Overall Sample (n =158) (%)
Group membership	61	59	60
Access to labour	45	50	48
Access to agro- inputs	26	29	28
Collective Marketing	25	17	21
Access to farm information	0	4	2
Access to credit	3	0	1

Source: Results from SPSS (Version 11) generated from field survey, 2012

7.11 Profitability and Commercialization level of Maize and Cabbage Enterprises

The indication from Table 7.11 is that smallholder irrigators concentrate more on maize production than the homestead food gardeners. According to the results, smallholder irrigators generate significantly higher maize yield, total revenues and gross margins from maize enterprise at a 5%, 10% and 5% levels, respectively more than homestead food gardeners. Also smallholder irrigators produce more marketable surplus of maize with a commercialization index score of 0.45 compared to 0.37 index score of the homestead food gardeners. However, homestead food gardeners spent more money in purchase of inputs and this may have contributed to their low gross margins (R254.655). Smallholder irrigators incur less input costs probably because they purchase inputs collectively, thereby reducing on the unit costs. Further, smallholder irrigators have higher chances of benefiting from price discounts and transport offer by input suppliers than homestead food gardeners. Further, this may be due to, smallholder irrigators have more access to reliable irrigation water supply and modernised irrigation systems compared to the homestead food gardeners who have less access to crop irrigation water and mainly rely on traditional irrigation methods. In South Africa, the potential grain yields that can be obtained under irrigation farming range from 7 to 12 tons/ha (Fanadzo *et al.*, 2009). This indicates that maize yields for both smallholder irrigators and homestead food gardeners are far below the expected yields. This suggests that smallholder irrigators are sub-optimally utilizing irrigation schemes. The low yields may be attributed to low fertilizer, pesticides and herbicides applications, among others. Further, the low use of these agro-chemicals may be due to lack of investment capital to purchase these inputs.

Table 7.11: Profitability of Maize Enterprises among Smallholders

	Description	Smallholder Irrigators (n=108)	Homestead Food Gardeners (n=50)	Overall Sample (n=158)	T -Value
		Mean	Mean	Mean	
Maize yields	Kg/ha	2199.59 (2967.64)	1468.497 (1488.9)	1834.04 (2228.27)	2.061**
Total revenues from Maize	Rand/ha	3469.89 (6560.57)	2141.48 (2900.1)	2805.69 (4730.34)	1.765*
Total Cost for maize production	Rand/ha	1448.68 (2280.22)	1869.30 (2803.02)	1658.99 (2541.62)	-0.995
Gross margins from maize	Rand/ha	2021.209 (6035.331)	254.655 (3012.671)	1137.932 (4524.00)	2.444**
Commercialization Index for Maize	Ratio	0.45 (0.37)	0.37 (0.35)	0.41 (0.36)	1.324

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where *, and **, represents significance levels at 10%, and 5% level, respectively. (SD) = standard deviation. , ha = hectares, Commercialization Index ratio = Quantity marketed of a given crop divided by total quantity harvested of the same crop

In addition to high gains from maize production, smallholder irrigators also generate more yields, total revenues and gross margins from the cabbage enterprise compared to homestead food gardeners. The low gross margin generated from cabbage production by homestead food gardeners may be attributed to more spending on purchased inputs compared to the smallholder irrigators as indicated in Table 12. Despite the low yields, total revenues and gross margins, homestead food gardeners have slightly higher commercialisation index, implying that they participate more in the cabbage marketing than smallholder irrigators. Smallholder irrigators harvest more yields than homestead food gardeners probably because they have more access to relatively less costly input through collective action. They also have more access to irrigation water and use modernised irrigation systems compared to homestead food gardeners who mainly rely on rainfall and use traditional irrigation methods. According to Allemann and Young (2008), the recommended cabbage yields in terms of number of cabbage plants per hectare ranges between 40 000 and 45 000 heads/ha, however, findings in this study indicated that smallholder irrigators and home stead food gardeners were planting far less (1111.24 heads/ha and 836.93 heads/ha, respectively) than the recommended amount. This is probably because both smallholder irrigators and homestead food gardeners apply less agro-chemicals which are important for fertility, pesticides and weed control and hence

resulting in low productivity. The less use of fertilizers, herbicides and pesticide may be due to lack of investment capital to purchase these inputs.

Table 7.12: Profitability of Cabbage Enterprises among Smallholders

	Description	Smallholder Irrigators (n=108)	Homestead Food Gardeners (n=50)	Overall Sample (n=158)	T -Value
Cabbage Yields	heads/ha	1111.24 (3627.21)	836.93 (1953.39)	974.09 2790.30	0.616
Total revenue from Cabbage	Rand/ha	6010.49 (21933.73)	2852.00 (8324.25)	4431.245 15128.99	1.307
Total Cost for Cabbage production	Rand/ha	654.91 (1868.97)	667.67 1499.51	661.29 1684.24	-0.046
Gross margins for Cabbage	Rand/ha	5355.586 (21760.48)	2184.333 (8284.46)	3769.960 (15022.47)	1.322
Commercialization Index for Cabbage	Ratio	0.19 (0.35)	0.24 (0.38)	0.22 (0.37)	-0.874

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where, (SD) = standard deviation, ha = hectares, Commercialization Index ratio = Quantity marketed of a given crop divided by total quantity harvested of the same crop

Therefore, it can be noted that smallholder irrigation farmers are mainly interested in growing maize for both home consumption (55%) and marketing (45%) while homestead famers are mainly interested in production of cabbages consuming 76% and sell 24% of their produce. The overall commercialization index of maize and cabbage seem to suggest that farmers sell more quantities of maize (41%) than cabbage (22%), although cabbage sales generate more gross margins (R3769.96/ha) than maize (R1137.93/ha). The high gross margin reaped from cabbage sales clearly indicates that cabbage is a high value product than maize and therefore smallholder irrigators are bound to earn more crop farm incomes than homestead food gardeners. Thus, this may need smallholder irrigators to devote more land to cabbage production for their increased household incomes rather than relying more on maize production that brings in relatively lesser profits.

7.12 Estimating the Allocative Efficiency of Smallholder Farmers

This section begins with estimating the input elasticities which are then used to estimate the allocative efficiency. The allocative efficiency was estimated using a log-linearized production function of selected inputs whose prices were easily estimated by farmers.

Due to insufficient information about the actual weights of cabbage and amount of cabbage seed planted, the study concentrated more on estimating allocative efficiency of maize whose input and output prices could easily be estimated by farmers. This approach calls for price information and without such information it is impossible to execute a single result.

7.12.1 Input Elasticities

When using a stochastic frontier approach, elasticities (β_i) are important in allocative efficiency estimation. The Cobb-Douglas production function was estimated for both smallholder irrigators and Homestead food gardeners. The Cobb-Douglas production function was estimated using log-linear Ordinary Least Squares (OLS) (see equation 19 in Chapter 6: Section 6.2.3) and the coefficients estimated represented individual elasticities. The elasticities associated with land under maize production and number of irrigations/ha/season for smallholder, and land under maize production and quantity of seed planted for homestead food gardeners were greater than one. For such inputs with elasticity greater than one and positively related to maize output, a 1% increase in the respective input would result into a more than 1% increase in maize output. In contrast, a 1% increase in input of less than 1% would result in less than 1% increase in maize output. Estimated elasticities are shown in Table 7.13.

Land under maize production, number of irrigation/ha/season and capital has positive and significant relationship with maize output at 1% level respectively among smallholder irrigators. Thus, a unit increase in land under maize, number of irrigation/ha/season and capital, would result in an increase of approximately 2.4, 1.1 and 0.4 units of maize output for smallholder irrigators, respectively. Among homestead food gardeners, the amount of land allocated to maize, amount of seed planted and numbers of irrigations/ha/season have a positive and significant impact on maize output at a 1% level, respectively. This indicates that, a unit increase in land under maize production, amount of seed planted and number of irrigations/ha/season result in an increase of approximately 2.2, 1.3 and 0.60 units of maize output, respectively, among homestead food gardeners. Therefore, for increased maize output among smallholder irrigators and homestead food gardeners, there is a need to expand land and increase access to irrigation water, although this may call for additional agricultural support services for sustainability.

Table 7.13: Input Elasticities for Maize Enterprise

Dependent = maize output Variable	Smallholder Irrigators		Homestead Food Gardeners	
	Elasticity (β)	p-values	Elasticity (β)	P-values
Land	2.377	0.000***	2.192	0.000***
Seed planted	0.152	0.238	1.381	0.000***
Fertilizers	-0.065	0.320	0.100	0.472
Pesticide	0.066	0.622	-0.378	0.508
Herbicides	-0.135	0.529	-0.263	0.458
Number of Irrigations	1.129	0.000***	0.599	0.006***
Capital	0.397	0.000***	0.037	0.841

Source: Results from SPSS (Version 11) generated from field survey. *** represents significance at 1% level.

Amount of fertilizers applied and herbicides have a negative impact on maize production among smallholder irrigators while pesticides and herbicides have the same impact on maize output among homestead food gardeners. This implies that, a unit increase in the amount of fertilizer applied and herbicides result into a decrease of 0.065 and 0.135 units of maize output, respectively, among smallholder irrigators, while a unit increase in pesticide and herbicides results into a decrease of 0.378 and 0.263 units of maize output, respectively, among homestead food gardeners. One would have expected application of fertilizers, pesticides and herbicides to have a positive relationship with maize output but this was not the case in this study. Increased use of fertilizers, pesticides and herbicides is expected to increase farm output. The negative relationship is probably because most farmers in this study apply small quantities of these agro-inputs, and thus, overall output decreases with an increase in number of smallholders using relatively small quantity of agro-inputs. Further, this may be due to lack of farmers' knowledge and skills on how to apply these inputs leading to low farm output. The negative relationship between output and agro-inputs like fertilizers, pesticides and herbicides in production processes has also been observed in some other studies in the region and elsewhere, notably Chirwa (2003), for smallholder maize producers in Malawi, and Kelemework (2007) who found out unexpected negative relationship between output and pesticide application for Batu Degaga irrigation scheme in Ethiopia.

7.12.2 Allocative Efficiency Estimation

Allocative efficiency estimation assumes that farmers' main goal is to maximise profits. For profits to be maximized, marginal value product (MVP) of a given crop should be equal to the respective unit factor price. Equations 21 to 23 stated in Chapter 6, Section 6.2.3 were used to generate results shown in Table 7.14. Table 7.14 presents the allocative efficiency of smallholder irrigators and homestead gardener. Results indicate that both smallholder irrigators and homestead food gardeners were allocatively inefficient in all the inputs considered in this analysis (Table 7.14). The smallholder irrigators' estimated average mean allocative efficiency for maize seed, fertilizer, pesticide and herbicide used is 2.483, 0.653, 14.193, and 7.063, respectively. This indicates that smallholder irrigators are sub-optimally using maize seed, pesticides and herbicide while over spending on fertilizer costs. Therefore, for maximization of profits earned from maize enterprise, the smallholder irrigators need to use more of the improved seeds, pesticides and herbicide and reduce fertilizer costs.

Since most smallholder irrigators operate in groups, they have access group loans and purchase inputs collectively in bulk. Group members benefit from price discount offer by input dealers and hence low unit costs. This probably has improved access to these inputs resulting in increased yields. Therefore, farmers can maximize their profits if they efficiently utilize group loans and collective purchase of inputs like improved seed varieties, pesticide and herbicides, and search for low fertilizer costs.

The allocative efficiency scores among homestead food gardeners do not differ much from the smallholder irrigators. Results in Table 7.14 indicate that homestead food gardeners were highly inefficient in allocating pesticides (28.355), herbicides (21.806) and seed (10.037), respectively. All these scores are greater than 1 meaning that $MVP > MC$ and therefore there is more room for increased use of these inputs. Homestead food gardeners' allocative efficiency scores for fertilizer (0.754) was relatively lower than 1 and hence inefficiently allocated. Therefore, there is a need to reduce the fertilizer costs or search for cheaper sources of fertilizers for homestead food gardeners to realize maximization of profits in the maize enterprise.

Table 7.14: Estimation of Allocative Efficiency for Maize Enterprise

Smallholder irrigators (n= 108)					
Variable	Coefficients (β)	APP	MPP	VMP_i (MP*Py) (Rand)	Allocative Efficiency (VMP_i / P_i) Scores
Seed (Kg)	0.152	161.094	24.486	57.935	2.483
Fertilizers (Kg)	0.065	40.825	2.654	6.278	0.653
Pesticide	0.066	1497.857	98.859	233.899	14.193
Herbicide (Litres)	0.135	673.084	90.866	214.990	7.063
Homestead Food Gardeners (n =50)					
Variable	Coefficients (β)	APP	MPP	VMP_i (MP*Py) (Rand)	Allocative Efficiency (VMP_i / P_i) Scores
Seed (Kg)	1.381	71.667	98.972	234.168	10.037
Fertilizers (Kg)	0.100	30.646	3.065	7.251	0.754
Pesticide	0.378	522.500	197.505	467.297	28.355
Herbicide (Litres)	0.263	1066.667	280.533	663.742	21.806

Source: Results from SPSS (Version 11) generated from field survey, 2012

In general, both smallholder irrigators and homestead food gardeners are using maize seed, pesticide and herbicides sub-optimally since their allocative efficiency scores for these inputs is above score 1 meaning that marginal revenues are greater than marginal cost. Therefore increase in amounts of maize seeds, pesticide, and herbicide, and a decrease in the fertilizer costs in the maize production for both smallholder irrigators and homestead food gardeners will lead to profit maximization at least cost input combination.

7.13 Estimating the Production Efficiency of Smallholder Farmers

For relatively more accurate results, both the Data Envelopment Analysis (DEA) and stochastic frontier Analysis (SFA) models are employed to estimate the production efficiency of both smallholder irrigators and homestead food gardeners. The DEA model results were generated using the Data Envelopment Analysis (computer) Programme (DEAP Version 2.1) explicitly presented by equation 24 and 25 in Chapter 6: Section 6.2.4.1. Equation SFA model Equation 26 was used to generate all results related to SFA models, and determinants of technical efficiency results were generated using equation 27. Efficiency coefficients were generated by STATA statistical software and determinants of technical efficiency were mainly generated using the SPSS statistical software. Both

Equations (26 and 27) are stated in Chapter 6: Section 6.2.4.2 and 6.2.4.3 respectively. The DEA model was first estimated for maize and then cabbage production as indicated in Table 7.15 and Table 7.19, respectively.

7.13.1 Estimating Production Efficiency in Maize Enterprise by the Data Envelopment Analysis Approach

The DEA model was run to estimate the technical, allocative and economic efficiencies of smallholder farmers in the study area. Considering the Variable Return to Scale (VRS) scores, both smallholder irrigators and homestead food gardeners are technically efficient in maize production, although homestead food gardeners are more and significantly efficient at 10% level. Looking at the VRS index scores for both categories of farmers, smallholder irrigators had an average score of 0.983 while homestead food gardeners scored 0.996. However, the Scale Efficiency (SE) and the Constant Returns to Scale (CRS) index indicate that smallholder irrigators are slightly more technically efficiency than homestead food gardeners. Smallholder irrigators' scores in both the SE and CRS indexes are 0.720 and 0.705 respectively while homestead food gardeners scored 0.676 of scale efficiency and 0.672 of CRS index. Based on Table 7.15 results, 90.74% of smallholder irrigators and 92% of homestead food gardeners are operating at increasing returns to scale, while 9.26% and 8% are operating at decreasing returns to scale, respectively.

The VRS scores may be considered more viable since both smallholder irrigators and homestead food gardeners are not considered to be operating at the same optimal scale/frontier. The CRS model specifications estimate has a tendency of eliminating all farms that seem not to be operating at the same optimal scale/frontier, and in this state, the CRS assumes the scale efficiency scores (Coelli, 1996).

The allocative, technical and economic efficiency index scores were generated using seed, fertilizer, pesticide and herbicide inputs because their prices and quantities were relatively more established and were used by both smallholder irrigators and homestead food gardeners in maize production. Results presented in Table 7.15 indicate that smallholder irrigators are more technically and economically efficient than homestead food gardeners at 10% significant level. In addition, the smallholder irrigators are slightly more allocatively efficient compared to homestead food gardeners in the use of seed, fertilizer, pesticide and herbicide for maize production. According to the allocative, technical and

economic efficiency, smallholder irrigators scored 0.694, 0.62 and 0.434, respectively while homestead food gardeners scored 0.670, 0.564 and 0.383 in allocative, technical and economic efficiency, respectively.

Therefore, for maximisation of maize output and profits, smallholder irrigators need to improve on their economic efficiency by 56.6% while homestead food gardeners need to improve by 61.7% without changing the existing technology. As expected, smallholder irrigators are more technically and allocatively efficient because they have access to cheaper inputs, water for irrigation and use modernized irrigation systems compared to homestead food gardeners whose farming greatly depends on rainfall and mainly use inefficient traditional irrigation methods like buckets. The finding match with Kelemework (2007) who found out that farmers irrigating their fields in Batu Degaga area were technically more technically efficient at 76% compared with those farming on dry-land who scored technical efficiency of 66%. Theoretically adoption of new technologies is thought to increase efficiency and productivity among farmers (CIMMYT, 1993).

Table 7.15 Estimating Farmers' Maize Production Efficiency: DEA Approach

Efficiency Categories	Smallholder Irrigators (n=108)	Homestead Food Gardeners (n=50)	Overall Sample (n=158)	T -Value
	Mean	Mean	Mean	
VRS technical efficiency	0.983 (0.068)	0.996 (0.030)	0.989 (0.049)	-1.687*
Scale technical efficiency	0.720 (0.173)	0.676 (0.213)	0.698 (0.193)	1.375
CRS technical efficiency	0.705 (0.171)	0.672 (0.211)	0.689 (0.191)	1.049
Allocative efficiency	0.694 (0.127)	0.670 (0.125)	0.682 (0.126)	1.156
Technical efficiency	0.620 (0.168)	0.564 (0.221)	0.592 (0.194)	1.749*
Economic efficiency	0.434 (0.153)	0.383 (0.189)	0.408 (0.171)	1.876*
Water use efficiency				
VRS	0.285 (0.259)	0.440 (0.366)	0.362 (0.312)	-3.051***
Scale efficiency scores	0.687 (0.218)	0.627 (0.292)	0.657 (0.255)	1.445
CRS	0.155 (0.093)	0.195 (0.161)	0.175 (0.127)	-1.975**
Scale of operation: Increasing Returns	90.74%	92.00%	91.37%	-
Decreasing Returns	9.26%	8.00%	8.63%	

Source: Results from DEAP (Version 2.1) generated from field Survey, 2012. Where ***, **and * represents significance level at 1%, 5% and 10% level (Std Errors) = Standard errors; VRS = Variable Returns to Scale, CRS =Constant returns to scale.

The number of irrigations carried out per season per hectare was used as a proxy to measure water use efficiency. Table 7.15 displays the VRS, scale and CRS technical efficiency index scores of water use for smallholder irrigators and homestead food gardeners. According to the results, the overall mean VRS efficiency index score for water use is low (0.362), although homestead food gardeners exhibited more efficient use of water (44.0%) compared to the smallholder irrigators who are only 28.5% water efficient users in maize production at 1% significant level. The smallholder irrigators are slightly more scale efficient (0.687) compared to the scale efficiency score of 0.627 for homestead food gardeners. When considering constant returns to scale (CRS), homestead food gardeners are more technically efficient than smallholder irrigators at 5% significant level. Therefore, for maximum output, smallholder irrigators and homestead food gardeners need

to step up their water use efficiency by 0.715 and 0.66 scores, respectively, based on the VRS technical efficiency estimate. A study carried out by Speelman *et al.* (2008) also displayed similar results where famers were technically efficient at 16% in regards to water use in the North-West Province of South Africa. Muchara (2011) also indicated that smallholder farmers were using irrigation water sub-optimally in the Eastern Cape Province of South Africa.

7.13.2 Estimating Technical Efficiency of Maize Production by SFA Approach

The stochastic production function was estimated for the pooled data combining the smallholder irrigators and homestead food gardeners. The estimated parameters and the related statistical test results obtained from the analysis are presented in Table 7.16. The estimated Wald chi-square (625.78) is significantly different from zero at 1 percent. This indicates a good fit of the model and takes into account of the composite random errors. Amount of land under maize production, quantity of maize seed planted, number of irrigations/hectare/season and capital invested positively and significantly influence the amount of maize produced at a 1% level, respectively. Amount of fertilizer, pesticides and herbicides negatively influence the level of maize output though not significantly. The negative impact of such inputs may be attributed to very low applications as presented in Table 7.11. This estimated stochastic production function was used to estimate the technical efficiency of smallholder farmers at Qamata and Tyefu irrigation schemes, respectively, as presented in Table 7.17.

Table 7.16: Estimates of the Stochastic Production Frontier for Maize Enterprise

Independent Variables (in natural logarithm)	Maize Output (Y) = Dependent Variable			
	Coefficient	S.E	Z Value	P-value
Land under maize farming (ha)	2.211	0.178	12.39	0.000***
Seed planted (Kg/ha)	0.468	0.124	3.76	0.000***
Fertilizer applied (Kg/ha)	-0.024	0.061	-0.40	0.691
Pesticide used	-0.066	0.144	-0.45	0.650
Herbicide applied (L/ha)	-0.131	0.188	-0.70	0.486
Number of irrigations/ha/season	0.974	0.111	8.76	0.000***
Capital (Rand)	0.271	0.090	3.01	0.003***
Constant	0.706	0.648	1.09	0.276
sigma_v	1.050	0.060		
sigma_u	0.015	0.750		
Sigma2	1.103	0.126		
lambda	0.015	0.757		
Log likelihood = -228.961				
Prob > chi2 = 0.000***				
Wald chi2(6) = 625.78				
Number of Observations (n =158)				

Source: Results from STATA (Version 9) generated from field survey, 2012; *** represents significance at 1%, ha = hectares, Kg = Kilograms; L = litres; S.E = Standard Error

The overall technical efficiency combining the smallholder irrigators and homestead food gardeners was estimated and a T-test was carried out to compare the performance of the two groups. Both the smallholder irrigators and homestead food gardeners were technically efficient at about 98.80%. Although the results presented in Table 7.17 indicate a slight difference between technical efficiency scores of smallholder irrigators and homestead food gardeners, the overall model indicates a significant difference at 1% level where smallholder irrigators were technically more efficient than homestead food gardeners. These stochastic production frontier results are closely related and confirm the VRS technical efficiency scores generated by the DEA modelling approach, suggesting that farmers do not operate at the same optimal scale/frontier.

Table 7.17: The T-Test of Technical Efficiency for Smallholder Irrigators and Homestead Food Gardeners; Maize Enterprise

Type of farmer	Sample Size	Mean Efficiency	Standard Error	Standard Deviation
Smallholder irrigators (y)	108	0.988017	0.000001	0.000076
Homestead food gardeners(x)	50	0.987964	0.000010	0.000071
Combined	158	0.9880012	0.000006	0.000078
Mean difference		0.0000536	0.000013	

Source: Results from STATA (Version 9) generated from field survey, 2012

Satterthwaite's degrees of freedom = 153

t = 4.1224

Ho: mean(y) - mean(x) $\neq$ 0

Ho: diff = 0

Ha: diff < 0

Ha: diff! = 0

Ha: diff > 0

Pr(T < t) = 1.0000

Pr(T > t) = 0.0001

Pr(T > t) = 0.0000

7.13.3 Determinants of T.E in Maize Production (n=158)

Using an OLS linear regression model of technical efficiency scores against explanatory variables for smallholder maize producers, a relationship between the two was estimated. The explanatory variables were specified as those related to socioeconomic factors of the smallholder farmers at Qamata and Tyefu irrigation schemes. According to results presented in Table 7.18, the Durbin-Watson statistic for the overall regression model was 2.222, signifying acceptable levels of autocorrelation. The F-value indicates that the explanatory variables combined, significantly influence changes in the technical efficiency at a 1% level. Household size, farming experience, use of agro-chemicals, gross margins earned from maize sales and off-farm incomes have a positive and significant impact on the farmers technical efficiency in maize production at 10%, 10%, 5%, 1%, 1% and 5% level, respectively. Thus, an increase in household size as source of farm labour, farming experience to reduce risks of crop failure, use of agro-chemicals to control weed and pests, gross margins, commercialization level and off-farm incomes to purchase inputs all result to increased technical efficiency of smallholder maize farmers in the study area.

The findings reported by Haji (2008), and Kibirige (2008) also indicated similar positive and significant relationship between technical efficiency and household size of smallholder farmers in the eastern and central parts of Ethiopia, and Masindi District in Uganda respectively. Furthermore, findings of this study match with previous studies carried out by

Bifarín *et al.* (2010) and Tshilanbilu (2011) elsewhere indicating a positive and significant influence of farming experience on technical efficiency. Khani *et al.* (2008) reported similar results related to the positive and significant relationship between use of agro-chemicals (pesticides) and technical efficiency of soybean production in the Mekong River Delta of Viet Nam.

Table 7.18: Determinants of T.E. in the Maize Production (n=158)

Explanatory Variables	Dependent Variable = T.E scores in maize production			
	Coefficients	Std. Error	T-Value	P-Value
Household size	0.000	0.000	1.688	0.094*
Age	-0.000	0.000	-0.520	0.604
Education level (years)	-0.000	0.000	-0.802	0.424
Farming experience	0.000	0.000	1.648	0.102*
Amount of land owned	-0.000	0.000	-1.906	0.059*
Training on input use	-0.000	0.000	-1.927	0.056*
Use agro-chemic	0.000	0.000	2.012	0.046**
Use tractor	-0.000	0.000	-1.481	0.141
Gross margins (maize)	0.000	0.000	3.093	0.002***
Commercialization level	0.000	0.000	3.413	0.001***
farm incomes	0.000	0.000	1.096	0.275
Off-farm income	0.000	0.000	2.456	0.015**
location of irrigation scheme	0.000	0.000	0.863	0.390
(Constant)	0.988	0.000	15487.295	0.000***
Adjusted R ² = 0.240				
F-Value = 4.653***				
Durbin-Watson statistics = 2.222				
Number of Observations (n = 158)				

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where ***, ** and * represents significance at 1%, 5% and 10% level respectively; Std. Error = Standard Error.

Both amount of land owned and training on the use of inputs have a negative and significant influence on technical efficiency of maize production at a 10% level, respectively. This indicates that farmers with small plots are more likely to be more efficient than their counterparts with relatively larger plots. This may be attributed to low incomes of smallholder farmers that are insufficient to purchase inputs necessary for relatively larger plots, so they decide to concentrate on small plots for output maximisation within the available resources and technologies. One would expect that increase in farmers' access to input use training would increase their efficiency in maize production, but rather results in the model indicate that increase in farmers' access to input use training leads to a decrease in the technical efficiency. The negative relationship between training

on input use and technical efficiency may be as a result of poor quality extension services rendered to farmers due to technically unqualified extension staff or farmers do not put to practice what is being taught by extension officers (Awoniyi *et al.*, 2007; and Kodua-Agyekum, 2009) Results of the model presented in Table 7.18 further indicate that age of the farmers and education level both have a negative influence on technical efficiency of maize production among smallholder farmers although not significant. Results further indicate that use of tractor had a negative impact on technical efficiency although not significant.

7.13.4 Estimating the Production Efficiency of Cabbage Enterprise by DEA

Results generated by the model are displayed in Table 7.19. The (VRS) scores for both smallholder irrigators and homestead food gardeners indicate that all are technically efficiency in cabbage production each scoring 0.976 and 0.986, respectively. Like the VRS scores of maize production, results suggest that smallholder irrigators are slightly less technically efficient than homestead food gardeners. Further, the scale efficiency and the CRS indices indicate that homestead food gardeners are more efficient than smallholder irrigators with scores of 0.498 and 0.485 compared to 0.471 and 0.454, respectively. However, the scale efficiency and CRS scores seem to be relatively correlated indicating that farms are not operating at the same optimal scale/frontier. Thus, this qualifies the VRS scores as the viable estimate to consider in such situations. Results further indicate that there are 98.7% of both smallholder irrigators and homestead food gardeners who operated at increasing returns to scale, respectively.

In addition to higher cabbage yield harvested by smallholder irrigators, they are more allocative and economically efficient than homestead food gardeners. The independent t-test results revealed a significant difference in the mean economic efficiency scores between smallholder irrigators (0.828) and homestead food gardeners (0.703) at 5% level. However, homestead food gardeners were slightly more technically efficient with efficiency score of 0.954 compared to 0.923 score exhibited by smallholder irrigators. Based on the allocative efficiency scores, for profit maximization at least input cost combination, smallholder irrigators have to reduce on costs incurred in the use of cabbage seed, fertilizer and pesticide by 21.2% while homestead food gardeners have to reduce on costs incurred in the use of the same inputs by 34.9%. In order to maximize output using

the same available inputs and technology, smallholder irrigators have to increase on their technical efficiency by 7.70% while homestead food gardeners have to increase the same by 4.60%.

Table 7.19: Estimating Farmers' Cabbage Production Efficiency: DEA

	Smallholder Irrigators	Homestead Food Gardeners	Overall Sample	T -Value
	Mean	Mean	Mean	
VRS technical efficiency	0.976 (0.092)	0.986 (0.070)	0.981 (0.081)	-0.746
Scale technical efficiency	0.471 (0.153)	0.498 (0.164)	0.485 (0.158)	-0.989
CRS technical efficiency	0.454 (0.129)	0.485 (0.138)	0.469 (0.133)	-1.354
Allocative efficiency	0.788 (0.290)	0.651 (0.310)	0.719 (0.300)	1.206
Technical efficiency	0.923 (0.182)	0.954 (0.133)	0.939 (0.158)	-1.207
Economic efficiency	0.828 (0.308)	0.703 (0.328)	0.765 (0.318)	2.334**
Water use efficiency				
VRS	0.861 (0.255)	0.746 (0.290)	0.803 (0.272)	2.522***
Scale efficiency scores	0.545 (0.221)	0.627 (0.242)	0.586 (0.231)	-2.116**
CRS	0.424 (0.127)	0.406 (0.088)	0.415 (0.108)	1.002
Scale of Operation: Increasing Returns Decreasing Returns	98.70% 0	98.70% 0	98.70% 0	-

Source: Results from DEAP (Version 2.1) generated from field survey, 2012. Where *** and ** represents significance level at 1% and 5% level, respectively. (Std Errors) = Standard errors; VRS = Variable Returns to Scale, CRS =Constant returns to scale.

According to results presented in Table 7.19, smallholder irrigators technically use irrigation water more efficiently compared to homestead food gardener at 1% level of significance. Based on the VRS efficiency index score, smallholder farmers are 86.1% technically efficient while homestead food gardeners are 74.6% technically efficient users of irrigation water. Nevertheless, homestead food gardeners had relatively higher scores for the scale efficiency (0.627) compared to smallholder irrigators who scored 0.545 of scale and the difference was found to be significant at 5% level. For maximum cabbage output, smallholder irrigators and homestead food gardeners need to increase their VRS

efficiency (Technical efficiency) for water use by 0.139 and 0.254 scores, respectively. Cabbage productions require well-drained soils and require more amounts of water in order to achieve optimal growth and high yields (Allemann and Young, 2008). This may explain the reason why water use efficiency is higher in cabbage production compared with maize production in this study.

7.13.5 Estimating Technical Efficiency of Cabbage Production by SFA

When calculating the technical efficiency levels among smallholder irrigators and homestead food gardeners, the Ordinary Least Square (OLS) estimation is made on the Cobb–Douglas production function of the cabbage enterprise. The amount of land under cabbage production, amount of seed planted, fertilizers applied, number of irrigations per hectare and capital were among the explanatory variables used in the estimation of the stochastic frontier model. Results of the stochastic frontier model presented in Table 7.20 indicate that size of land under cabbage production, amount of fertilizers and number of irrigations/ha/season have a positive and significant influence on cabbage output (number of heads harvested) at 1%, 5% and 1% level, respectively. Thus, an increase in the land allocated to cabbage production, amount of fertilizer applied and number of irrigations/ha/season results in increased cabbage output.

Table 7.20 Estimating the Stochastic Frontier for Cabbage Enterprise

Independent Variables (in natural logarithm)	Cabbage output (Y) = Dependent Variable			
	Coefficient	S.E	Z Value	P value
Land under maize farming (ha)	3.299	0.310	10.64	0.000***
Quantity of seed planted (Kg/ha)	-0.248	0.177	-1.40	0.161
Quantity of fertilizer applied (Kg/ha)	0.190	0.078	2.43	0.015**
Quantity of pesticide applied (L/ha)	-0.071	0.145	-0.49	0.625
Number times farmer irrigated a season	1.796	0.134	13.38	0.000***
Capital (Rand)	0.083	0.076	1.08	0.278
Constant	0.052	0.574	0.09	0.928
sigma_v	0.907	0.051		
sigma_u	0.018	0.710		
Sigma2	0.823	0.094		
lambda	0.019	0.717		
Log likelihood = -207.457				
Prob > chi2 = 0.000***				
Wald chi2(6) = 1263.55				
Number of Observations (n =157)				

Source: Results from STATA (Version 9) generated from field survey, 2012. Where ***, and ** represents significance at 1% and 5%, and ha = hectares, Kg = Kilograms; L = litres; S.E = Standard Error

The quantity of seed planted and pesticide applied have a negative impact on cabbage output. The negative relationship between amount of seed planted and cabbage output may be attributed to the overcrowding or high density of cabbage seeds on small pieces of land that reduce the survival rate and increased incidence of pest and disease spread. This calls for more agronomic practice trainings especially on nursery bed preparation and spacing of crops for increased yields. For pesticide use, the negative impact on the cabbage output may be explained by improper use of pesticides yet cabbages are highly exposed to pests and disease attacks and hence this may result into reduced output. Further, this may be attributed to lack or poor trainings received by smallholder farmers at both Qamata and Tyefu irrigation schemes on input use who may apply more or less pesticides than the recommended amounts.

A comparison of technical efficiency results generated by the stochastic frontier results (0.986) as presented in Table 7.21 and the average VRS efficiency scores (0.981) for DEA model for cabbage enterprise clearly indicate a slight difference. This confirms that both methods can be used in estimating technical efficiency and yield almost similar results.

When compare results from Table 7.19 for the DEA model and Table 7.21 for the stochastic production function, both indicate that homestead food gardeners are slightly more efficient than smallholder irrigators. Nevertheless, both the smallholder irrigators and homestead food gardeners were technically efficient at 98.29% and they need to increase their efficiency by only 1.39% to maximize cabbage output. Using the same methodology of DEA to estimate technical efficiency among vegetable farmers in the eastern and central parts of Ethiopia, Haji (2008) also found out that cabbage farmers were technically efficient at 91%, closely related to the findings of this study.

Table 7.21: T-Test of Technical Efficiency for Smallholder Irrigators and Homestead Food Gardeners: Cabbage Enterprise

Type of farmer	Sample Size	Mean Efficiency	Standard Error	Standard Deviation
Smallholder irrigators (y)	108	0.9861487	0.00001	0.0000973
Homestead food gardeners(x)	50	0.9861496	0.0000234	0.000164
Combined	102	0.986149	0.000001	0.0001217
Mean difference		-0.000001	0.0000211	

Source: Results from STATA (Version 9) generated from field survey, 2012

Satterthwaite's degrees of freedom = 154

t = 0.0457

Ho: mean(y) - mean(x) = 0

Ho: diff = 0

Ha: diff < 0

Ha: diff != 0

Ha: diff > 0

Pr(T < t) = 0.4818

Pr(T > t) = 0.9636

Pr(T > t) = 0.5182

7.13.6 Determinants of T.E. in the Cabbage Enterprise (n=158)

Ten explanatory variables were used in the model and these include household size, age of the household head, education level, farming experience, amount of land owned, group membership, use of agro-chemical, gross margins, location of the irrigation scheme and type of farmer (smallholder irrigator or homestead food gardener). The purpose of this analysis is to assess the impact of these variables on the technical efficiency of smallholder farmers in cabbage production as presented in the Table 7.22. Results in Table 7.22 indicate that the F-value (11.291) is significant and thus, a high correlation between technical efficiency and the explanatory variable. The Durbin-Watson statistic (2.585) also confirmed that there is low autocorrelation between the variables.

Table 7.22: Determinants of T. E. in the Cabbage Enterprise (n=158)

Explanatory Variables	Dependent Variable= Technical efficiency scores			
	Coefficients	Std. Error	T-Values	P-Values
Household size	-0.000	0.000	-0.704	0.483
Age of the household head	0.000	0.000	0.855	0.394
Education level (years)	0.000	0.000	0.763	0.447
Farming experience	0.000	0.000	3.223	0.002***
Amount of land owned	0.000	0.000	2.326	0.022**
Group membership	0.000	0.000	2.569	0.011***
Use agro-chemicals	0.000	0.000	1.916	0.058*
Gross margins	0.000	0.000	8.935	0.000***
Location of the Irrigation Scheme	0.000	0.000	0.510	0.611
Type of farmer	-0.000	0.000	-0.717	0.475
(Constant)	0.986	0.000	10848.306	0.000***
Adjusted R2 = 0.420				
F-Value = 11.291***				
Durbin-Watson statistics = 2.585				
Number of Observations = 158				

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where ***, ** and * represents significance at 1%, 5% and 10% level respectively; Std. Error = Standard Error.

According to the results, farming experience, group membership and gross margins from cabbage have a positive and significant impact on technical efficiency of cabbage production at a 1% level, respectively, while amount of land owned by the farmer and use of agrochemicals have a positive and significant influence on technical efficiency of the same enterprise at 5% and 10% level, respectively. Since cabbage production calls for more attention due to high risks related to crop failure, farming experience is crucial to avert these risks. Group membership is important for easy access to information, farm input and exchange of farm implement, and access to credit and group marketing. Increased gross margins are a source of capital for reinvestment in the cabbage enterprise and act as a catalyst for increased production. The agro-chemicals are also important in controlling weeds and pests for increased production and efficiency in this cabbage enterprise. According to Allemann and Young (2008), cabbages are always faced with several pests and diseases including Cabbage looper, Diamond Back Moth, Cabbage Aphid, Bagrada bug, American bollworm, Cutworm, Black rot, and Downy mildew. Farmers with relatively larger plot sizes are more likely to be technically efficient. Similarly, farm size was reported to have a positive and significant relationship with technical efficiency among smallholder vegetable producers in Ethiopia (Haji, 2008). Thus, an increase in any

of these farm/farmer characteristics results into a significant increase in technical efficiency of cabbage production.

7.14 Estimating the Smallholder Farmers' Human Dimensions

Following the description in the data sampling section in chapter 6, there were 108 smallholder farmers' questionnaires that qualified for this analysis to identify the most relevant human dimensions and their determinants for increased production, production efficiency and household commercialization level. A comparison between smallholder irrigators and homestead food gardeners is also carried out as the analysis proceeds. Furthermore, the section ends by establishing the impact of human dimensions on production, technical efficiency and household commercialization level of the smallholders' maize and cabbage enterprises.

7.14.1 Estimating the Entrepreneurial Spirit and Positive Psychological Capital

The human dimensions assessed and explained in this section include the entrepreneurial spirit or positive psychological capital. As indicated in the literature, positive psychological capital plays a great role in building the entrepreneurial spirit. Therefore, this section uses entrepreneurial spirit and positive psychological capital interchangeably. Farmers with higher entrepreneurial spirit or positive psychological capital are assumed to be more productive and have the ability to produce more marketable surplus. For a better understanding of the entrepreneurial spirit or positive psychological capital among smallholder farmers in Qamata and Tyefu irrigation schemes, the research used entrepreneurial attitudinal statements (positive psychological capital statements) as presented in the questionnaire. The statements were designed to measure the farmers' perceived risk taking ability (hope), innovativeness (confidence) and the ability to respond to available farm business opportunities (optimism) all aimed at maximizing profits. Using a 4 point Likert scale, respondents were asked to indicate their level of agreement in response to the 15 entrepreneurial spirit (positive psychological capital) attitudinal statements, where "1" being strongly disagreed and "4" being strongly agree. Some of the attitudinal statements used in this study were adapted from WIDCORP (2008) and redesigned to suit the research.

According to the smallholder irrigators' average mean score results presented in Table 7.23, they have the ability to adopt new technologies, organize available resources to achieve a goal, seize opportunities perceived to be profitable and can easily supply their produce on credit. This indicates that smallholder farmers are innovative and are demand driven. In addition to adoption of new technologies, organize resource to achieve a goal, seizing business opportunities and supply of produce on credit, the homestead food gardeners are risk takers and committed to spend more time on new technologies. Based on the homestead food gardeners entrepreneurial spirit attributes, they seem to be more enterprising than smallholder irrigators.

There is significant difference between the smallholder irrigators' and homestead food gardeners' scores on statements related to; not being afraid to be different from others when adopting a new and can supply produce on credit at 1% level, respectively. The ability to supply produce on credit however needs to be strengthened by formal contracts to avert opportunism behaviours between the buyer and the seller where buyers use limited market information (information asymmetry) as an opportunity to cheat the uninformed farmers.

Overall, farmers lacked confidence especially on statements regarding individual decision making and investing in new innovations and this explains the low total average entrepreneurial spirit scores. The low entrepreneurial spirit among smallholder farmers may not differ from the general low rates of entrepreneurial activities reported in South Africa (Modiba, 2009; First National Bank (FNB) and Endeavor SA, 2010, GEM, 2011). Farmers were not willing to invest more money in new technologies, and lacked the spirit of searching for information. Fear of risks to invest in new technologies and information search may result into low productivity and low farm incomes among smallholder farmers. Therefore, such may call for trainings on risk management and establishment of forward contracts for assured market of produce, and improved business environment that aid farmer's entrepreneurship skills (Kisaka-Lwayo and Obi, 2012). Using the positive psychological capital interpretation, it can be concluded that smallholder irrigators are confident and optimists in farm business, while homestead food gardeners are confident, optimists and endowed with hope attitudinal mindset. Thus, homestead food gardeners have relatively more accumulated positive psychological capital compared to smallholder

irrigators. However, the accumulated scores for both categories of farmers indicate that they have low positive psychological capital.

Table 7.23: Average Item Scores of Entrepreneurial Spirit for Smallholder Farmers

	Smallholder irrigators (n=75)		Homestead Food Gardener (n=33)		Overall Sample (n=108)		T-Test
	Mean	S. D	Mean	SD	Mean	S. D	
Entrepreneurship spirit/drive							
Not Afraid to try a new technique	3.09	0.89	2.85	0.97	2.97	0.93	1.28
Irrespective of any challenges I continue trying till the solution is got	2.35	0.89	2.46	1.06	2.41	0.98	-0.55
You have the ability to organize available resources to achieve a goal	2.60	0.92	2.76	0.90	2.68	0.91	-0.83
If there is a change in supply and demand, you take action faster before any government response	2.40	0.99	2.12	0.93	2.26	0.96	1.41
Take action always on the basis of what you perceive profitable	3.00	0.79	2.76	0.83	2.88	0.81	1.45
Do not wait for subsidies before applying new technology	2.21	1.04	2.24	1.03	2.23	1.04	-0.13
You take your own judgment about the new technology before consulting friends	2.15	0.98	2.46	1.20	2.31	1.09	-0.40
Not afraid to be different when adopting new technologies on your farm	2.27	1.01	2.88	1.02	2.58	1.02	-2.90***
Spend more time on new technologies where you anticipate profits	2.47	0.95	2.70	0.68	2.59	0.82	-1.42
You are not afraid of investing more money in new technologies	2.29	0.98	2.24	0.97	2.27	0.98	0.25
Risks of new technologies isn't your first priority to take a decision	2.04	0.86	2.15	0.87	2.10	0.87	-0.62
I prefer group marketing	2.77	1.07	2.64	0.99	2.70	1.03	0.63
Can supply produce on credit	2.21	1.03	3.21	1.02	2.71	1.03	-4.65***
Will to pay for any farm related trainings	2.15	1.11	2.42	1.09	2.29	1.10	-1.21
Will to source for information wherever possible at a cost	2.09	1.00	2.42	1.03	2.26	1.02	-1.57
Total Average Score	2.41	0.95	2.55	0.99	2.48	0.97	

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where ***,represents significance at 1% level: SD = Standard Deviation: Data was elicited using a 4-point Likert scale (1 = Strongly Disagree to 4 = Strongly Agree).

Since the t-value indicates a negative relationship between the individuals' responses of the categories of farmers, most homestead food gardeners are likely to be afraid to be different when adopting new technologies on their farms. Homestead food gardeners operate individually and they are exposed to more risks compared to smallholder irrigators who can use farmer groups as production risk buffers. Although homestead food gardeners are willing to supply produce on credit, they produce less marketable output (Fay, 2011) compared to smallholder irrigators. For example, a typical homestead food garden can generate income of less than R1000 per season (SSI, 2009), and thus, more likely to be a net buyer of food, with virtually no produce to supply on credit.

The low entrepreneurial spirit among smallholder irrigators may be attributed to reduced government support for small-scale irrigation schemes. Government stopped providing farmers with input subsidies, free tractor services, and reduced on the number of technical staff managing and operating the small irrigation schemes (Kodua-Agyekum, 2009). This has made farming on small irrigation schemes more expensive in the face of the resource poor smallholder irrigators. They can hardly meet input costs and tractor hire, and lack technical skills to efficiently utilization these schemes. Due to unfavourable entrepreneurial environment, most smallholder irrigators have resorted to intensifying cultivation of homestead food gardens that require less purchased inputs, less labour, and less technical skills. For example, farmer use manure and compost to improve soil fertility, horse pipes or buckets to irrigate their gardens, and family labour to plough for increased productivity (Fay, 2011).

7.14.1.1 The Principal Components for the Perceived Entrepreneurial Spirit or Positive Psychological Capital

Factor analysis was performed on the data of all the 15 entrepreneurial spirit (positive psychological capital) attitudinal statements. This analysis was used because of its ability to yield underlying factors that explain the variance within the entrepreneurial spirit (positive psychological capital) attitudinal statements. Factor loadings method (see equation 30 as stated in Chapter 6: Section 6.2.5) was employed to elicit factors that explain statistically the variances within the statements, and the principal components were generated. Under the entrepreneurial spirit (positive psychological capital), three factors or principal components were extracted that explained 61.48% variance in the responses. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (0.615) was above the

recommended minimum value of 0.60 (Table 7.24). Also, the Bartlett's test of sphericity test indicated the worthiness of proceeding to the factor loading stage.

Based on the factor correlation with entrepreneurial spirit (positive psychological capital) attitudinal statements, the extracted three principal components can be best described as risk taking (hope), innovativeness (confidence), and ability to seize opportunities (optimism). The most correlated entrepreneurial spirit statements that best described the first principal component were mainly related to risk taking (hope). This principal component was explained by 30.55% of the variance in the explanatory variables with six estimated coefficients above 0.3 being positive. Risk taking related variables included the ability to organize available resources to achieve a goal, spend more time on new technologies where you anticipate profits, not afraid of investing more money in new technologies, not considering risks as a first priority in adopting new technologies; willingness to pay for any farm related trainings, and willingness to source for information wherever possible at a cost. The attitudinal statements that form this principal component suggest that, it is mainly supported by homestead food gardeners more than smallholder irrigators.

The second extracted principal component was explained by 17.64% of the explanatory variables with five estimated coefficients above 0.3. Of the five coefficients, one statement is negatively associated with innovativeness (confidence) and four are positively associated with innovativeness. Farmers had a more positive attitude towards adopting new techniques, ability to organize available resources to achieve a goal, take action always on what is perceived to be profitable and willingness to investing more money in new technologies. However, farmers did not consider spending more time on new technologies anticipated to be profitable as an import aspect in innovativeness. Thus, farmers were willing to spend lesser time on any risky ventures and this call for time saving technologies with fewer risks involved. The second principal component is mainly considered by smallholder irrigators more than homestead food gardeners based on the entrepreneurial spirit (positive psychological capital) statements scores in Table 7.23.

Table 7.24: Estimated Principal Components for the Perceived Entrepreneurial Spirit/Positive Psychological Capital

	Risk Taking (Hope)	Innovative (Confidence)	Recognize Opportunities (Optimism)
<i>Proportion of Variation (%)</i>	30.55	17.64	13.29
<i>Eigen Values</i>	2.444	1.411	1.063
Entrepreneurial Spirit/drive	Factor Loadings		
	PC1	PC2	PC3
Not Afraid to try a new technique	-0.005	<u>0.714</u>	-0.106
You have the ability to organize available resources to achieve a goal	<u>0.393</u>	<u>0.395</u>	<u>-0.638</u>
Take action always on the basis of what you perceive profitable	-0.103	<u>0.608</u>	<u>0.597</u>
Spend more time on new technologies where you anticipate profits	<u>0.324</u>	<u>-0.527</u>	-0.085
You are not afraid of investing more money in new technologies	<u>0.505</u>	<u>0.309</u>	-0.178
Risks of new technologies isn't your first priority to take a decision	<u>0.742</u>	-0.012	-0.164
Will to pay for any farm related trainings	<u>0.828</u>	-0.044	<u>0.338</u>
Will to source for information wherever possible at a cost	<u>0.825</u>	-0.035	<u>0.329</u>
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.607			
Bartlett's Test of Sphericity: Approx. Chi-Square = 172.894			
df = 28			
Model significance level = 1%			

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where df = degree of freedoms; Note: The bold and underlined factors > (0.3) qualify to constitute a given component: Extraction method; Rotation Method: Varimax with Kaiser Normalization. (n=108)

The third principal component (PC3) describing farmer's entrepreneurial spirit (positive psychological capital) accounted for 13.29% of the variation and showed that farmers had a strong attitude towards seizing farm business opportunities available and sourcing for more opportunities through trainings and information access (optimists). With exception of organizing available resources to achieve a goal, farmers viewed taking action always on the basis of what is perceived to be profitable, access to training, and sourcing for information as vital tools for improved farm business. When comparing average scores displayed in Table 7.23 both smallholder irrigators and homestead food gardeners consider the third principal component important for maximizing farm profits.

7.14.1.2 Estimating the Relationship between Entrepreneurial Spirit/Positive Psychological Capital and Farm /Farmer's Characteristics

Determinants of farmers' entrepreneurial spirit or positive psychological capital were estimated using multiple regression models, and the Durbin-Watson statistical test to identify the level of autocorrelations within the models. Table 7.25 presents results from the estimated multiple regression models. Based on equation 31 as stated in Chapter 6: Section 6.2.5.1, the results presented in Table 7.25 were generated. The coefficients (β) and the p-values to establish the relationship and significance between the dependent and the independent variables are presented in the Table 7.25.

Results in Table 7.25 indicate that the regression models for the principle components one and three are statistically significant at 1% level, respectively, and the corresponding Durbin-Watson statistics for the regression model range from 1.5 to 1.8, indicating a low extent of autocorrelation problems among the variables. Socioeconomic factors that are responsible for a positive and significant impact on the first principal component (risk taking) at 1% level, respectively, include major occupation of the household head and livestock incomes while age and education level (year spent in school) of the household head have a positive and significant impact on the same at 10% level, respectively. Farming experience and source of water for crop production have a negative and significant influence on farmers' risk taking ability (hope) at 10%, respectively. Based on these results it can be concluded that an increase in farmers' age, education, farming as a major occupation and livestock incomes boosts farmers' hope to take up calculated farming risks while farming experience and irrigation water from the dam results in less and less farmer's interest in taking up risky farm business activities.

Roslan, Abdullah, Ismail and Radam (2012) argue that older farmers are more likely to be wealthier with more accumulated social capital as compared to youthful farmers. Accumulated wealth and social capital provides a stronger basis for older farmers to venture in more farm production risks than younger farmers. Results generated in this study are consistent with Roslan, Abdullah, Ismail and Radam (2012) who reported a positive and significant relationship between farmers' attitudes towards risk taking and age, education level, and rice farming as main occupation in Malaysia. In contrast, Dadzie

and Acquah (2012) reported a negative and significant relationship between farmers risk taking attitudes and age, and education level at Agona Duakwa in Agona East District of Ghana.

The negative impact of sources of water for crop irrigation (mainly dams) on the PC1 may be due to less or lack of control/power over the use of dam water and hence impeding individual's initiative and experimental techniques to be implemented. Some of the set regulations regarding irrigation water use include the number of times a farmer is allowed to irrigate, amounts of water used and dictate the type of crops grown on the irrigation scheme. Such rules and regulations on irrigation schemes suppress farmer's entrepreneurial spirit.

Table 7.25: Estimating the Relationship between Entrepreneurial Spirit/Positive Psychological Capital and Farm/Farmer's Characteristics

Independent Variables	Dependent Variables (Extracted from Factor Analysis -PCA)					
	Risk Taking (Hope)		Innovative (Confidence)		Recognizing Opportunities (Optimism)	
	β	p-value	β	p-value	β	p-value
Household size	0.000	0.978	-0.014	0.726	0.011	0.765
Age	0.018	0.074*	-0.003	0.816	-0.023	0.049*
Education level (years)	0.047	0.066*	0.042	0.172	-0.036	0.203
Major type of occupation	0.203	0.004***	0.143	0.088*	0.072	0.357
Farming experience	-0.015	0.091*	-0.018	0.085*	0.011	0.268
Amount of land owned	0.064	0.530	-0.021	0.861	-0.043	0.707
Crop Incomes	0.000	0.143	-0.000	0.330	0.000	0.010***
Livestock incomes	0.000	0.000***	0.000	0.256	0.000	0.339
Remittances, social grants & pension	0.000	0.270	0.000	0.955	0.000	0.030**
source of water for crop production	-0.148	0.060*	0.034	0.717	-0.128	0.145
Location of irrigation scheme	0.074	0.799	-0.326	0.350	0.894	0.007***
Constant	-1.529	0.102*	0.364	0.744	0.098	0.925
R2 adjusted	0.320		0.019		0.143	
p-value	0.006***		0.307		0.006***	
Durbin-Watson statistics	1.817		1.748		1.465	

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where *****, **, * = significant at 1%, 5% and 10% level, respectively: β = coefficients and p-value = probability value.

Only two socioeconomic factors have a significant impact on farmers' innovativeness (confidence) namely, major occupation and farming experience. Farming as a major occupation has a positive and significant impact on farmers' innovativeness while farming experience has a negative and significant impact on the same at 10%, respectively. This is an indication that considering farming as farmers' major occupation improves on farmers' confidence to innovate new ways of maximizing farm profits given that he/she spends more time on the farming activities. The negative impact of farming experience on farmers' innovativeness or confidence may be attributed to the tendencies of limiting adoption of new technologies based on the bad experiences or risk failures.

Age of the household head has a negative and significant impact on farmer's ability to seize farm business opportunities (optimism) at 10% level while crop incomes, remittances, social grants and pension, and location of the irrigation scheme have a positive and significant influence on farmers' ability to recognize business opportunities at 1%, 5% and 1%, respectively. Most smallholder irrigators are old and they tend to be less optimistic in future farm business. A study carried out by Giacomini, Janssen, Guyot and Lohest (2011), reported a negative relationship between necessity to recognise business opportunity and age of responding. They argue that often older individuals have already accumulated wealth and social capital and thus, their actions are not mainly driven by available opportunities. The old age demotivates them to undertake new technologies perceived to be profitable and they are not willing to pay for trainings and information important for profit maximisation. This may result into the old aged farmers' tendency to adhere to the old farming styles which are less productive. Crop incomes and remittance, grants and pensions may be a source of capital needed to undertake business opportunities. Results presented in Table 7.25 further suggest that smallholder farmers at Qamata irrigation scheme take faster action to benefit from available farm business opportunities (optimists) more than Tyefu smallholder farmers. This is so because most respondents interviewed are located around the Qamata irrigation scheme area. In the positive psychological capital perspective, optimism among smallholder farmers can be promoted by including the youths in farming, increase farm incomes, and remittances, social grants, and pensions.

In summary, smallholder farmers (both irrigators on the schemes and homestead gardeners) in the study area exhibited some entrepreneurial spirit or positive psychological

capital although it is low and need to be strengthened. Entrepreneurial spirit (positive psychological capital) statements that scored highly included farmers' ability to adopt new, ability to organize available resources to achieve a goal, take action always on the basis of what is perceived to be profitable, and supply of produce on credit. Farmers underscored attitudinal statements that had some aspects of individual decision making and sourcing for knowledge at a given cost. Three principal components were extracted using factor and principal component analysis through factor loading statistical method. The three components included risk taking (hope), innovativeness (confidence), and taking on available opportunities (optimism). Comparing the mean scores from Table 7.23 and Table 7.24 for entrepreneurial spirit principal component, smallholder irrigators are endowed with innovative spirit (or confident) while homestead food gardeners are more risk takers (or hopeful). Both smallholder irrigators and homestead food gardeners had a potential of taking on farm business opportunities (optimists).

Socioeconomic factors that significantly influence farmer's entrepreneurial spirit or positive psychological capital in the study area were identified. These include age, education level and major occupation of household head, and livestock incomes that have a positive and significant influence on farmers' risk taking (hope) while farming experience and source of water for crop production had a negative impact on risk taking. The determinants of the second principal component included farming as the major occupation which had a positive and significant influence on innovativeness (confidence) while farming experience had a negative and significant influence on same.

Farmers' recognition of business opportunities (optimism) was positively and significantly related to crop incomes, remittances, grants and pension, and location of the irrigation scheme while age had a negative and significant influence on farmers' ability to take on the available farm business opportunities. Therefore, policies that target to improve on the socioeconomic factors which are positively and significantly related to entrepreneurial spirit or positive psychological capital may catalyse the shift from subsistence to more business oriented commercial farming. This is thought to improve on productivity, household incomes, food security and poverty alleviation in rural communities. However, precautions should be taken in regards to the socioeconomic factors that negatively and significantly impact on farmers' entrepreneurial spirit/positive psychological capital.

7.14.2 Farmers' Goals and Aspirations among Smallholders

Farmers' goals are sometimes referred to as aspirations individuals strive to achieve to maximise utility (Obi, 2012). In short a goal can be defined as the end, and the method of achieving a goal as means. Some goals like to be recognised as the top producer of a given crop can act as means to achieve higher goals such as accumulation of wealth. Normally, farmer's values define their goals and the goals define the limits and means of attaining a desired endpoint or performance. Most researches carried out limit farmer's goals to profit maximisation with less concentration on other intrinsic goals (Padilla-Fernandez and Nuthall, 2001). This limitation of farmers' goals to profit maximisation may lead to condemnation or misjudging of rural farmers' inability to adopt new technologies and undermining rural development programmes. Therefore, this study tried to estimate more inclusive farmers' goals to generate more knowledge regarding the subject.

The rural household smallholder farmers' goals were estimated using a 4 point Likert scale where "1" being extremely not important and "4" being extremely important. Respondents were asked to indicate the level of importance of the 21 attitudinal statements related to farmers' goals. A comparison independent T-test was carried out to establish the differences in response to attitudinal statements that define a particular farmer's goal between the smallholder irrigators and homestead food gardeners as presented in Table 7.26.

The goals were clustered into four value orientations as defined by Gasson (1973). The four values included intrinsic, expressive, social and instrumental. Smallholder irrigators scored highly (> 3.0 average mean score) on goals related to instrumental values (business/developmental oriented) while homestead food gardeners attached more importance to social oriented values. Smallholder irrigators treated farming as a business and acknowledged its ability to lift them out of poverty while homestead food gardeners considered farming as cultural, family oriented and a lifestyle. Business oriented goals are instrumental in the transition from subsistence homestead food gardening to commercially oriented small-scale irrigation farming.

Smallholder irrigators' major goals that have an average score above 3.0 include self-employment and independence, like farming life, inherited the farm, contacts with people as means of transferring information, and access to social meetings and ritual. Increased

maximum farm income, expansion of the business and keep debts as low as possible were also among the business oriented goals considered by smallholder irrigators and had an average score greater than 3. For homestead food gardeners, the major goals considered and have an average mean score of greater than 3 include the intrinsic goals like self-employed and independent, farming as a lifestyle and be recognised as owner of the land. The social oriented goals of the homestead food gardeners include involving the family in decision-making, inherited the farm, belong to farming community, farming as part of culture, contacts with people, platform for social meetings and rituals, and providing employment to rural people. Further, the business oriented goals for the same category of farmers included increase standards of living and keep debts as low as possible

The three goals considered being important by smallholder irrigators more than homestead food gardeners and significantly differentiated the two categories are, having more leisure time, increased maximum farm income and expand the business all at 5% level. Seven goals were considered to be important among homestead food gardeners more than smallholder irrigators. These goals include self-employed and independence, like farming life, be recognised as owner of the land, involve family in decision-making, provide employment to rural people, inherited the farm and farming as part of culture at 5%, 1%, 10%, 1%, 5%, 5% and 1% significant level, respectively. Both, the smallholder irrigators and homestead food gardeners considered expressive values (Self-esteem) as less important.

Table 7.26: Average Item Scores of Farmers' Goals and Aspirations

	Smallholder Irrigators (n=75)		Homestead Food Gardeners (n=33)		Overall Sample (n=108)		T-Test
Intrinsic	Mean	SD	Mean	SD	Mean	SD	
Self-employed and independent	3.33	0.53	3.55	0.51	3.44	0.52	-1.98**
Like farming life	3.36	0.48	3.85	0.36	3.61	0.42	-5.79***
Have more leisure time	2.76	0.79	2.36	0.82	2.56	0.81	2.38**
Expressive							
Be recognised as top producer	2.69	0.79	2.58	1.06	2.64	0.93	0.64
Be recognised as a leader in the technology adoption	2.59	0.99	2.33	1.05	2.46	1.02	1.20
Be recognised as a specialist in growing these crop	2.64	0.92	2.61	0.97	2.63	0.95	0.17
Be recognised as owner of the land	2.79	1.02	3.12	0.86	2.96	0.94	-1.76*
Social							
Involve family in decision-making	2.87	1.02	3.46	0.79	3.17	0.91	-3.24***
Leave business for the next generation	2.77	0.83	2.97	0.77	2.87	0.80	-1.19
Provide employment to rural people	2.89	1.03	3.27	0.80	3.08	0.92	-2.07**
Belong to farming community	2.96	0.67	3.03	0.85	3.00	0.76	-0.46
Inherited the farm	3.00	0.96	3.42	0.87	3.21	0.92	-2.18**
It is part of culture (artefacts and adornment)	2.97	0.76	3.30	0.47	3.14	0.62	-2.64***
Contacts with people, transfers of Information	3.08	0.54	3.21	0.82	3.15	0.68	-0.99
Social participation: meetings and rituals	3.24	0.59	3.12	0.86	3.18	0.73	0.84
Avail time to spend with my family	2.84	0.62	2.91	0.91	2.88	0.77	-0.46
Instrumental							
Increase standards of living	2.97	0.66	3.00	0.94	2.99	0.80	-0.17
Increase maximum farm income	3.25	0.64	2.97	0.77	3.11	0.71	1.99**
Expand the business	3.15	0.59	2.82	0.95	2.99	0.77	2.20**
Keep debts as low as possible	3.28	0.69	3.24	0.66	3.26	0.68	0.26
Accumulate wealth	2.99	0.89	2.85	1.09	2.92	0.99	0.69

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where ***, **and * represents significance at 1%, 5%, and 10% level, respectively. The four value orientations were taken from Gasson (1973) cited by Padilla-Fernandez and Nuthall (2001), and Harwood (1979) though some questions were restructured to suit Rural farmers of Eastern Cape. Data was elicited using a 4-point Likert scale (1 = not important to 4 very important).

7.14.2.1 Estimating Principal Components for the Perceived Farmers' Goals and Aspirations

Factor analysis was used to estimate the principal components (See equation 30 stated in Chapter 6: Section 6.2.5) related to farmers' goals and attitudes as presented in Table 7.27. It was worth using this method to condense the 21 goal and attitudinal related statements into fewer well explained principal components. During the analysis, some statements

were dropped to achieve better results that correspond with the minimum Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy value of 0.60 and the Bartlett's Test of Sphericity. The KMO value for this particular analysis was 0.643 and passed the Bartlett's Test of Sphere with no autocorrelation among variables. Also the Eigen value proportions of the variance for the selecting optimal number of principal components were above the recommended value of 1. Eleven out of twenty one goal and attitudinal related statements passed the two mandatory tests and were considered in the factor loading statistical measurement stage. The eleven goal and attitudinal statements yielded four principal components that explained 68.52% of the variation in the explanatory variables. The four principal components are, farm status/expressive (PC1), business (PC2), social (PC3), and independence oriented goals (PC4).

The first principal component (farm status) displays a variation of 25.16 % in the farmers' rankings of their goals. The principal component was best described as a farm status, expressive or self-esteem oriented goal. There are six farmers' goal related statements that have estimated coefficients above 0.30 and defined this principal component. Farmers had an interest of being attached to their farm successes. All the four expressive or self-esteem related goals are part of the farmers' goals that explain the first principal component. In this case, the self-esteem or confidence may be of great importance to farmers for better performance as they strive to achieve these goals. Although the principal component was mainly described by the farm status/self-esteem goals, it has some elements of business oriented goals like increase maximum incomes and accumulating wealth.

The second principal component accounted for 19.70% of variation in the variables and mainly comprises business and developmental farmers' related goals. These include improved standards of living, increase maximise farm incomes and wealth accumulation. Although smallholder farmers produce low output and less marketable surplus, they still view farming as one of the major sources of livelihood. Farmers at Qamata and Tyefu irrigation scheme areas grow vegetables and maize and sell it within local markets to earn a living. The major vegetables grown for sale include cabbages, spinach, potatoes and carrots, among others. Farmers' business oriented goals can be of great importance in boosting production and increase marketable surplus. Farmers' business goals can therefore be incorporated in rural development programmes for improved smallholder incomes and general livelihood.

Table 7.27: Estimated Principal Components for the Perceived Farmers' Goals and Aspirations

	Farm status	Business Oriented	Social Oriented	Independence
<i>Proportion of Variation (%)</i>	25.16	19.70	14.07	9.60
<i>Eigen value</i>	2.767	2.167	1.548	1.056
Farmers' Goals and Aspirations	Factor Loadings			
	PC1	PC2	PC3	PC4
Self-employed and independent	-0.036	<u>0.516</u>	0.135	<u>0.478</u>
Have more leisure time	-0.070	-0.143	<u>0.552</u>	<u>0.697</u>
Be recognized as top producer	<u>0.768</u>	<u>-0.352</u>	0.208	0.044
Be recognized as a leader in the technology adoption	<u>0.754</u>	<u>-0.428</u>	-0.083	0.085
Be recognized as a specialist in growing these crop	<u>0.853</u>	-0.136	0.008	0.053
Be recognized as owner of the land	<u>0.405</u>	<u>-0.323</u>	<u>-0.546</u>	0.185
Contacts with people, and transfers of information	0.077	0.015	<u>0.792</u>	-0.278
Social participation: meetings and rituals	0.257	<u>0.589</u>	-0.284	<u>0.345</u>
Increase standards of living	0.193	<u>0.776</u>	-0.191	-0.030
Increase maximum farm income	<u>0.555</u>	<u>0.546</u>	0.024	<u>-0.300</u>
Accumulate wealth	<u>0.541</u>	<u>0.450</u>	<u>0.362</u>	-0.089
Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy = 0.643				
Bartlett's Test of Sphericity Approx. Chi-Square = 342.739				
df = 55				
Model significance level = 1%				

Source: Results from SPSS (Version 11) generated from field survey, 2012. Note: The bold and underlined factors > (0.3) qualify to constitute a given component. (n = 108)

In addition to wealth accumulation, farming activities are used as media of communication among rural communities and this can be of great importance in accumulating social capital. This principal component can be describes as farmers viewing farming as a channel for improved interpersonal relations (seeking utility or satisfaction through social relations) within a given community. The farmers' social oriented goals form the third principal component which accounts for 14.07% of the variation in the explanatory variables. Farmers' social oriented goals aid the flow of production and market information among themselves. Improved information flow is thought to increase adoption of new technologies and improved access to market information for reduced transaction costs caused by information asymmetry. Thus, rural development programmes can design

policies that are directed towards strengthening the social oriented goals among the smallholder farmers.

The fourth principal component generated from the farmers' goal statements could be best defined as farmers' independence oriented goal and was explained by 9.60% of variation in the explanatory variable. Farmers viewed farming as source of self-employment and independence (freedom), and avails more leisure time. More leisure time and freedom avails more opportunities for farmers to participate in social gatherings. The majority of rural population in developing countries engage in smallholder farming as a major source of livelihood and as source of self-employment. This attribute can be enhanced by promoting smallholder farming as business and source of self-employment among rural communities.

7.14.2.2 The Relationship between the Farm/Farmer's Characteristics and the Farmer's Goal Orientations

Using multiple regression analysis model as stated in equation 31 in Chapter 6: Section 6.2.5.1, the association between the farm/farmer characteristics and farmers' goals was established. Results indicate a significant relationship between the farmer/farm characteristics and farmer's goals as presented in Table 7.28. The three regression models related to farmers' goals of farm status, business, and independence are all significant at 1% level, respectively. There was low extent of autocorrelation registered within the regression models since results exhibited a Durbin-Watson statistics greater than 1. Farm status, business and independence goals exhibited an average goodness-of-fit of the model, although the R^2 was low like most discrete choice models (Kisaka-Lwayo and Obi, 2012).

Determinants of farmers' farm status goal (self-esteem) include education level (years in school), crops and livestock incomes, remittance, social grants and pension, source of water for crops and amount of land owned. Education level, livestock incomes, remittance, grants and pension, and source of water for crop farming had a positive and significant impact on farmer's farm status oriented goal at 1% level, respectively. Incomes from crops had a positive and significant influence on farm status oriented goal at 5% level while land size had a negative and significant impact on the same goal at 5% level. Thus, increased farm incomes, remittances, social grants and pension, and access to water improves

farmer's farm status/self-esteem while an increase in the amount of land owned reduce farmer's self-esteem.

The second principal component (business oriented goal) has a positive and significant relationship with the source of water for crop production at 5% level, and a negative and significant relationship with location of the irrigation scheme at 1% level. Thus, farmers who access dam and river water for crop production are more likely to view farming as an income generating activity. Water is one of the primary agricultural resources needed in farm business especially in semi-arid areas like Qamata and Tyefu, and hence, access to more water increases the farmers' ability to diversify for increased farm output. Increased farm output may result in increased farm incomes, standards of living, and accumulated wealth. Further, the negative relationship between the location of the irrigation scheme and farmers' business oriented goal can be explained as, farmers located at Tyefu irrigation scheme are more likely to view farming as business compared to farmers at Qamata irrigation scheme. Since most interviewed farmers were staying at Qamata, they view farming as not business.

Age of the household head and location of the irrigation schemes were the only farm/farmer characteristics that had a significant impact on farmers' social oriented goal. Both age and location of the irrigation scheme had a positive and significant impact on the social oriented goal at a 10% and 5% level, respectively. This means that the old aged farmers view farming as a social oriented activity and are mainly located at Qamata irrigation scheme.

Most smallholder farmers located at Qamata irrigation scheme with higher education level and earn more remittances, social grants and pension incomes are more likely to view farming as an activity that avails more freedom than any other related activity (or self-employment). Education level, amount of remittances, social grants and pension and the location of the irrigation scheme had a positive and significant influence on farmer's independence oriented goal. More education may facilitate innovation of time saving farm technologies/methods and adoption of labour saving technologies which in turn avails more leisure time.

Table 7.28: The Farm/Farmers' Characteristics Associated with Farmers' Goals and Aspirations

Independent Variables	Extracted Components of Farmers' Goals & Aspirations							
	Farm status		Business Oriented		Social Oriented		Independence	
	β	p-value	β	p-value	β	p-value	β	p-value
Age	-0.010	0.267	0.003	0.755	0.020	0.091*	0.015	0.151
Education	0.061	0.012***	0.040	0.157	0.013	0.673	0.103	0.000***
Farming Experience	-0.013	0.112	0.010	0.317	-0.007	0.493	0.009	0.309
Land size	-0.215	0.028**	0.094	0.402	0.010	0.936	0.164	0.135
Crop incomes	0.000	0.017**	-0.000	0.356	0.000	0.187	-0.000	0.226
livestock Incomes	0.000	0.002***	0.000	0.361	0.000	0.411	-0.000	0.673
Remittances, social grants, pensions	0.000	0.009***	0.000	0.499	0.000	0.946	0.000	0.006***
Source of water for crop production	0.197	0.011***	0.206* *	0.021**	-0.119	0.209	-0.000	0.567
Location of irrigation scheme	-0.411	0.133	-0.897	0.005***	0.671	0.049**	0.955	0.002***
(Constant)	0.001	0.999	-0.186	0.841	-1.848	0.065*	-3.124	0.001***
R ² adjusted	0.354		0.131		0.004		0.179	
p-value	0.000***		0.006***		0.411		0.001***	
Durbin-Watson statistics	2.153		1.833		1.960		1.460	

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where ***, **, * represents significance at 1%, 5% and 10% level, respectively: β = coefficients and p-value = probability value

In summary, smallholder irrigators mainly view farming as source of incomes while homestead food gardeners view farming mainly as a social activity. The smallholder irrigators are focused on expanding their farm business, increase maximum farm income and accumulate wealth while homestead food gardeners viewed farming as a lifestyle and social medium with less focus on business/development oriented goals.

Out of the twenty one, eleven farmers' goal related statements yielded four principal components, namely farm-status, business, social and independence oriented goals. The farmer/farm characteristics associated with the farmers' farm-status goal are education, crop income, livestock income, remittance, social grants and pension, source of water for crop production and land size. With exception of land size, these factors have a positive and significant influence on farmers' farm-status oriented goal. Increased farmers' access to dam and river irrigation water has a positive and significant influence on farmers' business oriented goal while location of the irrigation scheme has a negative and significant impact on farmers' business oriented goals. Determinants of the farmers' social oriented goal include age of the household head and location of the irrigation scheme. Both have a positive and significant relationship with the farmers' social oriented goal. Farmers' independence oriented goal is positively and significantly influenced by education level of the household head, remittances, social grants and pension, and the location of the irrigation scheme. Since smallholder farmers have multiple goals rather than a single goal of maximising profits as established in this study, policies geared towards poverty reduction may need to incorporate all these goals in their strategic plans especially during the formulation and implementation phases for a sustainable rural economic development.

7.14.3 Average Mean Scores of Smallholders' Perception on the Importance of Social Capital in Farming

Due to its complexity, the concept of social capital has been defined, measured and applied differently by different authors (McHugh and Prasetyo, 2002). Most conceptual frameworks have acknowledged the role of individuals and groups (Bonding social capital) and societal interrelations (Exclusive Social Capital) in defining social capital. Also, identified structures (state institutions, rules and laws) and cognitive factors like trust, norms and values (Paxton, 1999; Grootaert and Van Bastelaer, 2002) important in defining social capital. The group cohesion and societal interactions coupled with rules, norms, laws and rules are critical in enhancing proper management and utilization of natural resources for both social and economic gains. Several socioeconomic researches have been carried out and attested the importance of social capital in increasing agricultural productivity (Tshikolomo, 1996; Wolz, Fritzsche and Reinsberg, 2005; Yamaoka, 2007; McAllister, 2010; Hongmei and Mangxian, 2011).

In this context, this study attempted to estimate farmers' perception on the importance social capital in agricultural production and marketing using a 4 point Likert scale where "1" being extremely not important and "4" being extremely important. The attitudinal statements included farmers' perceptions towards exclusive/external social networks like government, NGOs and private companies' for improved agricultural productivity. Also the statements were aimed at establishing farmer's attitude towards bonding social capital (farmer groups) and its role in aiding productivity and marketing. Generated average mean scores for both smallholder irrigators and homestead food gardeners are displayed in Table 7.29.

Considering factors with an average mean score of greater than 3, smallholder irrigators acknowledged the importance of working with government departments, support fellow farmers in times of hardship, access to farm information through fellow farmers, cultural rules and norms, and participation in voting as crucial social factors needed for increased productivity and access to agricultural markets. Homestead food gardeners considered, working as farmer groups/cooperatives, group membership for labour access and farm implements, support fellow farmers in times of hardships, adhering to cultural rules and norms, and participation in voting of village leaders as important social capital factors that can enhance productivity and market access. Table 7.29 show the statements that were underscored by both smallholder irrigators and homestead food gardeners as factors needed for improved agricultural production and marketing and these include access to farm inputs through farmer groups, trust, and lacked confidence in existence of constitution and rules among farmer groups/cooperatives.

The smallholder irrigators and homestead food gardeners differed in four statements on the importance of social capital in agricultural production and marketing. Smallholder irrigators scored higher than homestead food gardeners on statements related to the importance of information access from fellow farmers and trust among community members at 1% and 5% significant level, respectively. Homestead food gardeners believed in farmer groups as an easy channel of accessing farm implements and acknowledged the importance of cultural rules and norm more than smallholder irrigators at 1% and 5% significant level, respectively.

Table 7.29: Average Item Scores of Farmers' Perception about the Importance of Social Capital on Farming

	Smallholder Irrigators (n=75)		Homestead Food Gardeners (n=33)		Overall Sample (108)		T-Test
	Mean	S D	Mean	SD	Mean	SD	
Working with government improves production & market access	3.04	0.95	2.79	1.11	2.915	1.03	1.205
Working with private companies/NGOs improves production & access to markets	2.76	1.14	2.70	1.13	2.73	1.14	0.266
Working as farmer groups/cooperatives improves production & access to market	2.79	0.87	3.00	1.09	2.895	0.98	-1.081
Attending group meetings regularly improve production & access to market	2.88	0.92	2.88	0.74	2.88	0.83	0.007
group membership ease access to farm labour,& improves production & marketing	2.80	0.75	3.00	1.03	2.90	0.89	-1.131
Can easily access farm inputs like fertilizer when connected to group membership	2.51	0.92	2.67	0.96	2.59	0.94	-0.822
Can easily access farm implements when belonging to farmer group	2.51	0.96	3.12	1.08	2.82	1.02	-2.938***
Access to information from fellow famers is vital in production, and output marketing	3.09	0.52	2.76	0.66	2.93	0.59	2.821***
I support others (fellow farmers) and they support me in times of hardships	3.20	0.77	3.12	0.96	3.16	0.87	0.453
Group membership ease access and adoption of new technologies	2.68	0.90	2.70	0.95	2.69	0.93	-0.089
Can contribute money towards a common goal in my community	2.69	0.97	2.73	1.21	2.71	1.09	-0.155
Farmer groups/cooperatives with constitution/rules perform better than others	2.55	0.92	2.76	1.09	2.66	1.01	-1.036
Culture rules and norms are vital in group formation, farm production and marketing	3.08	0.96	3.49	0.71	3.29	0.84	-2.439**
Trust among community members is a key factor for successful farmer	2.88	0.97	2.42	0.94	2.65	0.96	2.303**
Participation in voting village committees is crucial for equitable access to resources	3.12	1.00	3.27	0.88	3.195	0.94	-0.799

*Survey: Results from SPSS (Version 11) generated from field survey, 2012. Where *** and ** represents significance at 1% and 5% respectively: SD = Standard Deviation*

7.14.3.1 The Principal Components for the Perceived Farmers' Social Capital

Equation 30 in Chapter 6: Section 6.2.5 was used to elicit results as presented in Table 7.30. Three principal components were obtained out of nine farmers' social capital attitudinal statement using the Kaiser-Guttman rule where the entire three principal

components scored Eigen values greater than 1. To satisfy the KMO minimum value and Bartlett's Test of Sphericity, the fifteen farmers' social capital related statements were reduced to nine statements that best described the three principal components as indicated in Table 7.30. The Kaiser-Meyer-Olkin measure (KMO) of sampling adequacy was 0.603 and all the three principal components that explained 64.16% of the variance in the 9 statement were extracted from the covariance matrix. Based on the factor loading results presented in Table 7.30, principal components 1 to 3 can be best described as bonding social capital index, exclusive social capital index, and social values index, respectively.

The first principal component explained 31.30% of the variance in the explanatory variables. Smallholder farmers indicated that belonging to farmer groups can ease access to inputs and implements. Voluntarily, smallholder farmers were willing to contribute some money towards a common goal of the community. Voluntary participation or collective action is thought to strengthen social relations and bonds, and participating individuals are regarded as responsible members of the community. Collective action is one of the major instruments advocated for by most cooperatives especially in managing and use of resources in a more efficient and sustainable way for increased productivity and bulk marketing. Created social bonds sometimes serve as strategies to get rid of future risks and societal shocks. Smallholder irrigators who belong to groups believe in constitution/rules as vital instruments for better performance of groups/cooperatives.

Involving community members in farm work result into reciprocation within farm community members that creates a psychological bond. The constructed psychological bonds can then results into increased sustainability and achievement of the farm goals (Dillon, 1990). In their farming endeavours, Bantu groups shared group farming responsibilities among communities and in some cultures they exchange gifts in form of crop harvests and livestock. The socialisation creates farmer's sense of belonging to farming community and farmer groups. These activities avails a chance of interacting and transfer of a range of farm and community related information. Development programmes can purpose to use these social bonds to strengthen farmer groups in different farm business related activities like collective marketing, labour supply, bulk farm inputs and implement acquisition, and group/cooperative credit unions.

Table 7.30: Estimated Principal Components for the Perceived Farmers' Social Capital

	Bonding Social Capital	External Social Capital	Social Values
<i>Proportion of variance (%)</i>	<i>31.30</i>	<i>17.61</i>	<i>15.25</i>
<i>Eigen values</i>	<i>2.817</i>	<i>1.585</i>	<i>1.372</i>
	Factor Loading		
Social Capital Aspects	PC1	PC2	PC3
Working with government departments improves production & market access	0.167	<u>0.855</u>	-0.075
Working with Private companies improves production & access to markets	<u>0.377</u>	<u>0.734</u>	0.140
Working as farmer groups/cooperatives improves production & access to market	<u>0.763</u>	-0.018	-0.186
Can easily access farm inputs like fertilizer when connected to farmer groups	<u>0.873</u>	-0.122	-0.245
Can easily access farm implements when belonging to farmer group	<u>0.813</u>	0.012	<u>-0.359</u>
Can contribute money towards a common goal in my community	<u>0.337</u>	-0.071	<u>0.673</u>
Farmer groups/cooperatives with constitution/rules perform better than others	<u>0.673</u>	<u>-.378</u>	<u>0.318</u>
Trust among community members is a key factor for successful farmer	0.055	<u>-.388</u>	<u>-0.312</u>
Culture rules and norms are vital in group formation, farm production and marketing	0.269	-0.031	<u>0.687</u>
Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy = 0.603			
Bartlett's Test of Sphericity: Approx. Chi-Square = 299.053			
df. = 36			
Model Significance level = 1%.			

Source: Results from SPSS (Version 11) generated from field survey, 2012. Note: The bold and underlined factors > (0.3) qualify to constitute a given component. (n = 108)

The second principal component (external social capital) accounted for 17.60% variation in the explanatory variables with two positive estimated coefficients above 0.30. The index suggests that smallholder farmers believe that exclusion/external social network is crucial for improved farm production and market accessibility. Rural smallholder farmers view connections with government departments, private companies and NGOs and belonging to farmer groups/co-operatives improves access to farm inputs, implements and agricultural markets.

The third principal component was mainly defined by social values and accounted for 15.25% of variance in the explanatory variables. Farmers valued cultural rules and norms, and group/cooperative constitutional rules and regulations as vital factors in farming with less importance attached to trust among community members. Availability of cultural rules and norms, and group/cooperatives constitutional rules and regulations ensures order in the management and operations of farm business. Thus, policy makers may need to consider farmers' social values to strengthen farmer groups and cooperatives for improved access to input/output markets. Strong social values can also aid the flow of information regarding efficient and sustainable use of resources, diffusion of new technologies and good agronomic practices, and quality assurance along the agricultural produce value chain.

7.14.3.2 Farmer/Farm Characteristics and Farmers' Social Capital

Multiple linear regressions (See equation 31 stated in Chapter 6: Section 6.2.5.1) were ran to establish the relationship between the farmer/farm characteristics and farmers' attitude towards the role of social capital in improving production and marketing among smallholder farming. Overall, results in Table 7.31 indicate that the first and the second principal components regressed models are significant at 1% level, respectively, while the third component had a significant relationship between the dependent and the independent at a 5% level. The Durbin-Watson statistical value for the three components ranged from 1.70 to 2.33 indicating low extent of autocorrelation among variables. The goodness-of-fit of the models are indicated by adjusted R^2 and had low average scores across the three regressions.

According to the results generated in Table 7.31, education level has a positive and significant influence on bonding social capital at a 1% level while land size, sex and age of the household head were also positively and significantly related to bonding social capital at 10% level, respectively. Thus, increase in education level, land size, more men participating in farming and age of a farmer are important in strengthening the bonding social capital among farmer groups. Remittances, social grants and pension, and source of water for crop production have a negative and significant influence on bonding social capital at a 10% and 5% level, respectively. During interviews, farmers reported some conflicts within smallholder irrigators' groups especially during the distribution of farm inputs, access to tractor and access to irrigation water. This was also reported by Van

Averbeke *et al.* (2011). The negative relationship between the bonding social capital and water source for crop production (mainly dams and rivers) may be due to existence of these conflicts.

Smallholder farmers who are highly experienced and use irrigation water from the dam and river are more likely to have loose ties with external social networks this is because farm experience and source of water have a negative and significant impact on external social capital at 5% and 10% level, respectively. However, farmers located at Qamata irrigation area and those who earn more crop incomes are more likely to recognise the importance of external social networks especially with the government departments. This is so because crop incomes and location of irrigation scheme have a positive and significant impact on the farmers' external social capital at 10% level, respectively. The negative attitude of more experienced farmers towards external social networks may be attributed to the disappointments caused by government's withdrawal from providing subsidised inputs as it were during the first regimes of the establishment of small-scale irrigation schemes. Also, smallholder farmers who have stayed long together in farming tend to resist external influence which is viewed as a threat to established internal group cohesion/bonding (Yamaoka, 2007 and Ostrom, 1998).

Social values were positively and significantly influenced by farming experience at 10% level while source of water for crop production negatively and significantly influence farmers' perception on the importance of social values in agricultural production and marketing at 1% level. As farmers grow older they tend to respect the cultural rules and norms, and group constitutional rules and regulations. The negative relationship between sources of water for crop production and social values may be due to social conflicts that undermine the cultural rules and norms, and group/cooperative constitutional rules. Most conflicts are related to skewed land distribution on the irrigation scheme and inequitable distribution of input subsidies and farm support rendered by the government, private companies and NGOs.

Table 7.31: The Relationship between Farmers' Social capital, and Farmer/Farm Characteristics

Independent Variables	Dependent Variables (Extracted from Factor Analysis -PCA)					
	Bonding Social Capital		External Social Capital		Social Values	
	β	p-value	β	p-value	β	p-value
Age of the household head	0.017	0.094*	0.010	0.385	0.008	0.497
Sex of the household head	0.343	0.092*	0.172	0.434	0.258	0.247
Education level	0.113	0.000***	-0.007	0.813	0.047	0.115
Farming experience	0.011	0.215	-0.019	0.050**	0.016	0.086*
Land size	0.189	0.076*	0.175	0.129	-0.084	0.471
Household size	-0.055	0.120	0.043	0.265	0.002	0.964
Crop incomes	-0.000	0.234	0.000	0.062*	0.000	0.202
Remittances, grants & pension	-0.000	0.085*	0.000	0.313	0.000	0.316
Source of water for crop production	-0.177	0.033**	-0.148	0.099*	-0.235	0.011***
Location of irrigation scheme	0.568	0.056**	0.542	0.093*	0.371	0.254
(Constant)	-2.132	0.023**	-1.427	0.158	-1.033	0.311
R ² adjusted	0.257		0.123		0.103	
p-value	0.000***		0.010***		0.022**	
Durbin-Watson statistics	2.328		1.749		1.704	

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where ***, **, * represents significance level at 1%, 5% & 10%, respectively; β = coefficient

In summary, the independent sample T-test statistic was ran to establish the difference between smallholder irrigators' and homestead food gardeners' attitudes towards the importance of social capital in agricultural production and marketing. Results revealed that smallholder irrigators acknowledged the importance of working with government departments, support fellow farmers in times of hardship, access of farm information through fellow famers, cultural rules and norms, and participation in voting as crucial for increased agricultural productivity and marketing. Homestead food gardeners regarded working as farmer groups, group membership for labour access, access to farm implements, support of fellow farmers in times of hardships, adhering to cultural rules and norms, and participation in voting as important factors needed to enhance agricultural productivity and market access. However, both, smallholder irrigators and homestead food

gardeners underscored the importance of social networks in accessing farm inputs and individual trust in the community for improved agricultural productivity and market access.

Using factor analysis statistical method, three principal components were extracted from the covariance matrix. The three principal components extracted can be best described as bonding social capital index, external social capital index and social values index, respectively. Age, sex and education level of the household head, and land size had a positive and significant influence on bonding social capital while household incomes earned from remittances, social grants and pension, and source of water for crop production had a negative and significant influence on bonding social capital. Crop incomes and location of the irrigation scheme had a positive and significant influence on external social capital while farming experience and source of water for crop production had a negative and significant influence on external social capital. Social values had positive and significant relationship with age of the farmer while source of water for crop production had a negative and significant influence on social values. Therefore, for improved external social capital and adherence to social values, conflicts on the former state ran small-scale irrigation schemes need to be addressed.

7.14.4 The Impact of Human Dimensions on Maize Productivity

A Robust OLS Cobb-Douglas log-linear regression model (See equation 19 stated in Chapter 6: Section 6.2.3) was estimated to establish the impact of human dimensions on maize production. The model included other agro-inputs used by smallholder farmers since neither human dimensions nor physical resources can be used exclusively to yield agricultural outputs. According to the results presented in Table 7.32, the tangible (physical) agro-inputs that have a positive and significant impact on maize production include land size under maize production, amount of seeds planted and the number of irrigations/ha/season at a 1%, 10%, and 1% level, respectively. Therefore, for increased maize output, farmers need to increase land size under maize production, amount of improved seeds and increased number of irrigations/ha/season. The human capital related farmer characteristics have a positive relationship with maize output though not significant. Farmers' education level is linked to adoption and efficient use of new technologies and higher education level attainment is expected to increase production.

Among the intangible resources expected to positively influence maize production includes entrepreneurial spirit or positive psychological capital. All farmers' entrepreneurial spirit (positive psychological capital) aspects have no significant impact on maize production. However, farmers' risk taking (hope) and innovativeness (confidence) have a negative influence on maize production while response to available opportunities (optimism) had a positive impact on maize production. This means that, the smallholders' maize enterprise has less risks and calls for less innovativeness to achieve increased maize output while a sense of farmers' responsiveness to available opportunities (optimism) may be crucial for increased production. Therefore, farmers may need to have the ability to organize resources, take on the available opportunities, have the zeal to pay for trainings in good agronomic practices and business skills, and engage in information search in order to maximize maize output.

Farmers' social oriented goal has a negative and significant impact on maize production at 10% level while farmers' independence goal has a positive and significant impact on maize production at 5% level. These results suggest that, farmers who view farming as a social activity pay less attention to increased maize output. Also, the negative impact of the social oriented goals on maize output may be explained by farmers' tendency to cultivate land for tenure security purposes. In most African tradition land is regarded as one of the most important factors that define the individuals' social status (Obi, 2006). Farmers' independence oriented goal view farming as a source of self-employment, leisure time, participate in social gathering and maximize farm incomes. Thus, promoting this farmers' goal may enhance job creation and increased household incomes of the smallholder farmers both at Tyefu and Qamata irrigation schemes.

Table 7.32 Estimating the Role of Human Dimensions on Maize Productivity among Smallholders

Independent Variables (in natural logarithm)	Maize Output (Y) = Dependent Variable			
	Coefficient	Robust S.E	T-value	P-value
Land (ha)	2.411	0.367	6.58	0.000***
Seed (Kg/ha)	0.284	0.149	1.90	0.061*
Fertilizer (Kg/ha)	0.005	0.070	0.08	0.939
Pesticide (L/ha)	0.239	0.175	1.37	0.175
Herbicide (L/ha)	0.140	0.234	0.60	0.553
Number of irrigations/ha/season	1.241	0.236	5.26	0.000***
Total input costs (R)	0.132	0.170	0.78	0.439
Cost for tractor hire (R)	0.018	0.049	0.37	0.712
Education level (years)	0.110	0.079	1.39	0.167
Farming experience (years)	0.148	0.094	1.58	0.118
Risk taking (hope) (score)	-0.747	0.530	-1.41	0.162
Innovativeness (confidence) (score)	-0.564	0.491	-1.15	0.254
Recognizing opportunities (optimism)	0.608	0.672	0.91	0.368
Farm status oriented goal (score)	1.806	0.595	1.13	0.261
Business oriented goal (score)	-3.423	2.287	-1.50	0.138
Social oriented goal (score)	-1.684	0.962	-1.75	0.084*
Independence oriented goal (score)	3.489	1.469	2.38	0.020**
Bonding social capital (score)	-0.765	0.483	-1.58	0.117
External social capital (score)	2.292	0.854	2.68	0.009***
Social values (score)	-0.819	0.645	-1.27	0.208
(Constant)	-0.196	0.934	0.21	0.834
R-squared = 0.8671				
Prob > F = 0.000***				
Number of Observations (n = 108)				

*Source: Results from STATA (Version 9) generated from field survey, 2012. Where ***, **, * represents significance at 1%, 5% and 10% level, respectively. Kg = Kilograms, ha = hectares, L = litres, and scores = average item scores of the human dimensional Principal Components.*

Further, results presented in Table 7.29 indicate that external social networks are important for increased maize production since this type of capital is positively and significantly related to maize output at 1% level. At least some smallholder farmers at the irrigation scheme receive support from government's extension officers who sometimes get involved directly into crop production in farmer fields. Also, farmers receive some input subsidies, tractor services to plough their fields and the irrigation scheme facility rehabilitation costs which are mainly paid by the government. Other external social networks include private companies/business that avail market for farmer produce.. For social values, some cultural rules and norms may have a negative impact on agricultural production like denying

women access to land and have less power to decisions making concerning farming in the household yet they contribute about 70% of farm labour (Kodua_Agyekum, 2009; Kibirige, 2008).

7.14.5 The Role of Human Dimensions on Cabbage Production

When estimating the impact of human dimensions on cabbage production (number of heads produced), a robust log-linear Cobb-Douglas production function (See equation 19 stated in Chapter 6: Section 6.2.3) was ran. Results were generated as presented in Table 7.33. According to the results, the amount of land under cabbage production, amount of fertilizer applied and the number of times a farmer irrigate his/her field per hectare per season have a positive and significant impact on cabbage output at 1% level, respectively. For farmers to realize increased cabbage output, they need to allocate more land to cabbage production, apply more fertilizer and increase on the number of irrigations per hectare per season. Smallholder farmers' increased use of pesticides, total input costs and tractor hiring costs results into decreasing cabbage production since all have a negative impact on the number of heads of cabbage produced.

Farming experience has a positive and significant impact on cabbage produce at 10% level. Thus, increased cabbage production among smallholder farmers calls for more farming experience and this may be due to the agronomic practices which need skills developed overtime. Such skills that call for more experience may include estimating the right measure of seeds and pesticides applied, and reduction in crop failure risks. In this regard, there is a need of improving the human capital for a vibrant vegetable production among Qamata and Tyefu smallholder farmers. The level of education has a negative impact on cabbage production. Sometimes higher education level has a negative impact on agricultural production because individual with higher qualification tend to migrate from the less paying farming activities to formal employment thought to be more paying in terms of incomes (Bagamba, 2007).

Entrepreneurial spirit or positive psychological capital related factors have no significant influence on cabbage production. Risk taking (hope) has a negative relationship with the number of heads of cabbages produced while innovativeness (confidence) and response to opportunity (optimism) positively affect cabbage production. This may call for more

innovativeness (confidence) and use of available opportunities (optimism) with calculated risks for increased cabbage production. The negative impact of risk taking entrepreneurial spirit on cabbage production may be due to lack of storage facilities and geographical location of the area which is far away from the major urban markets yet cabbage is perishable produce. Thus, farmers tend to produce less to reduce on marketing and postharvest lose risks. These findings are consistent with Kisaka-Lwayo and Obi (2012) who indicated that farmers are risk averse and are reluctance to invest in unclear and high risky farming activities.

Table 7.33 Estimating the Role of Human Dimensions on Cabbage Production

Independent Variables (in natural logarithm)	Cabbage Output (Y) = Dependent Variable			
	Coefficient	Robust S.E	T-value	P-value
land under cabbage (ha)	4.071	0.703	5.79	0.000 ***
cabbage seeds (Kg/ha)	0.276	0.470	0.59	0.559
Fertilizer (Kg/ha)	0.619	0.159	3.89	0.000***
Pesticide (L/ha)	-0.047	0.211	0.22	0.826
Number of irrigations/ha/season	2.192	0.310	7.07	0.000***
Total input costs (R)	-0.244	0.166	1.47	0.146
Cost for tractor hire (R)	-0.09	0.065	-1.42	0.160
Education level (years)	-0.019	0.117	-0.16	0.871
Farming experience (years)	0.207	0.116	1.79	0.077*
Risk taking (hope) (scores)	-0.512	0.510	1.00	0.318
Innovativeness (confidence) (scores)	0.503	0.621	0.81	0.420
Recognizing opportunities (optimism)	0.724	0.586	1.24	0.220
Farm status oriented goal (scores)	4.477	1.451	3.08	0.003***
Business oriented goal (scores)	-6.648	2.314	-2.87	0.005***
Social oriented goal (scores)	-0.785	0.748	-1.05	0.298
Independence oriented goal (scores)	3.434	1.292	2.66	0.009***
Bonding social capital (scores)	0.917	0.612	1.50	0.137
External social capital (scores)	-0.098	0.745	-0.13	0.896
Social values (scores)	-0.492	0.681	-0.72	0.472
(Constant)	-1.155	1.047	-1.10	0.273
R-squared = 0.9136				
Prob > F = 0.0000***				
Number of Observations (n = 107)				

Source: Results from STATA (Version 9) generated from field survey, 2012. Where *** and * represents significance at 1%, and 10% level, respectively. Kg = Kilograms, ha = hectares, L =litres, and scores = average item scores of the human dimensional Principal Components.

Based on the results displayed in Table 7.33, farmers' goals have an important role in defining the number of heads of cabbages produced among smallholder farmers. The farm status/self-esteem and independence (self-employed) have a positive and significant impact on cabbage production at 1% level, respectively, while the business oriented goal has negative and significant impact on cabbage production at 1% level. Therefore, policies and development programmes that are geared towards promoting the farmers' farm status oriented goal, and independence oriented goal (farming as self-employment) may lead to increased cabbage production. All social capital related human dimensional factors have no significant influence on cabbage production. The external social capital and social values were regarded less important in the smallholder cabbage production since they exhibited a negative relationship with cabbage output.

7.14.6 The Role of Human Dimensions on Technical Efficiency for Maize Enterprise by SFA Approach

Technical efficiency scores of maize enterprise among smallholder farmers were generated from this estimation and are presented in Table 7.34. Keeping other factors constant, estimated stochastic frontier production function indicated that amount of land, seed planted, number of irrigations/ha/season and input total costs have a positive and significant influence on maize output at 1% level, respectively. Thus, a unit increase in land allocated to maize production, amount of improved seed planted, and number of irrigations/ha/season and purchased farm inputs increases maize output by 1.982, 0.391, 1.013 and 0.326 units, respectively. Amount of pesticides applied on maize crops had a negative and significant impact on maize output at 5% level. Indicating that an increase in the number of smallholders applying less amounts of pesticide result in a decrease of 0.234 units of maize output. The amount of fertilizers applied had an unexpected negative sign since most studies claim a positive relationship. This is probably because most smallholders were applying inadequate amounts fertilizers leading to low maize output.

Table 7.34: Stochastic Frontier Analysis Results for Maize Enterprise (n=108)

Independent Variables (in natural logarithm)	Maize Output (Y) = Dependent Variable			
	Coefficient	S.E	Z Value	P-value
Land under maize farming (ha)	1.982	0.244	8.13	0.000***
Quantity of seed planted (Kg/ha)	0.391	0.099	3.93	0.000***
Quantity of fertilizer applied (Kg/ha)	-0.053	0.070	-0.75	0.450
Quantity of herbicide applied (L/ha)	0.095	0.153	0.62	0.536
Quantity of pesticide applied (L/ha)	-0.234	0.115	2.04	0.041**
Number irrigations per season/ha	1.013	0.134	7.57	0.000***
Total costs on maize inputs (Rand)	0.326	0.082	3.97	0.000***
Constant	1.078	0.484	2.23	0.026**
sigma_v	0.253	0.167		
sigma_u	1.310	0.196		
Sigma2	1.780	0.447		
lambda	5.171	0.347		
Log likelihood = -120.805				
Prob > chi2 = 0.000***				
Wald chi2(6) = 426.62				
Number of Observations (n =105)				

Source: Results from STATA (Version 9) generated from field survey, 2012. ***, ** represents significance at 1% and 5%, ha = hectares, Kg = Kilograms; L = litres; S.E = Standard Error

Technical efficiency was obtained by using the estimated parameters from the log linear Cobb-Douglas Stochastic Frontier Analysis. Technical efficiency computed for each household later was disaggregated into ranges of efficiencies in terms of percentages. The minimum estimated efficiency score of smallholder farmers whose production activities were less influenced by direct interference of extension officers and cooperative management is 2.37 percent, the maximum is 88.0 percent and the overall mean was 44.21 percent. The efficiency ranges in percentages are presented in Table 7.35.

Overall, few smallholder farmers (30%) growing maize in the study area were technically efficient. Only 12% of smallholder irrigators were 80% and above technically efficient while 26% of them were at least operated between 60% and 79% of technical efficiency level. The most efficient homestead food gardeners operated between 60% and 79% of technical efficiency level. According to the results presented in Table 7.35, more than half of smallholder irrigators (62%) and homestead food gardeners (77%) were technically inefficient and operated below 60% of technical efficiency. Therefore, smallholder

irrigators and homestead food gardeners whose production activities are less influenced by direct interference of extension officers need to step-up their efficiency by 55.79% for increased maize productivity.

Table 7.35: Range of Technical Efficiency for Maize Enterprise (n=108)

Ranges of Efficiency (%)	Smallholder Irrigators (n=75) (%)	Homestead Food Gardeners (n=33) (%)	Overall (n=108) (%)
<20	4	32	18
20- 39	50	45	48
40-59	8	0	4
60-79	26	23	24
80-99	12	0	6
Total	100	100	100

Source: Results from SPSS (Version 11) generated from field survey, 2012

7.14.6.1 The T-Test of T. E. for Smallholder Irrigators and Homestead Gardeners for Maize Enterprise (108)

The STATA software was used to test and compare efficiency levels of smallholder irrigators and homestead food gardeners (Table 7.36). As expected, smallholder irrigators are more and significantly technically efficient than homestead food gardeners at 1% level. This proves the efficacy of the use of improved technology for increased farmers' technical efficiency. Smallholder irrigators on average were 48.35% technically efficient while homestead food gardeners on average were 34.32% technically efficient in maize production. These results suggest that homestead food gardeners should shift from the type of irrigation systems they use in maize production to that of smallholder irrigators in order to be more technically efficient.

Table 7.36: The T-test of T.E for Smallholder Irrigators and Homestead Gardeners: Maize Enterprise

Type of farmer	Sample Size	Mean Efficiency	Standard Error	Standard Deviation
Smallholder irrigators (y)	74	0.4835	0.0281814	0.24242
Homestead food gardeners(x)	31	0.3432	0.0371633	0.206917
Combined	105	0.4421	0.0234501	0.240292
Mean difference		0.1403	0.0497723	

Source: Results from STATA (Version 9) generated from field survey, 2012.

Satterthwaite's degrees of freedom = 103

t = 2.8198

Ho: mean(y) - mean(x) = 0

Ho: diff = 0

Ha: diff < 0

Ha: diff != 0

Ha: diff > 0

Pr(T < t) = 0.9971

Pr(T > t) = 0.0058

Pr(T > t) = 0.0029

7.14.6.2 Estimating the Impact of Human Dimensions on T.E. of Maize production

A linear regression of technical efficiency scores against explanatory variables was estimated (See equation 32 stated in Chapter 6: Section 6.2.5.2). The inefficient effects (explanatory variables) were specified as those related to farm/famers' characteristics, human capital, entrepreneurial spirit and positive psychological capital, farmers' goals, and social capital. The Durbin-Watson statistic for the regression model was 1.781 signifying low extent of autocorrelation problems. The F-value indicates that the explanatory variables combined, significantly influence changes in the dependent variable at 1% level. The technical inefficiency model indicates that socioeconomic characteristics such as household size and farm incomes have a positive impact on technical efficiency though not significant while age of the household and amount of land owned have a negative impact on technical efficiency though not significant. Incomes earned from remittance, social grants and pension has a negative and significant impact on the technical efficiency of maize production at 1% level. This is probably because rural households that receive more social grants tend to reduce their interests in farming as source of livelihood and hence, devoting less farm labour and energy to cultivate.

In most African rural settings, increased household size means increased farm labour force. Although not significant, an increase in the family size improves on efficiency by availing more family labour for a more equitable labour distribution among farming

activities. Increased farm labour distribution is thought to result into a higher concentration of an individual on the given task and thus improving production efficiency. Several studies carried out especially in Sub Saharan Africa have attested similar results. This finding is consistent with the estimate of Amos (2007) among cocoa producing households in Nigeria. Another study carried out by Haji (2007) also indicated a positive impact of family size on technical efficiency among small-scale vegetable farming households in Ethiopia.

Age of the household head is associated with general decision making ability (Aung, 2011). The literature about the impact of farmers' age on technical efficiency indicates that, an increase in age increases technical efficiency as the farmer gains experience though at a decreasing rate. This indicates that as farmers grow older they lose energy needed in farming activities thereby becoming less and less efficient (Bagamba, 2007). Furthermore, a bulk of literature has suggested that technical efficiency decreases with an increase in land sizes. The literature argues that farmers with small plots tend to concentrate all their energies, crop management skills and knowledge, and agro-inputs for increased production resulting into higher technical efficiency. This may explain why land size has a negative impact on technical efficiency. Nevertheless, less emphasis should be focused on this subject matter because the impact of small-scale verses large-scale farm on technical efficiency is an age-old argument among scholars and has produced mixed results without concrete conclusions (Padilla-Fernandez and Nuthall, 2001).

Human capital investment considered in this analysis comprises education level (years spent in school) and farming experience. Both education level and farming experience of the smallholder farmers have a positive impact on technical efficiency. Farming experience positively and significantly influences the level of technical efficiency at 5%. Several studies have displayed similar results (Dhungana *et al.*, 2010; Inoni and Ike, 2006; Kebede, 2001; and Coelli and Battese, 1996). This indicates that farmers' ability to manage risks based on past experiences probably assists in ensuring optimal timing and use of inputs more efficiently.

The technically efficient smallholder maize farmers are less risk takers (risk averse) since the variable is negatively and significantly related to technical efficiency at 1% level. According to the principal component analysis, farmers who are less risk takers recognize

opportunities and act quickly on existing opportunities (optimists). The quick action may call for less concentration on the use resources more efficiently and much focus put on the end-product. Also risk taker farmers lacked the ability to adopt new technologies of which such a component is a crucial ingredient for improved technical efficiency (Kibirige, 2008). Recognition of farm business opportunities (optimistic) has a positive and significant influence on technical efficiency at 1% level. Thus, the increased farmers' ability to take on available opportunity, ability to organize available resources, willingness to pay for trainings and information results in increased technical efficiency. However, maize production does not necessarily need new innovations or more confidence for improved technical efficiency. This is so because findings indicate that farmers' innovativeness (confidence) has a negative influence on technical efficiency though not significant.

Table 7.37: The Impact of Human Dimensions on T.E of Maize Production

Explanatory Variables	Dependent Variable = Technical Efficiency Scores			
	Coefficients	Std. Error	T-values	P-values
Household size	0.009	0.009	0.988	0.326
Age	-0.003	0.003	-1.055	0.294
Amount of land owned	-0.035	0.023	-1.434	0.155
Farm incomes	0.000	0.000	1.003	0.319
Remittances, social grants & pension	-0.000	0.000	-2.410	0.018**
Education level (years)	0.002	0.007	0.217	0.829
Farming Experience (years)	0.005	0.002	2.275	0.025**
Risk taking (hope)	-0.187	0.070	-2.672	0.009***
Innovativeness (confidence)	-0.098	0.066	-1.490	0.140
Recognizing opportunities (optimism)	0.208	0.063	3.284	0.001***
Farm status	0.055	0.114	0.481	0.632
Business	-0.218	0.171	-1.270	0.207
Social	-0.034	0.072	-0.469	0.640
Independence	0.234	0.086	2.702	0.008***
Bonding	-0.050	0.059	-0.848	0.399
External	0.185	0.049	3.783	0.000***
Social values	-0.169	0.060	-2.806	0.006***
(Constant)	0.711	0.255	2.790	0.006***
Adjusted R ² = 0.342				
F-Value = 4.181***				
Durbin-Watson statistics = 1.781				
Number of observation (n=108)				

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where *** and ** represents significance at 1%, 5% level, respectively; Std.Error = Standard Error.

Farmers' independence goal has a positive and significant impact on technical efficiency at 1% level. Thus, farmers who view farming as source of self-employment, avail leisure time to socialise, and accumulation of wealth are likely to be more technically efficient. Also, farm status (self-esteem) has a positive relationship with technical efficiency though not significant. This indicates that farmers' self-esteem or positive psychological capital towards the progress of their farms improves technical efficiency. However, farmers' business oriented and social goals have a negative impact on technical efficiency of maize production. Padilla-Fernandez and Nuthall (2001) findings are consistent with this study regarding the negative impact of business and social oriented goals on technical efficiency. Thus, inefficient farmers view farming as a business and a social activity. For smallholder farmers to be more technically efficient, they need to set-up farmer's goals that promote self-employment and independence, self-esteem and labour saving technologies that avail enough time for leisure and socialisation.

The external social capital has a positive and significant influence on technical efficiency at 1% level. This may be attributed to government support rendered to farmers in terms of providing farm input loans through micro-finance institutions especially at Qamata irrigation scheme. However, government direct involvement at these Qamata and Tyefu irrigation schemes is minimal. According to Ostrom (1998) and Yamaoka (2007) the direct interventions of external social capital may disrupt mutual dependences and reciprocity patterns between farmers that have long been supporting the system, thereby changing patterns of relationships among farming community and individual households.

The social values like cultural rules and norms have a negative and significant impact on technical efficiency at 1% level. The tribal authorities played a key in distribution of the farm land among community members of both the former homelands of Transkei and Ciskei in South Africa. The land distribution was mainly carried out based gender and kinship as part of cultural rules and norms. The skewed distribution of land on irrigation scheme left some households landless (Obi, 2006; and Kodua-Agyekum, 2009). This can contribute to low technical efficiency through low farm investments especially where households are not sure about their land tenure security. The bonding social capital is believed to be crucial in promoting inter-unit resource exchange and innovation for increased efficiency (Adler and Kwon, 2002; and Hong and Sporleder, 2007). However,

bonding social capital in this study was found to have a negative impact on technical efficiency though not significant.

7.14.7 The Role of Human Dimensions on T.E. for Cabbage Enterprise by SFA

A Cobb-Douglas production function results are presented in Table 7.38. For a better understanding of the functional relationships between several variables that affects Cabbage production, a Cobb-Douglas production frontier model was employed. Amount of land under cabbage production, quantity of fertilizer applied and number of irrigations per hectare per season have a positive and significant impact on cabbage output at 1% level. Indicating that, a unit increase in the amount of land allocated to cabbage production, amount of fertilizer applied and number of irrigations per hectare per season results into an increase of 3.64, 0.48 and 2.02 units of cabbage output.

Table 7.38: Stochastic Production Frontier Results: Cabbage Enterprise (n=108)

Independent Variables (in natural logarithm)	Cabbage output (Y) = Dependent Variable			
	Coefficient	S.E	Z Value	P-value
Land under cabbage farming (ha)	3.640	0.343	10.63	0.000***
Quantity of seed planted (Kg/ha)	-0.103	0.260	-0.40	0.691
Quantity of fertilizer applied (Kg/ha)	0.476	0.105	4.55	0.000***
Quantity of pesticide applied (L/ha)	-0.112	0.166	0.68	0.499
Number times irrigated a season	2.024	0.147	13.76	0.000***
Total input costs	-0.124	0.098	1.26	0.209
Constant	0.079	0.908	0.09	0.931
sigma_v	0.982	0.068		
sigma_u	0.026	1.129		
Sigma2	0.965	0.137		
lambda	0.027	1.142		
Log likelihood = -149.906				
Prob > chi2 = 0.000***				
Wald chi2(6) = 833.34				
Number of Observations (n =107)				

Source: Results from STATA (Version 9) generated from field survey, 2012. Where *** represents significance at 1%. Ha =hectares; Kg = Kilograms; L = Litres; S.E = Standard Errors.

The amount of cabbage seed planted and pesticide applied has a negative impact on the number of heads of cabbages produced. The negative impact of amount of cabbage seed planted on cabbage output can be explained by the overcrowding or high density of

cabbage seeds on small pieces of plots which may lead to low survival rate due to competition for nutrient and high disease/pests incidences, and hence resulting into low productivity.

Both the smallholder irrigators and homestead food gardeners were technically efficient at 98% level (Table 7.39). Findings of this study are not so different from Haji (2008) estimated technical efficiency (91%) of the predominantly known vegetable production area in the eastern parts of Ethiopia. Since smallholder farmers have access to relatively small sizable plots of land, they tend to utilize them more efficiently with available farm inputs to maximize profits. There was no significant difference of technical efficiency scores between smallholder irrigators and homestead food gardeners. Results from this study coincide with the study carried out by Makombe *et al.* (2011) who hypothesized that the rain-fed farmers who have access to irrigation scheme facilities may transfer some resource by using the incomes earned and farming techniques from irrigated farms to intensify rain-fed production. Generated incomes from irrigation farms are used to acquire fertilizer, herbicides and other inputs to be used in dry land farming. Such a relationship was also found at Qamata and Tyefu irrigation communities where smallholder irrigators owned homestead food gardens in addition to irrigation plots on the schemes.

Table 7.39 The T-Test of T. E for Smallholder Irrigators and Homestead Gardeners: Cabbage Production (n=108)

Type of farmer	Sample size	Mean Efficiency	Standard Error	Standard Deviation
Smallholder irrigators (y)	75	0.9792647	0.00002	0.0002
Homestead food gardeners(x)	32	0.9792859	0.00005	0.0003
Combined	107	0.979271	0.00002	0.0003
Mean difference		-0.0000212	0.00005	

Source: Results from STATA (Version 9) generated from field survey, 2012

Satterthwaite's degrees of freedom = 105

t = -0.3984

Ho: mean(y) - mean(x) = 0

Ho: diff = 0

Ha: diff < 0

Ha: diff != 0

Ha: diff > 0

Pr(T < t) = 0.3456

Pr(T > t) = 0.6912

Pr(T > t) = 0.6544

7.14.8 Estimating the Impact of Human Dimensions on T. E. of Cabbage Production

The impact of human dimensions on technical efficiency of cabbage production was estimated by fitting the principal component generated in the OLS linear regression model (See equation 32 stated in Chapter 6: Section 6.2.5.2). The adjusted coefficient of determination (R^2) of the overall model (22.6%) and explanatory coefficients are basically very low. However, the F-test values indicate a high significant relationship between the dependent and explanatory variables at 1% level. The autocorrelation among variables was statistically tested using a Durbin-Watson statistic scores and no such problems were observed since the score (2.256) is greater than one.

Household size has a positive and significant impact on technical efficiency in cabbage production at 10% level. During interviews farmers indicated that cabbage production requires more labour compared to other crops and they lacked money to hire farm labour, an indication of high dependence of household farm labour. Thus, increased family labour serves the purpose to meet the high demand of labour in cabbage production. Off-farm incomes also had a positive impact on cabbage production although not significant. These incomes may be used to purchase farm inputs for efficient utilisation of resources. Smallholder farmers who recognise farming as their major occupation, have more crop incomes and use improved seed are more likely to be technically inefficient. This is explained by the results which indicate that farmers' major occupation (mainly farming), crop incomes and use of improved seed negatively and significantly influence the level of technical efficiency in cabbage production at a 10%, 5% and 1% level, respectively.

The negative association between crop income and technical efficiency indicates that since cabbage is a high value crop, most incomes generated from this enterprise may be diverted to off-farm activities like trading to generate more incomes. The negative impact of use of improved cabbage seed still goes back to the agronomic techniques needed to use this technology which may be lacking among farmers, leading to overcrowding, low survival rates and hence low productivity. For improved utilization of cabbage seed, technologies needed may include timely planting, crop spacing and nutritional demands of these improved seeds. Tyefu irrigation scheme's smallholder irrigators are likely to be more technically efficient than Qamata smallholder irrigators in cabbage production since location of the irrigation scheme has a negative impact on technical efficiency. This is

because Qamata farmers constitute a relatively larger number of respondents interviewed than Tyefu farmers.

Results indicate that human capital has a major role to play for improved efficiency of cabbage production. The education level and farming experience attained by smallholder farmers have a positive impact on technical efficiency of cabbage production. Farming experience has a positive and significant influence on technical efficiency of cabbage production at 5% level. The positive relation indicates that farmers with more farming experience are more technically efficient. Experience may help in knowing the best agronomic practices and how to avoid risks related to crop failure.

Table 7.40: The Impact Human Dimensions on T. E. for Cabbage Enterprise

Explanatory Variables	Dependent Variable = Cabbage Output			
	Coefficients	Std. Error	T-Values	P-Values
Household size	0.000	0.000	1.702	0.092*
Major occupation of the farmer	-0.000	0.000	-1.914	0.059*
Crop incomes	-0.000	0.000	-2.154	0.034**
Off-farm incomes	0.000	0.000	1.261	0.211
Location of irrigation scheme	-0.000	0.000	-1.588	0.116
Use improved seeds	-0.000	0.000	-3.228	0.002***
Education level (years)	0.000	0.000	1.066	0.289
Farming Experience	0.000	0.000	2.409	0.018**
Risk taking (hope)	-0.000	0.000	-1.862	0.066*
Innovativeness (confidence)	0.000	0.000	2.076	0.041**
Recognizing opportunities (optimism)	0.000	0.000	1.352	0.180
Farm status oriented goal	0.000	0.000	2.627	0.010***
Business oriented goal	-0.000	0.000	-1.302	0.196
Social oriented goal	-0.000	0.000	-2.902	0.005***
Independence oriented goal	0.000	0.000	1.746	0.084*
Bonding social capital	0.000	0.000	0.680	0.498
External social capital	0.000	0.000	0.469	0.640
Social values	-0.000	0.000	-0.248	0.805
(Constant)	0.979	0.000	3164.985	0.000***
Adjusted R ² = 0.226				
F-Value = 2.716***				
Durbin-Watson statistics =2.256				

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where ***, ** and * represents significance at 1%, 5% and 10% level, respectively; Std. Error = Standard Error.

Like in maize production, risk taking (hope) has a negative and significant influence on technical efficiency of cabbage production at 10% level while innovativeness (confidence) has a positive and significant influence on technical efficiency of cabbage production among smallholder farmers. Thus, risk taking (hope) is not necessary for improved technical efficiency of cabbage production while increased farmers innovativeness (confidence) is much more needed for improved technical efficiency. Use of available farm business opportunity was also positively related to technical efficiency though not significant. Therefore, for a farmer to be more technically efficient and maximize cabbage output, development programmes and policies may need to promote more of the farmers' innovativeness (confidence) and optimistic behaviour.

Farmers' farm status and independence goals have a positive and significant impact on technical efficiency of cabbage production at 1% and 10% level, respectively while social oriented goals have a negative and significant influence on technical efficiency of the same enterprise at 1% level. Thus, efficient farmers want to be recognised by their farm status, take farming as self-employment, and farming provides more leisure time with less socializing. Farmers who view farming as business are more likely to be less efficient since the business goal was found to have a negative impact on technical efficiency. Therefore, building farmers' self-esteem and promoting farming as source of self-employment among smallholder farmers may result in increased technical efficiency in the cabbage enterprise.

The bonding and external social capitals have a positive impact on technical efficiency for smallholder cabbage producers. Thus increased accumulation of bonding and external social capital may result in increased technical efficiency of cabbage production. Based on the principal component extraction results, the bonding social capital promotes access to farm labour, agro-inputs and farm implements and this may enhance efficiency and maximise cabbage output. The external social capital in this case may be attributed to access to vegetable markets which are considered to be sophisticated due to the product's perishability and high value characteristics. Although social values like trust are reported to be vital in cementing corporation among groups (Migueluez *et al.*, 2009), findings of this study indicated that social values have a negative impact on technical efficiency in cabbage production.

7.14.9 The Impact of Human Dimensions on Household Commercialization Index for Maize Enterprise

As discussed in the literature review in chapter 3, commercialization of agriculture is believed to play a key role in the development of rural economies especially in the sub-Saharan Africa thereby contributing to poverty reduction. However, results presented in Table 7.11 indicate a low household commercialization index (HCI) among smallholder farmers. Therefore, it is worth knowing the factors responsible for the low commercialization level among smallholders and these may include the farm/farmer's characteristics and the human dimensional factors. Using an OLS linear regression model (equation 32 in Chapter 6: Section 6.2.5.2), the relationship between HCI of the maize enterprise and farm/farmer's characteristics, and the human dimensions was estimated. There is a high correlation between the HCI and the explanatory variables since the F-value (5.076) indicates a 1% significance level as shown in Table 7.41. Also, the Durbin-Watson statistic results (1.964) indicated low extent of autocorrelation between the variables.

Farmer's characteristics such as household size and crop incomes have a positive and significant influence on HCI at 1% level, respectively. In this case, household size may be considered as source of labour and crop incomes as source of capital for reinvestment to increase marketable output. According to Future Agricultures (2012) and Jaleta *et al.* (2009), household size and availability of relatively larger number of household members participating in farming positively and significantly affects smallholder farmers' commercialization level. The age of the household head also has a positive impact on HCI though not significant. Off-farm income has a negative and significant influence on HCI at a 1% level. This may be due to less time committed by farmers to participate in the agricultural markets. Farm characteristics like the size of land owned by the smallholder farmers has a negative impact on HCI for maize Enterprise. This suggests that as land size increases farmers tend to produce less marketable surplus. Further, this may be related to the negative impact of land size on technical efficiency where increased land size results in inefficiency and hence reducing maize productivity.

Smallholder farmers who use dams and rivers as source of water for crop production are likely to produce more marketable surplus than farmers who depend on rain-fall, tap and springs as source of water for crop production. The source of water for crop production

(mainly the dams and rivers) was found to have a positive and significant influence HCI. Further, results indicate that location of the irrigation scheme has a negative and significant influence on the HCI for maize enterprise. This is an indication that smallholder farmers at Tyefu irrigation schemes are likely to produce more marketable surplus despite cultivation of small food plots (0.25ha/person) compared to smallholder irrigators at Qamata irrigation scheme (1.5ha/person).

Table 7.41: The Impact of Human Dimensions on the HCI for Maize Enterprise

Explanatory Variables	Dependent Variable = HCI for Maize			
	Coefficients	Std. Error	T-values	P-Values
Household size	0.033	0.011	2.882	0.005***
Age of the household head	0.003	0.003	0.897	0.372
Amount of land owned	-0.018	0.035	-0.513	0.609
Crop incomes	0.000	0.000	3.965	0.000***
Off-farm incomes	-0.000	0.000	-4.354	0.000***
Source of water for crop production	0.100	0.032	3.096	0.003***
Location of irrigation Scheme	-0.300	0.115	-2.608	0.011***
Education level (years)	0.002	0.010	0.234	0.816
Farming Experience (years)	0.001	0.003	0.252	0.801
Risk taking (hope)	0.233	0.096	2.433	0.017**
Innovativeness (confidence)	0.136	0.091	1.497	0.138
Recognizing opportunities (optimism)	-0.276	0.086	-3.199	0.002***
Farm status	-0.049	0.159	-0.308	0.759
Business	-0.285	0.245	-1.165	0.247
Social	-0.127	0.099	-1.286	0.202
Independence	0.277	0.123	2.253	0.027**
Bonding	0.124	0.090	1.386	0.169
External	0.165	0.068	2.442	0.017**
Social values	-0.237	0.084	-2.816	0.006***
(Constant)	0.237	0.383	0.618	0.538
Adjusted R ² = 0.432				
F-Value = 5.076***				
Durbin-Watson statistics = 1.964				
Number of observations (n) =108				

Source: Results from SPSS (Version 11) generated from field survey, 2012. Where *** and ** represents significance at 1%, 5% and 10% respectively; Std Error = Standard error, and HCI= household commercialization index

The human capital explained by the education level and faming experience did not have a significant influence on commercialization level though positive. Thus, increase in human capital may result in increased household commercialization level of smallholder farmers' maize enterprise. The role of entrepreneurial spirit on commercialization level

can be best described by the significance and signs (-/+) carried by the coefficients and t values.

The smallholder farmers who take risks (hopeful) are likely to produce more marketable surplus than risk averse farmers since risk taking has a positive and significant impact on household commercialization level of maize enterprise at 5% level. Smallholder farmers who are ready to take-up risks are more likely to benefit from specialization through utilization of limited land size and agro-input to maximize output and profits (Jaleta *et al.*, 2009). However, according to Jaleta *et al.* (2009), farmers' shift from subsistence to commercial production face higher risks of fluctuating prices and yields resulting in fluctuation of household incomes. Farmers' recognition of business opportunities (optimism) is less important for increased commercialization of maize. This is because farmers' recognition of opportunities had a negative and significant impact on household commercialization at 1% level. However, innovativeness (confidence) may be important for increased marketable surplus of maize among smallholder farmers since it exhibited a positive impact on HCI. Therefore, for increased household commercialization level of maize, farmers need to take calculated risk (hopeful) and innovativeness (confidence) without necessarily acting on opportunities perceived to be profitable (optimism).

Household commercialization level (HCI) in maize enterprise is positively and significantly related to farmer's independence goal at 5% level while farm status, business and social goals have a negative impact on HCI for the maize enterprise. Based on these results, farmers who view farming as a source of self-employment have a higher commercialization's level compared to farmers who set their goals in terms of farm status, business or social oriented. For social capital, farmers' external social capital has a positive and significant impact on household commercialization level of maize at 5% level while social values have a negative and significant impact on the same at 1% level. Social values constitute part of institutional environment and arrangements that establish the basis for production, exchange, and distribution (Jaleta *et al.*, 2009). Formal institutions like unclear property rights including land ownership and inconsistencies within institutional arrangements have a negative impact on commercialization of agriculture. Thus, smallholder farmers' facing unclear land ownership and lack of trust among cooperative union and community members may result in low household commercialization index. This implies that government, private sector and NGOs have an important role to play for

improved household commercialization level of maize among smallholders especially through indirect support such as provision of inputs, implements and extension services. The findings reported by Chirwa and Matita (2012) indicated that the main purpose of farmers' association with National Smallholder Farmer Association of Malawi (NASFAM) programmes were to have access to business training, have access to produce markets and other services. These benefits from NASFAM had a positive and significant influence on farmers' degree of commercialization.

7.14.10. The Impact of Human Dimensions on the HCI for Cabbage Enterprise

Overall, results of the linear regression model (See equation 32 stated in Chapter 6: Section 6.2.5.2) using F-value statistic score (2.209) indicate a high significant relationship between the dependent (household commercialization Index (HCI) for cabbage) and explanatory variables at 1% level. The Durbin-Watson statistic score (2.038) also confirms low extent of autocorrelation among the variables. In respect to farmer's characteristic, gender of the household head has a negative and significant impact on HCI of cabbage at 5% level, indicating that female farmers are more commercially oriented than men in cabbage enterprise. According to Jaleta *et al.* (2009), smallholder commercialization greatly depends on the commodity-specific labour demand and who controls sales earned from this crop. Further, Jaleta *et al.* (2009) cited Von Braun (1994) indicating that a shift from maize to vegetable production in Guatemala resulted in increased proportion of women's labour use from 6.1% to 21.5%. Smallholder farmers who generate more crop incomes are likely to produce more marketable output than low income earners from crop production. This may be due to reinvestment of crop incomes into cabbage production which results into increased marketable output. Household size and age of the farmer have positive impact on HCI of cabbage enterprise though not significant.

Smallholder cabbage farmers with small plots are more likely to produce more marketable surplus than relatively larger farms because, land size owned by the farmer has a negative and significant impact on HCI of cabbage enterprise at 10% level. Source of water has a positive and significant influence on cabbage commercialization at 5% level, indicating water availability is crucial for increased production of marketable surplus of cabbage. Furthermore, results in Table 7.42 suggest that smallholder farmers at Tyefu irrigation scheme food plots are likely to be more commercially oriented in

cabbage enterprise than farmers at Qamata irrigation scheme. This is explained by the negative and significant relationship between the location of the irrigation scheme and HCI of the cabbage enterprise at 1% level. This is because most respondents in this study were Qamata farmers.

The estimated human capital parameters (education level, and farming experience) had no significant influence on the level of commercialization of cabbage enterprise. Education level of the farmers has a positive relationship with HCI for the cabbage enterprise while farming experience is negatively related to the level of marketed cabbage output among smallholder farmers. The principal components for entrepreneurial spirit (positive psychological capital) like innovativeness (confidence) has a positive and significant impact on HCI for cabbage enterprise at 10% level while risk taking (hope) and recognizing farm business opportunities (optimism) have a negative impact on HCI of the cabbage enterprise though not significant. Thus, the cabbage business among smallholder farmers in the study area may call for more innovativeness (confidence) with less risk taking and recognition of farm business opportunities (optimism). Further, this indicates that there is market for cabbages, and farmers may need to increase production and add value for better prices. Jaleta *et al.* (2009) also attested the importance of increased innovation especially in resource-saving and yield-enhancing technologies for increased smallholder commercialization. In order to benefit resource-poor farmers, Jaleta *et al.* (2009) indicated that much focus should be directed towards food crops since poor farmers can hardly afford expensive technologies needed in cash crop production.

The independence goal of smallholder farmers has a negative and significant influence on cabbage HCI at 5% level. This indicates that smallholder farmers at both Tyefu and Qamata irrigation scheme who view cabbage production as source of self-employment and independent are more likely to produce less marketable surplus of cabbage. Also, the farm-status/self-esteem goal of smallholders has a negative impact on HCI for cabbage enterprise though not significant. Both farmers' business and social oriented goals have a positive impact on HCI for cabbage production. Therefore, there is a need to promote more of the business and social oriented farmers' goals than the independence and farm status oriented goals for increased marketable surplus of cabbage.

Table 7.42: The Impact of Human Dimensions on the HCI for Cabbage Enterprise

Explanatory Variable	Dependent Variable = HCI for Cabbage			
	Coefficients	Std. Error	T-Values	P-Values
Household size	0.001	0.015	0.055	0.956
Gender of the household head	-0.195	0.090	-2.176	0.032**
Age of the household head	0.005	0.004	1.153	0.252
Crop incomes	0.000	0.000	1.905	0.060*
Amount of land owned	-0.088	0.046	-1.932	0.057*
Source of water for crop production	0.097	0.045	2.142	0.035**
Location of irrigation scheme	-0.441	0.154	-2.857	0.005***
Education level (years)	0.004	0.013	0.322	0.748
Farming Experience (years)	-0.004	0.004	-0.933	0.353
Risk taking (hope)	-0.099	0.128	-0.772	0.442
Innovativeness (confidence)	0.234	0.122	1.911	0.059*
Recognizing opportunities (optimism)	-0.048	0.115	-0.421	0.675
Farm status	-0.124	0.211	-0.589	0.557
Business	0.194	0.324	0.600	0.550
Social	0.139	0.132	1.054	0.295
Independence	-0.386	0.164	-2.357	0.021**
Bonding	0.110	0.118	0.932	0.354
External	-0.221	0.091	-2.444	0.017**
Social values	0.106	0.112	0.948	0.346
(Constant)	0.830	0.510	1.630	0.107
Adjusted R ² = 0.177				
F-Value = 2.209***				
Durbin-Watson statistics = 2.038				
Number of observations (n) =108				

Source: Results from SPSS (Version 11) generated from field survey, 2012: where *** and * represents significance at 1% and 10% respectively; Std Error = Standard error, and HCI= household commercialization index

The farmers' HCI for cabbage enterprise has a positive relationship with bonding social capital and social values. Thus, increased accumulation of the two may result in increased marketable surplus of cabbage output. The bonding social capital improves access to cheap farm labour, inputs and farm implements. Although external social capital has a positive relationship with technical efficiency of cabbage production, it is regarded less important for HCI for cabbage enterprise among smallholder farmers. External social capital has a negative and significant impact on the HCI for cabbage enterprise at 5% level. This may be attributed to farmers' fear of risks related to opportunism behaviors exhibited by some middlemen, hawker and private companies that use information asymmetry to offer low farm gate prices.

CHAPTER 8

SUMMARY AND RECOMMENDATIONS

8.1 Introduction

Small-scale irrigation schemes in former Transkei and Ciskei homelands of Eastern Cape Province were established for improved food security, employment and eradication of poverty in rural areas. Despite the apartheid and post-apartheid government's efforts through improved access to land, water, farm inputs and implements, and extension services, smallholder farmers' productivity is still low and bound to continued decline. Further, the historical and apartheid skewed laws, policies and programmes have been held responsible for the poor performance of rural smallholders. However, these conclusions have dwelt much on literature that focuses more on improved access to tangible agricultural factors as engine for increased agriculture productivity with less devotion on the role of the intangible human dimensional aspects. If improved access to tangible resources is failing, then someone may consider the role of the intangible human dimensions for increased production efficiency and commercialisation of smallholder irrigation farms. Thus, the central purpose of this study was to assess the role of human dimensions on production efficiency and commercialisation level in the transition from subsistence homestead food gardening to smallholder commercially oriented irrigation farming in the former homelands of Transkei and Ciskei, in the Eastern Cape Province of South Africa.

8.2 Summary

For the systematic flow of this thesis, 8 chapters were developed; these include the introduction and background of the study, a review of the South African agricultural sector and agricultural land and irrigation farming issues, a review of the human dimensions and commercialisation of agriculture, and agricultural productivity and production efficiency. The thesis also presented the description of the study area and the methodology used to address the set objectives. Results estimation of the smallholder profitability, production efficiency, principal component of the human dimensions and their impact on technical

efficiency and commercialisation level is also presented. Below are the highlights of the issues covered in this study.

8.2.1 The Socioeconomic Characteristics of Smallholder Farmers of Qamata Area

Most farm households were headed by men, the proportion being slightly higher among the homestead food gardeners. The sample suggests that the biggest proportion of farmers had some education, mostly up to 5 years of primary school education. Education level is higher among the homestead food gardeners and lower among the smallholder irrigators. Both smallholder irrigators and homestead food gardeners have household size of approximately 4 persons. Overall, 92% of smallholder irrigators and homestead food gardeners considered farming as their major occupation. The average age of household head among smallholder irrigators and homestead food gardeners is 60.23 and 61.9 years, respectively. The average farming experiences of smallholder farmers and homestead food gardeners is approximately 11 and 15 years, respectively. The sources of livelihood among smallholder farmers at Qamata and Tyefu irrigation scheme are mainly farm income and remittances, social grants and pensions with little earnings from off-farm activities.

8.2.2 Major Crops Grown and Input use by Smallholder Farmers

Overall, there are three major crops grown on the irrigation schemes and homestead food gardens. These include maize, cabbage and potatoes, and others categorised as vegetables. Farmers mainly grow these crops to meet their daily household food needs, generate incomes and can be easily grown. In their farming endeavours, smallholder farmers at Qamata and Tyefu irrigation schemes use most of the important agro-inputs and some degree of mechanisation. The common agro-inputs used include improved seeds, fertilizer, agro-chemicals, and tractor hire for mainly clearing and ploughing of fields/gardens. Smallholder irrigators significantly have more access to improved seeds and tractors than homestead food gardeners and this is mainly attributed to more government support received by smallholder irrigators than homestead food gardeners.

Smallholder irrigators devoted less land and seed in maize production with slightly more fertilizer, pesticide, herbicide and much higher number of irrigations/hectare/season compared to homestead food gardeners. However, homestead food gardeners are

significantly higher users of fertilizers and irrigation water in cabbage production compared to smallholder irrigators. Therefore, smallholder irrigators devote more physical input resources in maize production while homestead food gardeners devote more resources in cabbage production. However, both smallholder's irrigators and homestead food gardeners were using far less amounts of fertilizers, pesticides and herbicides compared to the recommended amounts and thus, leading to low yields. This may call for more provision of input subsidies especially among smallholder irrigators for optimal utilization of the irrigation schemes.

8.2.3 Irrigation Water use

Through observations, Qamata and Tyefu areas experience a dry-semi-arid type of climate where farming can hardly be successful without irrigation. In a series of interviews carried out during the pre-survey period, extension officers and scheme managers reported an almost impossible situation to farm without irrigation in these areas. Farmers at Qamata and Tyefu irrigation schemes identified dams, rainfall, rivers, taps and springs as sources of water for crop production, dam, river and rainfall being the most used. Homestead food gardeners mainly depend on rainfall as their major source of water for crop production while smallholder irrigators consider both dams and rainfall as their major source of irrigation water. Furrowing and sprinkler are the major used type of irrigation system by smallholder irrigators while horse pipes connected to tap water and furrowing are the major types of the irrigation systems used by homestead food gardeners. Half of respondents in this study indicated that access to land was a major problem hindering their participation on the irrigation schemes and 30% of challenges faced by irrigators are attributed to inadequate water and high costs of repair and rehabilitation at the irrigation schemes.

8.2.4. Extension Services

Although a good number of farmers indicated a direct participation of extension officer in farm field especially in decision making on which inputs to acquire and amounts applied, findings indicate a poor performance in record keeping, financial, marketing and group management trainings. Judging from the poor access to farm management training by farmers, one is inclined to conclude that lack of farmer trainings resulting in low

agricultural productivity is a major factor hindering the transition from subsistence farming to smallholder commercial farming both at Qamata and Tyefu irrigation schemes.

8.2.5. Profitability and Household Commercialisation Level/Index (HCI)

Participation on the irrigation scheme seem to be more profitable than homestead food gardening. This is probably because smallholder irrigators produce more maize yields and earned more revenues and gross margins from the enterprise compared to homestead food gardeners despite a slightly higher expenses on input purchased by homestead food gardeners. Although the overall findings indicate a low commercialisation among both type of farmers, the higher maize yield of smallholder farmers contributed to a higher commercialisation level compared to homestead food gardeners. In addition to the higher yield, total revenues and gross margins from maize enterprise, smallholder irrigators also produce more yields and earn slightly more total revenues and gross margins from the cabbage enterprise. However, most cabbages produced by smallholder irrigators is consumed at home and only 19% is sold while homestead food gardeners sale at least 24% of their cabbage output. Although smallholders' yields were higher than homestead food gardeners, findings indicate that both farmers' yields for maize and cabbage were far below the expected potential, and thus suggesting big room for increased yields within the existing irrigation technology and other fixed variables. Therefore, these results suggest a transition from homestead food gardening to smallholder irrigation farming aimed at increased marketable output.

8.2.6. Allocative Efficiency

Using the available input prices easily estimated by farmers, allocative efficiency scores where generated. Both smallholder irrigators and homestead food gardeners are allocatively inefficient in utilizing maize seed, fertilizers, pesticide and herbicides. Smallholder irrigators and homestead food gardeners underutilize improved maize seed, pesticides and herbicides and over spent money on fertilizers as indicated by the marginal revenues of each inputs verses the marginal costs of the same input (or unit input price) results. Therefore for maximization of profits, both farmers need to reduce on fertilizer costs or search for cheaper fertilizers as they increase use of improved maize seed, pesticide and herbicides.

8.2.7 Production Efficiency for the Overall Sample

The non-parametric (DEA approach) and parametric (Stochastic Frontier approach) methods were used to estimate the production efficiency of smallholder farmers at Qamata and Tyefu irrigation scheme. Based on the DEA findings on maize production, homestead food gardeners are significantly more technically efficient (99.6%) than smallholder irrigators (98.3%) when considering the Variable Returns to Scale (VRS). This may be attributed to significantly more efficient use of irrigation water by homestead food gardeners compared to smallholder irrigators. However, smallholder irrigators are significantly more technically and economically efficient in the use of maize seed, fertilizers, pesticides and herbicides compared to the homestead food gardeners. Therefore, smallholder irrigators need to improve on technical efficiency for irrigation water use in order to maximise output within the existing resources and technology in maize production. Further, when using DEA approach, homestead food gardeners are technically more efficient in cabbage production while smallholder irrigators are more economically efficient and they were efficiently utilizing the irrigation water in cabbage production. Overall, both smallholder irrigators and homestead food gardeners are more economically efficient in cabbage production than maize production. This suggests that farmers put more emphasis on cabbage production for income generation than maize production.

Contrary to the DEA results, the stochastic frontier results indicated that smallholder irrigators are more technically efficient compared to homestead food gardeners in maize production while homestead food gardeners are more technically efficient than smallholder irrigators in cabbage production.. Generally, the VRS results of the DEA model are closely related to technical efficiency results generated by stochastic frontier suggesting that farmers are not operating at the same frontier. Thus, both approaches can be used to achieve the same result when keeping other factors constant. Factors that are positively associated with technical efficiency in maize production included household size, farming experience, off-farm income, use of agro-chemicals, gross margins and commercialisation level. The amount of land owned and access to input use training had a negative impact on technical efficiency in maize production. The determinants of technical efficiency in cabbage enterprise included farming experience, amount of land owned, use of agro-chemicals, group membership and gross margins accrued to cabbage sales.

8.3 The Entrepreneurial Spirit and Positive Psychological Capital

For any success to be achieved in business it requires entrepreneurial spirit. Entrepreneurial spirit is enhanced by positive psychological capital. Therefore, in this study entrepreneurial spirit was interchangeably used with positive psychological capital as part of smallholders' human dimensions anticipated to have an effect on farm production, efficiency and commercialization level. According to the overall results, smallholder farmers in Qamata and Tyefu irrigation scheme have low entrepreneurial spirit (positive psychological capital). The findings in this study indicated that farmers were innovativeness, confident to adopt new technologies and ready to invest money in farm business. They were also optimistic and willing to take action on farm business perceived to be more profitable. Three principal components that explained 61.48% of the variance in the original scores were extracted from the covariance matrix. These were defined as risk taking (hope), innovativeness (confidence) and recognition of opportunities (optimism). Using a multiple regression analysis, factors that had a significant impact on entrepreneurial spirit/positive psychological capital were identified and these included age, education, farming as a major occupation, farming experience, incomes from crop, livestock, and remittances, social grants and pension, source of water for crop production and location of the irrigation scheme.

8.4 Farmers' goals and Behaviour

The findings of this study revealed that smallholder irrigators mainly view farming as source of incomes while homestead food gardeners view farming mainly as a social activity. Expanding farming business, increased maximisation of farm income and accumulation of wealth were the major goals of the smallholder irrigators while homestead food gardeners' goals were more of farming as a lifestyle and source of social medium. Using factor analysis, four principal components were generated and were labelled as: farm-status (self-esteem), business, social and independence oriented goals. In terms of positive psychological capital, farmers' farm-status goal or be recognised as part of success of the farm can be identified as confidence. Factors associated with farmers' goals included age and education of the household head, land size owned, incomes from crop, livestock, and remittances, social grants and pension, and source of water for crop production and location of the irrigation scheme.

8.5 Farmers' Attitude towards Social Capital Contribution to Farm Business

Smallholder irrigators considered both internal and external social capital important for improved farm production and marketing while homestead food gardeners recognised internal social capital important for the same. Using factor loading statistical method of factor analysis, three principal components were extracted from the covariance matrix. The three principal components extracted can be best described as bonding/internal social capital index, exclusive/external social capital index and social values index, respectively. Determinants of social capital among smallholder farmers included age, sex and education level of the household head, farming experience, amount of land owned, crop incomes, remittance, social grant and pension, source of water for crop production and location of the irrigation scheme.

8.6 Contribution of Human Dimensions towards Maize and Cabbage Production

A Robust OLS Cobb-Douglas log-linear regression model was estimated to establish the role of human dimensions on maize and cabbage production. In addition to the human dimensions, the model included other factors of production like land, water and financial assets. Findings in this regard indicated that amount of land under maize production, amount of seed and number of irrigations/hectare/season have a positive and significant impact on maize production. The human capital and entrepreneurial spirit or positive psychological capital have no significant impact on maize production while farmers' independence goal and external social capital have a positive and significant influence on maize output. Also, findings indicated that farmers' social goals have a negative and significant impact on maize output.

Amount of land under cabbage, quantity of fertilizer applied and number of irrigations/hectare/season have a positive and significant influence on cabbage output. Considering the human dimensions under study, human capital in terms of farming experience and farmers goals were found to have a significant relationship with cabbage production. Farmers' farm-status (self-esteem) and independence oriented goals were positively and significantly related to cabbage production while farmers' business oriented goal had a negative and significant influence on cabbage production. In general, this indicates that profit maximization is not the major goal for most farmers at Qamata and

Tyefu irrigation scheme but rather the carry out farming for self-employed, external social capital, for experience and farmers' self-esteem (farm-status).

8.7 The Impact of Human Dimensions on Smallholder farmers' Technical Efficiency

The human dimensions that had a positive and significant influence on technical efficiency for maize production included farming experience for human capital, recognition of opportunities (optimism) for entrepreneurial spirit/positive psychological capital, independence (self-employment) for farmers' goals and external social capital for social capital. Risk taking (hope) for entrepreneurial spirit/positive psychological capital and social values for social capital both had a negative and significant impact on technical efficiency for maize production. The human dimensions considered to have a significant impact on technical efficiency for cabbage production included farming experience for human capital, risk taking (hope) and innovativeness (confidence) for entrepreneurial spirit/positive psychological capital, and farm-status (self-esteem), social and independence for farmers' goals. Farming experience, innovativeness (confidence), farm-status and independence (self-employment) are positively and significantly related to technical efficiency in cabbage production while risk taking (hope) and farmers' social oriented goal have a negative and significant influence on the same enterprise.

8.8 The Impact of Human Dimensions on HCI for Maize and Cabbage Enterprises

Farmers' recognition of opportunities (optimism) and social values had a negative and significant impact on commercialization level of maize enterprise while risk taking (hope), farmers' independence (self-employment) goal and external social capital had a positive and significant influence on commercialization level of the same enterprise. Innovativeness (confidence) had a positive and significant influence on commercialization of cabbage enterprise while farmers' independence (self-employment) goal and external social capital had a negative and significant impact on commercialization of cabbage enterprise. Thus optimism and social values are less important in maize commercialization while farmers' goal of independence and external social capital are less important in commercialization level of households who participate in cabbage market.

8.9. Conclusion

The South African smallholder agricultural industry has been identified as a major source of livelihood for the rural poor households despite its low and declining performance in terms of productivity. Due to government recognition of its importance, several attempts have been made to save its pathetic performance in the face of increasing food insecurity, unemployment and wide spread poverty as observed at Qamata and Tyefu irrigation schemes. Despite the government efforts, the transition of smallholder farmers from low subsistence to smallholder commercial farming is slow. In the context of this study it was apt to establish the general performance of the smallholder farmers and the role of the intangible human dimensional capital in the transition from subsistence to smallholder irrigation commercial farming. This study made recognition that the physical and financial capital cannot be viewed in isolation from the human dimensions as essential factors for the transition.

The transition from subsistence homestead food gardening to smallholder irrigation commercial farming for improved incomes, employment and poverty alleviation among the rural poor is inevitable. The findings of this study indicate that smallholder irrigators harvest more output and earn more incomes from maize and cabbage enterprise than homestead food gardeners. Furthermore, smallholder irrigators are more economically efficient and this provides a better future for increased marketable output and household incomes thereby reducing unemployment and poverty. However, the future performance of the smallholder agricultural industry is doomed to collapse due to low participation of youths as the aged generation fades away. This may worsen the situation by increasing food insecurity, unemployment and increased poverty levels in the face of increasing population. Insecure land tenure, rigid land markets and lack of access to farm land especially on the irrigation schemes is also a threat for the transition. Based on the findings extension services especially in terms of capacity building is desperately lacking and may hamper the intended transformation of the sector. In addition, monetization of agricultural production with insufficient provision of input subsidies especially among the resourced poor smallholders is another threat for the declining productivity and increased food insecurity in rural communities.

The low entrepreneurial spirit exhibited by smallholder farmers and its impact on efficiency and productivity may result in stagnant and declining smallholder agricultural productivity. Low productivity may result in risks of increased food insecurity and increased levels of poverty. This calls for policies and rural programmes that can create an environment for increased entrepreneurial activities through improved farmers' access to human, social, natural, physical and financial assets. Lack of farmers' recognition of the importance of external social capital and social values (Institutions) in promoting increased productivity and agricultural marketing may hinder the implementation of government and other development partners' rural development programmes and hence resulting in poor performance. Considerations of promoting and strengthening external social networks among smallholder communities through frequent contacts and organising farmers in the most appropriate way to ease service delivery may be of great importance. Results from improved social capital within and without farmer communities are anticipated to improve access to farmer trainings, access to input/output markets and other resources for faster transition from homestead food gardening to smallholder irrigation commercial farming. Since farmers' goals and aspirations were found to significantly influence productivity, efficiency and household commercialization level, they can be of great importance in providing a sense of direction in planning and implementing policies and rural developmental programmes. Incorporation of these farmers' goals and aspiration in policies and rural development programmes may also reduce on the rate of failure of these programmes and enhance poverty eradication.

The above exposition of the research findings suggests that the null hypothesis of the study outlined in Section 1.4 of Chapter 1 should be rejected because, the identified smallholder farmers' human dimensions were found to have a significant impact on the level of maize and cabbage production, technical efficiency, and commercialization level. The determinants of the level of maize and cabbage outputs included human capital, farmers' goals and external social capital. All human dimensions considered in this study had varying significant impact on production, technical efficiency and commercialisation level of maize and cabbage enterprises.

8.10 Recommendations

This study has established that small-scale irrigation scheme plots are mainly cultivated by elderly persons above 60 years on average and who lack the enthusiasm and have low entrepreneurial spirit important to transform subsistence agricultural to commercially oriented irrigation farming. Therefore, government policies geared towards attracting youth in smallholder irrigation commercial farming are important. In addition to government policies NGOs should also avail packages that are gender inclusive to attract youth in farming venture. Agricultural programmes that target establishment of youth associations and clubs need to be created to catalyse youths' involvement in agricultural activities for improved employment and rural development. Since most youths are dependants and lack capital, they should be provided with financial assistance to avail start-up capital and enhance their economic empowerment.

8.10.1 Improving Acquisition of Farm Land

Land acquisition was cited as a major hindrance for homestead food gardeners' participation in irrigation farming yet findings indicated that a unit increase in farm land result into a significant increase in maize and cabbage production. Therefore, policies that will ease access to land for the smallholder farmers especially on the irrigation plots and expansion of irrigated farm land should be encouraged. Contrary, the large part of potential arable land on the irrigation schemes especially at Qamata is idle while some families are striving to have access to this land. Managers of the irrigation schemes were of the view to redistribute the land to families who have interests in farming. However, the land problem is still complex due to contradicting interests between the state and the traditional chiefs. Thus, the land redistribution should be a participatory exercise which incorporates all stakeholders' interests.

Increased population at Tyefu resulted into more subdivision of land to small plots (0.25ha) which can hardly produce enough farm output to cater for the household food requirement and marketable surplus. Therefore, more land should be availed to smallholder irrigators to induce the desired agricultural transformation and development. This can be done by re-organizing the land size holdings to make smallholder farming more economic through catalysing the programme of land redistribution or resettlement. Due to the land

acquisition problems, farmers are encouraged to expand their farming activities by utilizing both the homestead food gardens and irrigation plots. Caution should be considered that improved access to land as a single entity may not automatically result into increased marketable surplus but rather farmers need to be supported financially for acquisition of capital and build their capacity in farm management and marketing.

8.10.2 The Enterprise Selection

Cabbage enterprise is clearly more profitable than maize production as expected because cabbage is considered to be a high value crop. Despite the low commercialization of the cabbage output compared to maize output, findings indicate that more total revenues and gross margins were earned from the cabbage enterprise. Therefore farmers are encouraged to allocate more land and other agro-inputs to cabbage production for increased household incomes. Furthermore, the enterprise (cabbage production) calls for more farmers' training in production for increased output and assured quality control acceptable in most restricted large supermarkets. For assured quality, storage facilities suitable to handle fresh vegetable are needed at both irrigation scheme and these can be provided by the government or other development partners. Given that maize is the main staple food in Qamata and Tyefu communities, efficient food production and food security can be enhanced through policies that improve access to more resources like land, revitalisation of irrigation schemes, financial related programme, tractor acquisition and input subsidies.

8.10.3 Production Efficiency

Smallholder farmers at Qamata and Tyefu are technically efficient based on findings but are allocatively inefficient. The technical efficiency partly is attributed to the direct extension officers' engagement in application of farm inputs in farmer fields. Allocative efficiency mainly deals with maximizing profits but most farmers lacked access to farm business trainings which entails record keeping and financial management important in calculating business profit and losses. According to the findings, farmers need to reduce on fertilizer costs per hectare and increase use of improved seeds, pesticides and herbicides in order to maximize profits both in maize and cabbage enterprises. Use of agro-chemicals is important for increased technical efficiency therefore its use should be increased for increased maximization of maize and cabbage output. For increased efficient allocation of

these resources and economic efficiency among smallholder farmers, extension services should be improved through capacity building of extension officers to equip them with farm business skills and appropriate methods for transferring this knowledge to farmers for self-sustenance.

8.10.4 Enhancing the Human Dimensions in Farming

Since entrepreneurial spirit and positive psychology capital were found to have a significant impact on farming among smallholder farmers in Qamata and Tyefu, the government and development partners should embark on providing appropriate technologies which are characterised by low cost of production, simple, time and labour saving and should provide the social and psychological benefits to farmers. In addition to provision of more appropriate technologies, the government and other development partners should set a favourable environment to enhance farmers' entrepreneurial spirit growth and these include establishment of agro-based small scale industries that are fed with primary agricultural outputs for value addition. Also, the government should set policies that promote investment incentives. There should be integration of business management into every farmer's trainings for improved allocative efficiency. This environment also is essential for improved positive psychological capital since it instils hope and confidence among smallholder farmers.

Efficient farmers tended to value independence goal (GOAL4) both in maize and cabbage production and success of the farm (self-esteem) goal (GOAL1) positively and significantly influence maize production efficiency. Therefore, policies geared towards promoting farming as self-employment opportunity with less direct intervention of the external agencies should be emphasized for increased job creation and improved rural livelihood.

There is need to enhance social capital in smallholder farming through strengthening farmers clubs or establishment of agricultural cooperatives through governmental agencies. The role of the governmental agencies should be rendering advice to the cooperative members rather than direct interference in the day to day running of the cooperatives. Since external capital was found to be essential for increased production, private farms and

NGOs are of great importance to foster farm business at Qamata and Tyefu irrigation schemes.

A reasonable transformation of smallholder farmers from subsistence to commercial farming may call for a level of specialization in a few crops; expansion of agricultural land, reduced management gaps, innovation and adoption of improved technologies, and efficient resource use. In addition, the government should not only focus on land and water accessibility but also consider improved population quality and advances in knowledge through trainings in farm production and business management for increased productivity and market participation..

Improved managerial capabilities, human capital, and accumulated social capital, in complementarity with other capitals for increased agricultural productivity is viewed as an engine for economic growth and rural development especially in developing countries. However, new innovations and technologies that target increased agricultural productivity should be built on existing farmers' knowledge and experience to ease adoption. Further, more research and innovation should be considered to avail productive information for policy makers, extension advisers, and other stakeholders.

8.11 Recommendation for Further Research

For a more focused research, this study mainly dwelt on production efficiency as a measure of smallholder farmers' performance and the impact of human dimensions on technical and commercialization level leaving out other proxy of performance and determinants of both technical efficiency and commercialization level of smallholder agriculture. It is therefore necessary to conduct further research using other evaluation tools to unearth more factors that hinder the development of smallholder farming industry and also in-depth analysis of other factors such as soil type, water quality and other physical factors which have an impact on technical efficiency and commercialization of smallholder agriculture in Qamata and Tyefu irrigation schemes.

Furthermore this research was carried out only on two irrigation schemes situated at Qamata and Tyefu areas in the Eastern Cape Province and thus, results and recommendations generated may be of less importance to other geographical locations in

South Africa which exhibit different types of climate and agriculture systems. Therefore similar studies can be carried out in different locations of South Africa to establish concrete conclusions and recommendations for policy formulations in those areas. Throughout the entire study, much emphasis was put on smallholder farmers and left out large commercial farmers whose contribution to South African agricultural GDP is considered to be the highest. Therefore, it is worth carrying out a comparison study in terms of production efficiency and their human dimensions as well as a platform for more focused policies that work towards the integration of the two agricultural economies for increased national agricultural productivity.

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APPENDIX

Appendix 1: Questionnaire

UNIVERSITY OF FORT HARE, DEPARTMENT OF AGRICULTURAL ECONOMICS

**THE HUMAN DIMENSION IN THE TRANSITION FROM HOMESTEAD FOOD GARDENING TO SMALLHOLDER
IRRIGATED FARMING IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA**

Questionnaire number..... Name of Interviewer Contacts.....

Local Municipality Ward..... Village.....

Do you farm on any Small scale irrigation schemes 1) Yes [☐] 2) No [☐]

Do you own a homestead food garden 1) Yes [☐] 2) No [☐] Both Homestead garden and Irrigation plot [☐]

A) BACKGROUND INFORMATION

1) Respondent's Name.....

2) Household size

3.0 Household Characteristic

	Qn.3.1 Position in home	Qn. 3.2 Sex 1 = Male 2=Female	Qn.3.3 Marital Status 1= married 2=single 3=Divorced 4 =widow 5= separated	Qn.3.4 Age (yrs)	Qn.3.5 Education level & Grade 1=Primary 2=Secondary 3=Tertiary 4= Non	Qn.3.6 No. years in School/ Grade	Qn.3.7 Type Occupation 1=Farmer 2=Farm laborer 3= trader 4=casual work 5=civil service 6=private firm 7= student	Qn.3.8 No of year employed in the named occupation	Qn.3.9 No of years farming
1	Husband								
2	Wife								
3	Child								
4	Child								
5	Child								
6	Others								
7									

B) LAND UTILISATION

4. What is the average price of land in this area.....R/ha

5. What is the average cost of renting land in this Area.....R/ha

6. Who set the rules concerning land acquisition? 1) Traditional/Community [] 2) Government [] 3) Both [] 4) No rules []

7. How did you access the land you are cultivating on? 1) Restitution [] 2) Redistribution [] 3) Inherited [] 4) N/A []

8. Land allocation (all in ha)

2 nd season of 2011 July - December				1 st season of 2012 January - June			
Land owned [ha]	Land hired [ha]	Land rented out [ha]	Total land cultivated [ha]	Land owned [ha]	Land hired [ha]	Land rented out [ha]	Total land cultivated [ha]

(9) What crops do grow in order of preference 1)..... 2) 3)..... 4).....

(10) Land allocation to crops by order of preference

2 nd season of 2011 July – December							1 st season of 2012 January - June						
Qn.10.1 Crop	Qn.10.2 Cropped Area (ha)	Qn.10.3 Qty produced	10.4 Qty sold	Qn.10.5 Unit 1 =Kg 2=suck 3.Heads	10.6 Unit price	10.7 Total cost	10.8 cropped area (ha)	Qn.10.9 Qty Produced	10.10 Qty Sold	10.11 Unit 1=Kg 2=suck 3.heads	10.12 Unit price	10.13 Total Cost	10.14 System 1= Rain fed 2=irrigation 3=Both
1)Maize													
2) Cabbage													
3)spinach													
4. Carrots													
5.Butternut													
6. Potatoes													

C) PRODUCTION INFORMATION

INPUT UTILISATION

11. Do you use the following inputs in your gardens?

Qn. 11.1 Improved Seeds	Qn. 11.2 Fertilizers	Qn. 11.3 Agro-Chemicals	Qn.11.4 Oxen-draught	Qn.11.5 Tractor
1 = yes 2 = No	1 = yes 2 = No	1 = yes 2 = No	1 = yes 2 = No	1 = yes 2 = No

12. Do you access inputs [refer to Qn. 11] from government agencies 1) Yes [] 2) No []

13. If yes, how much was received [*in Rand*]

Qn. 13.1 Improved Seeds	Qn. 13.2 Fertilizers	Qn. 13.3 Agro-Chemicals	Qn.13.4 Oxen-draught	Qn.13.5 Tractor

14. Input utilization in Production for past 2 seasons

2 nd season 2011							1 st season 2012					
Qn. 14.1 Type of crop	Qn. 14.2 Input type	Qn. 14.3 Quantity used (Kg or liters)	14.4 Unit Price(R)	14.5 Distance to source (Kms)	14.6 Source/ Provider indicate C for cash and L for credit	14.7 For credit amount to be repaid	14.8 Quantity used (Kg or liters)	14.9 unit Price (R)	14.10 Distance to source (Kms)	14.11 Source/ Provider indicate C for cash and L for credit	14.12 For credit amount to be repaid	14.13 SYSTEM 1=rain fed 2=irrigation 3=Both
Maize	Seeds											
	Fertilizer											
	pesticide											
	Herbicides											
Cabbage	Seed											
	Fertilizer											
	Pesticide											
	Herbicides											
Potatoes	Seed											
	fertilizer											
	pesticide											
	Herbicides											

15) Have you received any form of training on input use, agronomic practices, record keeping, and financial management, and marketing?

Qn. 15.1 Input use	Qn. 15.2 Agronomic practices	Qn. 15.3 Record keeping	Qn.15.4 Financial management	Qn.15.5 Marketing	Qn.15.6 Group formation
1 = yes 2 = No	1 = yes 2 = No	1 = yes 2 = No	1 = yes 2 = No	1 = yes 2 = No	1=yes 2=No

16) If yes, who provided the training? 1) Extension agent [] (2) NGO [] (3) Farmer [] (4) other specify.....

17) Please mention the number of times they rendered service per season

D. (18) WATER USE

Qn.18.1 Community Sources Water 1= Rain 2=Taps 3=Borehole 4=Dam 5=River	Qn. 18.2 Source of water for crop production [use same codes in column 1]	Qn. 18.3 Who provided the Water Source 1 = Government 2=NGOs 3=Municipality 4=Community 5=Others	Qn. 18.4 Are you a member of any Irrigatio n scheme 1= yes 2=No	Qn.18.5 Who provided the Irrigation Scheme [Use codes in Column 3]	Qn. 18.6 If not member why 1= no funds 2=social conflicts 3=lack information 4=not interested	Qn. 18.7 crops grown on irrigation scheme 1=maize 2=Cabbage 3=butternut 4=carrots 5=potatoes	Qn. 18.8 Number of times you irrigate a week [actual No.]	18.9 Water rate per /month	18.10 Land used Before Irriga tion [ha]	18.11 Land used after irrigat ion [ha]

19. What type of irrigation facility are you using? 1) Sprinkler [] 2) Drip irrigation [] 3) Furrowing irrigation [] 4) Others (specify)

20. Mention challenges faced with irrigation 1) Hard to Operate [] 2) poor management [] 3) Underutilized []
4) Inadequate water [] 5) Not profitable [] 6) Not productive [] 7) High costs of repairing and rehabilitation []
8) Others []

21. What are the possible solutions to the above mentioned challenges? 1) Government intervention [] 2) NGOs support []
3) Community intervention [] 4) Do not Care []

E) LABOUR INPUTS IN CROP PRODUCTION

22) What is the main source of labour? 1) Family labour [] (2) Hired labour [] (3) Both []

23) How many labour units or number of times in total worked in the field in the last two seasons of 2011/2012?

2 nd season 2011					1 st season 2012			
Type	Men	Women	children		Men	Women	children	
Family labour								
Hired labour								
Total								
Oxen/Tractor (No. of Times								

24) Activity labour demands in crop production for last Season

Activity	Type of Worker											
	Men			Women			Children			Oxen/Tractor		
	No.	Days	Cost	No.	Days	Cost	No.	Days	Cost	No.	Days	Cost
Land prep 1 st .												
2 nd ploughing												
Planting												
Fertilizer application												
1 st weeding												
2 nd weeding												
Spraying												
Harvesting												
Post-Harvest (drying, packaging)												
Transport to market												

Key: men/ women = > 18yrs, children <18. 1 Man- day = 6 person hours for a man = (0.75*6) person hours for woman = 12 child hours.

F) CROP OUTPUT AND MARKETING

25) Do you sell any produce from your farm 1) Yes [] 2) No []

26) If yes, please fill the table below.

Qn.26.1 Crop 1=maize 2=Cabbage 3=Potatoes	26.2 Water System 1= Rain 2=Irrigation 3=Both	Qn. 26.3 Season 1=Summer 2=Winter	Qn.26.4 Harvested area (ha)	Qn.26.5 Quantity harvested (Kg, Sucks, Heads)	26.6 Quantity sold (Kg, suck, Heads)	26.7 Price/ Kg (R)	Qn.26.8 Point of sale 1= farm gate 2=middlemen 3= Supermarkets 4.Others	Qn.26.9 Cost of sale (tax, transport) (R)	Qn.26.10 Qty consumed at home (Kgs, Sucks, heads)	Qn.26.11 Qty donated to friends/ relatives (Kgs, Sucks, heads)

27) What problems are faced in production and marketing of agricultural produce? 1) Lack Inputs [] 2) Lack of own capital []
3) Lack knowledge on agronomic Practices [] 4) low rainfalls [] 5) lack transport [] 6) Lack access to credit []
7) Poor soil fertility [] 8) lack of access to market information 9) lack markets for produce [] 10) Others (specify)

28) What are the Possible Solutions to the above mentioned problems? 1) Government improves on roads and financial agricultural institutions []
2) Provide more irrigation schemes by Government and NGOs [] 3) Provide input subsidies and farm implements []
4) More extension services [] 5) Encourage more cooperatives and farmer groups [] 6) NGOs & Government provide Market
Linkage services to farmers [] 7) Others (Specify)

G) GENERAL INFORMATION

29) Do you belong to any group or association? 1) Yes [] 2) No []

30) If yes, what service do you receive from such association? 1) Production labour [] 2) access to cheap inputs [] 3) collective marketing
[] 4) others []

32) if yes in Qn. 29, how many times did you meet last month.....

33) Please estimate your total seasonal income (Rand) from the following source.

Crop farming	Livestock farming	Non –Farm income	Remittances

34. Do you have access to extension services 1) Yes [] 2) []

35. If yes which organization renders the services 1) Government [] 2) NGOs [] 3) private Companies [] 4) others []

36. Where do you mostly access information about farming and marketing? 1) Radio [] 2) Television [] 3) phone [] 4) fellow farmers []

5) Others

37. Do you have access to credit [*Check Question 27. 6*] 1) yes [] 2) No []

Qn. 37.1 Source (s) of credit	Qn.37.2 Amount received	Qn.37.3 Interest rate	Qn.37.4 Total Amount paid	Qn.37.5 Payback period	Qn.37.6 Use of credit received	Qn.37.7 Challenges faced

Code Challenges. 1) Bureaucracy in terms of administration, 2) takes long to get the loan, 3) too much paper work, 4) lack knowledge about credit.

38. Scaling Level of entrepreneurial Spirit and Positive Psychological Capital

Description	Please rate/Rank as indicated below with a tick [✓]			
	<i>Strongly Disagree</i> 1	<i>Disagree</i> 2	<i>Agree</i> 3	<i>Strongly Agree</i> 4
Not Afraid to try a new technique				
Irrespective of any challenges I continue trying till the solution is got				
You have the ability to organize available resources to achieve a goal				
If there is a change in supply and demand, you take action faster before any government response				
Take action always on the basis of what you perceive profitable				
Do not wait for subsidies before applying new technology				
You take your own judgment about the new technology before consulting friends				
Not afraid to be different when adopting new technologies on your farm				
Spend more time on new technologies where you anticipate profits				
You are not afraid of investing more money in new technologies				
Risks of new technologies isn't your first priority to take a decision				
I prefer group marketing				
Can supply produce on credit				
Will to pay for any farm related trainings				
Will to source for information wherever possible at a cost				

39. Farmer's Perspectives, Aspiration and Goals of an Enterprise

Qn. 39.1 Which crops do you grow most 1=maize 2=Cabbage 3=Potatoes 4=Carrots 5=butternut 6=Spinach	Qn.39.2 Why grow mostly the crop mentioned 1= profitable 2=staple food 3=high yield 4=easy to grow 5= community grows it 6=easy to market 7=others (specify)	Qn.39.3 Which crop takes most of your time <i>Use codes in Column Qn.40.1</i>	Qn.39.4 If you're to expand farm which crop is consideration first <i>Use codes in Column Qn.40.1</i>	Qn.39.5 Why choosing to expand production of mentioned crop <i>[Use codes in column Qn.40.2]</i>	Qn.39.6 Why do you farm 1= market 2=consume 3. both 4.Others	Qn.39.7 Are you Willing to expand your farm 1= Yes 2= No	Qn.39.8 If No why 1=hard land acquisition 2=No markets 3=lack capital	Qn.39.9 Have you ever considered quitting farming 1=Yes 2=No	Qn.39.10 What could be your 2 nd option of income earning 1=farm laborer 2=trader 3= do nothing	39.11 What should be provided to take action 1=inputs 2=loans 3=grants 4=irrigation facility 5= access market linkages

40. Scaling Farmer's Goals and Behaviors

		Ranking from 1 = Not Important to 4 = Very Important [Pl'se Tick]			
		1	2	3	4
1	Self-employed and independent				
2	Like farming life				
3	Have more leisure time				
4	Be recognised as top producer				
5	Be recognised as a leader in the technology adoption				
6	Be recognised as a specialist in growing these crop				
7	Be recognised as owner of the land				
8	Involve family in decision-making				
9	Leave business for the next generation				
10	Provide employment to rural people				
11	Belong to farming community				
12	Inherited the farm				
13	It is part of culture (Artefacts and adornment)				
14	Communications experience: contacts with people, transfers of information				
15	Social participation: meetings and rituals				
16	Avail time to spend with my family				
17	Increase standards of living				
18	Increase maximum farm income				
19	Expand the business				
20	Keep debts as low as possible				
21	Accumulate wealth				

Adapted from Padilla-Fernandez M. Dina and Nuthall Peter (2001) and Harwood (1979) though some questions are restructured to suit Rural farmers in Eastern Cape and ranked from 1 = not important to 4 very important to the farmer.

41. Scaling Social Capital related issues

	STATEMENT	Ranking from 1 = Not Important to 4 = Very Important [Pl'se Tick]			
		1	2	3	4
1	Working with government departments improves production & market access				
2	Working with Private companies improves production & access to markets				
3	Working as farmer groups/cooperatives improves production & access to market				
4	Attending group meetings regularly improve production & access to marketing				
5	group membership ease access to farm labour, and improves production & marketing				
6	Can easily access farm inputs like fertilizer when connected to groups, company, Gov't				
7	Can easily access farm implements when belonging to farmer group, company, Gov't				
8	Access to information from fellow famers is vital in production, and output marketing				
9	I support others (fellow farmers) and they support me in times of hardships				
10	Group membership ease access and adoption of new technologies				
11	Can contribute money towards a common goal in my community				
12	Farmer groups/cooperatives with constitution/rules perform better than others				
13	Culture rules and norms are vital in group formation, farm production and marketing				
14	Trust among community members is a key factor for successful farmer				
15	Participation in voting village committees is crucial for equitable access to resources				

THANK YOU AND GOD BLESS