A Journey Without Maps

Towards Sustainable Subsistence Agriculture in South Africa

Samantha Adey

Promotor: Prof.dr.ir. J.S.C. Wiskerke
Hoogleraar Rurale Sociologie
Wageningen Universiteit, Nederland

Co-promoter: Prof.dr. F.H.J. Rijkenberg
Emeritus hoogleraar Plantenziektekunde
University of KwaZulu-Natal, Zuid-Afrika

Promotiecommissie

Prof.dr. W. van Averbeke	Tshwane University of Technology, Zuid-Afrika
Prof.dr. A. Rip	Universiteit Twente, Nederland
Prof.dr. K.E. Giller	Wageningen Universiteit, Nederland
Dr. P. Hebinck	Wageningen Universiteit, Nederland
Prof.dr. A.P. Wood	University of Huddersfield, Groot-Brittannië

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Samantha Adey

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Towards sustainable subsistence agriculture in South Africa

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Abbreviations used in this thesis

AGRINOVIM	The dynamics of AGRicultural Innovation: studies at the interface of NOVelty creation and sociotechnical regIMes
AIDS	Acquired Immune Deficiency Syndrome
AIO	Researcher in Training
ANC	African National Congress
ANT	Actor Network Theory
CEAD	Centre for Environment and Development
CERDES	Centre for Rural Development Systems
CSP	Critical Systems Practice
CST	Critical Systems Thinking
DED	German Development Service
DFID	Department For International Development
CBO	Community-Based Organization
EMG	Environmental Monitoring Group
FERTREC	FERTilizer testing and RECommendation service
FIA	Far Infra-red Analysis
FLO	Fair trade Labelling Organisation
FAO	Food and Agriculture Organisation of the United Nations
FSG	Farmer Support Group
FSR	Farming Systems Research
FSR-E	Farming Systems Research and Extension
FSRU	Farming Systems Research Unit
GPS	Geographical Positioning Systems
HEIA	High External-Input Agriculture
HIV	Human Immuno-deficiency virus
HST	Hard Systems Thinking
IFP	Inkhata Freedom Party
Indigo	Indigo Development and Change
INR	Institute of Natural Resources
KZN	KwaZulu-Natal
KZNDAEA	KwaZulu-Natal Department of Agriculture and Environmental Affairs
l.s.d.	least significant difference
LEISA	Low External-Input Sustainable Agriculture
MBC	Microbial Biomass Carbon
Midnet	Midlands Development Network
NGO	Non-Government Organisation
NLP	National LandCare Programme
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek
PASA	Post-apartheid South Africa
PEA	Participatory Extension Approach
PTD	Participatory Technology Development
SANPAD	South African Netherlands Programme for Alternatives in Development

SLA	Sustainable Livelihoods Approach
SLF	Sustainable Livelihoods Framework
SPUP	Social Plant-Use Programme
sSA	sub-Saharan Africa
TVT	The Valley Trust
UKZN	University of KwaZulu-Natal
WICC	Wageningen International Conference Centre
YIELD	Youth In Environment and Land Development
ZAR	South African Rand (currency)

Prologue

The research conducted for this thesis was one of six research projects in a multi-national and multi-disciplinary research programme: The dynamics of AGRicultural Innovation: studies at the interface of NOVelty creation and sociotechnical regIMes (AGRINOVIM). The proposal for the South African research project focussed on the design of remunerative farming systems for small-scale farmers:

> *Project 2. A systems approach to improve small-scale farm income progressively and sustainably: No serious attempts have yet been made in southern Africa to design sustainable and remunerative farming systems for the resource-poor small-scale black farmer. This project addresses the urgent need for the identification and adoption of new flora, fauna, agroforestry and value-adding components in the design of new farming systems for this group in South Africa and integrating these into existing methodologies. By demonstration plots, on-farm experiments, and the activities of extension staff, such systems will need to be conveyed to the beneficiaries. The results of this work will then need to be extrapolated to other parts of southern Africa and elsewhere.*

My training as a scientist was based in plant pathology and more specifically in mycology and epidemiology. Plant disease epidemics are a function of many interrelated factors including among others: the macro- and microclimate; the pathogen; a host plant; and also the physiology of the host plant. The epidemic is sustained for as long as the ideal conditions for pathogen growth and dissemination prevail. The central actor in agricultural plant disease is the farmer. The farmer manages the crop environment and thus plays a key role in enhancing or balancing factors necessary for the establishment and maintenance of the pathosystem. The farmer is also the central actor in the cropping system and is thus the key determinant of system sustainability. Every situation is unique to time and place and in finding a means of addressing sustainability in subsistence farming, research should ideally be conducted on-farm in collaboration with the farmer. Only through this method can factors relevant to sustainability be identified and their impact measured. It was for these reasons that I chose to change the focus of the research to: investigating factors that contribute to sustainable technology development in farming systems instead of: designing technology for sustainable farming systems.

Successful participatory technology development at farm level is common in sub-Saharan Africa but due to apartheid, South Africa is behind other countries. In KwaZulu-Natal there are a number of organizations working on-farm towards participatory and sustainable development. I decided to examine their work more closely and determine if technology development was sustainable, and also to identify the key factors that contributed to the sustainability of the farming system and to the sustainability of the development project. This approach has shortcomings in that it lacks disciplinary depth it also had strengths, in particular understanding better the multitude of interactions and elements that constitute sustainability and sustainable development in subsistence agriculture in South Africa. The research was a journey into unfamiliar territory, a journey without maps.

Chapter 1: Setting the Scene
The technico-institutional landscape

1.1 Introduction

Although agriculture in the former homelands of South Africa was generally perceived as being of the subsistence type and extremely marginal in terms of the commerce-dominated agricultural sector (Bembridge, 1990) it continued to play a part in the livelihoods of large numbers of households, involving substantial numbers of farmers (Cooper, 1988). South African agriculture in the post-apartheid era faced the challenge of providing, through design, new remunerative options for small-scale farming systems that would improve family food security and create new employment opportunities for historically disadvantaged people.

In South Africa, large-scale commercial farming was seen as the predominant model for farming success, and as a result, the capacity of agricultural service providers to support the emerging sector of small-scale farmers was still relatively low. Alternative, ecologically orientated agricultural systems, which typically combined smaller-scale farming practice with a diversity of crop and stock varieties, and soil and water conservation practices, were far more familiar to many other African countries than they were to South Africa (Turner, 1998). In this country, ecological approaches to agriculture were traditionally viewed as synonymous with subsistence agriculture, and were considered to be unable to provide a route for income generation.

KwaZulu-Natal province contains some of the most intensively developed large-scale farms in the country as well as some of the poorer subsistence areas in the country. Nevertheless, in the province, some promising examples of sustainable small-scale farming systems can be found. However, the opportunities and constraints regarding the development of these farming systems need to be seen against the background of the apartheid system as South Africa enters a new age. The old and new Agriculture and Land Reform Policies, the provincial agricultural policies, the bio-physical environment of small-scale farming, the social and cultural context and agricultural research and extension are all important in setting the scene for this thesis.

1.2 Agriculture and land reform in South Africa

Prior to the advent of the apartheid era, black people in South Africa were confined to native reserve areas, known as homelands. In 1936 the total reserve area was 13.8% of the national area. Under apartheid the process of homeland consolidation continued into the 1980s. By 1980 homelands covered 20% of the national area and supported 11 million people (Wilson, 1991). It was impossible for people classified as black to own land in the white farming areas and measures were taken to impede black agricultural production on white-owned farmland, driving black farmers out of the commercial farming areas. As a result, many households became reliant on incomes from migrant labour in towns and mines.

The agricultural policies during the apartheid era in South Africa reflected a biased concern for white-owned commercial farming units. The White Paper for Agriculture in 1984 stated that a '*maximum number of financially sound owner-occupant farms*' was an important aim of the policy as it would '*contribute to the retention and*

establishment of a stable, happy and prosperous rural population' (Anonymous 1984). This largely excluded the homelands, which where far from being stable and prosperous.

Almost all of the land in the former homelands of South Africa then, and now, is held under communal tenure, which combines elements of individual and collective property rights. It is communal in that an individual's entitlement to land flows from membership of a socio-political community (e.g. a tribal unit), rather than from private ownership, but production is generally on an individual basis (Bennett, 1995). Tribal Authorities manage communal tenure through tribal chiefs and headmen, who have survived the transition to democracy with their powers virtually intact. In KwaZulu-Natal, even now, the system enjoys a relatively high level of legitimacy even though tribal authority is waning.

Every household within a communal area has, in principle, a right to a residential site, an arable plot for crop production, and access to common property resources, such as grazing land. In practice, however, a substantial proportion of people in communal areas have little or very meagre access to land (Simkins, 1981; Lahiff, 2000). The right to land usually applies only to male household heads but was sometimes extended to women (Bennett, 1995). Those who obtain land receive a right to its permanent use, but not to sell it. Unallocated land is generally used as commonage, providing pasture for livestock and other natural resources, such as timber, grass and sedges for craft production, thatching grass, edible fruits and plants and materials for use in traditional medicine (Cousins, 1996). Tribal leaders have the power to repossess allocated land but seldom do so, and the communal system is generally seen as a reasonably secure form of tenure (Bromberger, 1988; Lahiff, 2000).

At the onset of the new South African democracy in 1994, the government of national unity faced the challenge of redressing distribution of land injustices without risking the collapse of the nation's commercial farming sector. It adopted a broadly neoliberal approach to economic policy and avoided many of the demands of its more radical supporters for nationalization or expropriation of white-owned land (Lahiff, 2000). To address the highly controversial issue of land ownership and access to land, the Land Reform Programme was initiated. The Land Reform Programme aims to return land to those who had been denied land based on racially discriminatory laws and to transfer ownership of land in the former homelands from the state to the people who lived on that land and had legitimate right to it. The Land Reform Programme has three key elements: land restitution, land redistribution and land tenure reform (see Table 1.1). A core problem of the redistribution model is that it offered little scope for sustainable small-scale agricultural growth. There was also little prospect for the rural poor to enhance their income from agriculture through land and agrarian reform as these were not part of a broader, integrated rural development process. Rural development efforts suffered from fragmentation and lack of a coherent programme or agency at both the national and provincial levels. Land and agrarian reform shows little sign of effectively addressing the deepening crisis of the rural poor, who remained marginalized by the process of economic growth (Turner and Ibsen, 2000). Wildschut and Hulbert (1999) emphasized that the government had adopted a low-key welfarist rather than productive approach to rural development. This was based on the belief by government that urban-based growth would trickle down to the rural areas.

Table 1.1 Aims, expectations and implications for agriculture of the three aspects of the land reform programme namely: land restitution, land redistribution and land tenure reform

Programme:	Land Restitution	Land Redistribution	Land Tenure Reform
Aims and Expectations	Direct return to the previous owners of land and property that had been removed due to racially discriminatory law or practice. (Act 22 of 1994)	Redistribution of a third of all white-owned land to black farmers over a period of 5 years[b]. Anticipated that this market-led, demand- driven, state-supported land reform could achieve political and equity goals and create strong economic growth in the agricultural sector.	Transfer of ownership of land in the former homelands from the state to legitimate residents. A complex process due to the lack of fit between the exclusive nature of Western property ownership and the inclusive nature of African systems of property rights.
Implications for Agriculture	Restitution offers no assurance with regard to livelihoods, as there is not an effective link between restitution and development[a]	Despite many 'beneficiaries' not having serous farming intentions, long-term support and extension services were to be supplied by provincial departments of agriculture. Little post-transfer advice existed for potential farmers as the challenge was greater than initially anticipated[a]	Tenure reform has demonstrated a striking capacity to adapt to economic change in areas where economic incentive is strong, but without economic space into which the rural economy can expand, no amount of tenure reform will be effective[c].

[a] (Turner and Ibsen, 2000) [b] (Williams *et al*,. 1996) [c] (Cross *et al.*, 1982)

Land ownership is only one of the many complex issues facing subsistence farmers in South Africa and the socio-economic constraints faced by subsistence farmers will now be discussed.

1.3 Socio-economic constraints to subsistence agriculture in South Africa

For most families in rural areas, income is derived from a number of activities. Food is often produced on the land and some animals are kept. Usually, at least one family member works away from home, this may be within the community, within another community or in an urban centre. Up to 48% of rural households in South Africa are dependent on wages, with approximately half of South Africans earning less than ZAR1000 (approximately Euro 125) per month. The average expenditure on food in rural households constitutes 23% of total household earnings (www.hsrc.org.za:

Human Sciences Research Council). In South Africa, one fifth of all children are stunted due to malnutrition, the main contributing factor being not enough food in the household, and the subsequent lack of a balanced diet. Unfortunately, the macroeconomic policy of South Africa has not led to rapid change in the socio-economic status of many South Africans (Bonti-Ankomah, 2001).

Poverty is the root cause of food insecurity in SA and as a result, food insecurity is a major concern among a large proportion of the South African population, and 30% of South Africa's population is food insecure (Mander, 2003). According to the Food and Agriculture Organization of the United Nations definition, food security depends on sufficient food production and access to food and is defined as: the access by all people at all times to adequate, safe and nutritious food for a healthy and productive life.

Unemployment within South Africa is currently estimated at approximately 40%, and it is a commonly held belief that urban unemployed are moving back into the rural areas. There is also an influx in the rural areas of people too sick to work (often due to Acquired Immune Deficiency Syndrome (AIDS), the final stage of Human Immunodeficiency Virus (HIV) infection, putting pressure on rural households.
Besides small crop sales, income-generating activities include craft making, beadwork, beer selling and woodwork. Few rural people make a significant income from agriculture. The financial return is often not worth the effort when set against the risks (Taylor and Cairns, 2001). As a result, agriculture is often perceived as being the occupation of the poor, and young people have little desire to be involved (Mtshali, 2002).

With the dismantling of the apartheid regime, expectations for the commercialisation of black small-scale farming were high. However, progress was slow owing to: dwindling financial and human resources within the National and Provincial Departments of Agriculture; lack of a coherent overall rural development programme at national and provincial levels; a high level of poverty ('poverty trap'); and slow delivery in the transfer of land (Adey *et al.*, 2004).

Another major constraint to agricultural and rural livelihoods and the advancement of rural agricultural communities is the AIDS pandemic. The economically productive citizens, those between the ages of 15 and 49 are most affected and HIV-positive people are discriminated against in both urban and rural areas. Most HIV-positive people do not admit their condition to their families, which find out when the person has full-blown AIDS (Kelly, 2000). In dealing with the reduced availability of labour and time for farming activities, there is a need to encourage labour-saving innovations in technology e.g. lighter ploughs, modified hoes and planters and intercropping (Kelly, 2000). AIDS is proving to be one of the biggest challenges which development work has ever faced; rural development workers (in particular non-government organizations) have to go beyond raising awareness of AIDS, to active strategies to support rural communities (Lekalakala and Monare, 2000). Ideally, localized agricultural production (home gardens) should be encouraged, as this should improve household food security and allow for carers to be home-based, near the sick.

Despite the socio-economic constraints faced by subsistence farmers, the provincial Departments of Agriculture and other research and extension organisations played a significant role in the agricultural development of subsistence farmers. The role of

agricultural research and extension services in KwaZulu-Natal will be discussed in the following section after a brief description of the province.

1.4 KwaZulu-Natal: agricultural research and extension services

KwaZulu-Natal (KZN), one of the nine provinces of the Republic of South Africa (see Figure 3.3), has a total area of 9.2 million hectares. Only a third of this area is suitable for dryland cultivation, with half already under cultivation. Over half (60.4%) of the land area is still natural vegetation; excluding Nature Conservation Areas that cover another 10% of the total provincial area. KwaZulu-Natal has a population of 8.6 million people (21% of South Africa), of which 5.3 million (62%) live in rural areas (Anonymous, 1996). There are an estimated 400 000 rural agricultural land-user households (i.e. black farming families).

The diversity of the natural resources in KZN is enormous. Altitude, which ranges from sea level to over 3000m, results in a considerable range in temperatures. The topography varies from the undulating coastal plains of Maputaland to the rugged, broken terrain of the Valley of a Thousand Hills and the precipitous mountains of the Drakensberg (Camp, 1997).

Rainfall variations (mean annual from 600 to 2000mm), temperature variations and soil variations have resulted in a diverse and intricate vegetation pattern (Camp, 1995). Savannah is found in the low-lying hot and dry areas of northern KZN and in most of the river valley systems. In the northern plains of the province a tall grassland is characteristic, while in the colder highland areas the grassland is typically short (Camp, 1997). Soil variations include deep sands along the northern coastal belt, young weathering soils in the steep valleys, well drained, deep soils in the midlands and the highland areas and poorly drained duplex soils in the upland areas with rainfall below 750mm per year (Camp, 1997).

This great variation in natural resources in turn has led to variations in the type of farming and levels of production throughout the province. KwaZulu-Natal had long been recognized as the ‘food basket province’ in South Africa, particularly with regard to vegetable production and dairy farming, which take place in the midlands of the province.

The research and extension services made available for small-scale farming by the KwaZulu-Natal Department of Agriculture and Environmental Affairs (KZNDAEA), since 1994, will be highlighted. A number of non-governmental organizations (NGOs) active in KwaZulu-Natal also provide much needed extension services to emerging small-scale farmers. However, as the KZNDAEA services are more widely spread, more visible and thus more open to critical comment, they will be discussed, after a brief history of extension services in South Africa.

The commercial farming sector in South Africa has been served by extension services since the early 1900s. The main tasks of the extension workers were the selection of breeding livestock for farmers and the provision of services to farmers’ associations and show societies. Due to the limited impact at the time of educational films, lectures and demonstrations, whole-farm demonstrations were initiated and were more successful in stimulating the adoption of new farming methods (Bembridge, 1990).

In the homelands, demonstrators were appointed to teach improved cultivation to small-scale farmers (Bembridge, 1990). It is interesting to note that historically, white commercial farmers and black small-scale farmers were treated differently with regard to the content and methods (stimulation *versus* teaching) of extension service. From 1949, after the establishment of an Agricultural Division, the focus of extension work was on irrigation farming, physical development, soil conservation works, planning of arable lands, development of stock watering points, fencing and tree planting. After reorganization in 1962, an in-service training programme for extension staff was established and the function of extension staff was reorganized, general development work was divorced from agricultural extension and areas were demarcated as extension wards, each to be serviced by an extension officer (Bembridge, 1990).

During the period of this study (2000-2004), extension wards serviced by an extension officer still existed. Extension personnel in the former KwaZulu homeland areas had the hardest task as they dealt with small-scale farmers who historically had had little service from government research and extension. There was, and is today, also inadequate information on subsistence farming and its constraints. As a result provincial departments of agriculture were facing difficulties in providing an appropriate extension service to the majority of small-scale farmers. Due to budget cuts and the loss of skilled staff (resignations and voluntary severance packages) departments were forced to make do with fewer resources. Budget restrictions and the lack of candidates to immediately fill vacated posts meant that some departments were without engineers, veterinarians, agricultural scientists, economists and skilled, experienced administrators (Greenberg, 2000).

Many of the problems that extension workers encountered amongst small-scale farmers were related to agriculture but were not directly associated with improving agricultural production. For example, commercial farmers required services related to advice on fertilizer type and application rates for increasing the yield of crops, whereas small-scale subsistence farmers were more concerned with how to purchase fertilizer on a pensioner's budget and how to transport the fertilizer from the depot to their farmland.

In the late 1990s, there was a positive move by the Farming Systems Research Unit of the KZNDAEA to address the needs of small-scale farmers, through the establishment of a farming systems demonstration unit focusing on small-scale enterprises. The Farming Systems Research Unit (FSRU) conducts trials with farmers on their fields, primarily in maize production. The Soil Science section addresses soil fertility constraints by investigating the use of chicken litter to correct various soil nutrient imbalances. This research was conducted initially on the research farm with plans for trials in interested farmers' fields. The interested farmers had already been identified from community outreach work by the FSRU team during the mid 1990s.

University research within KwaZulu-Natal to address the needs of small-scale farmers has largely focused on the development of appropriate technologies on research farms, in greenhouses and laboratories. These technologies include: tread mill water pumps; improved crop varieties; reduced tillage planters; and feed intake programmes for chickens, goats and cattle. A systems approach to agricultural development was lacking and to address this need, Professor F.H.J. Rijkenberg of the University of Natal (The University of Natal changed its name to the University of

KwaZulu-Natal in 2004) launched the Centre for Rural Development Systems (CERDES) in 1999, which had as its aim the continuity between the University's teaching, research and extension personnel and the small-scale farmer. While directly assisting the small-scale farmer, the University in this manner was also able to provide its students with a more relevant training programme (Rijkenberg, 2000).

At the level of policy, there is still a dichotomy present within the agricultural sector and its associated assistance provided to commercial and small-scale farmers. The Mandela Government (1994-998) gave support to subsistence farmers and they were in some ways the focal point of assistance to the new agricultural sector. The Mbeki government on the other hand shifted focus more to assisting emerging farmers (those who intended to become commercial farmers). So in many ways, the agricultural services provided by national government departments are directed towards the needs of the emerging commercial farmers, and not towards the needs of the subsistence farmers.

The organizations concerned with agricultural production by small-scale farmers are varied and consequently have a diversity of underlying motives and objectives for intervention. These objectives, which shape and define the role played by the different actors, include the following:

- promote commercialisation and profitability of production amongst black farmers;
- facilitate the transfer of agricultural land to black people, who have been disadvantaged by past injustices;
- enhance food security;
- alleviate poverty;
- promote the ecological sustainability of production (Adey *et al.*, 2004).

The objectives overlap to varying degrees, with some (e.g. food security and poverty alleviation) being predominantly re-enforcing. Others, however, are potentially opposing (e.g. focussing resources on promoting promising emerging black commercial farmers rather than spreading resources to reach as many subsistence farmers as possible in an effort to promote food security and farming as a sustainable livelihood intervention).

The emphases placed on the objectives vary according to the actors. For example, the sugar industry has been relatively successful in increasing the commercialised production by small-scale farmers through their 'Out-growers Programme'. By 2000, over 30% of South Africa's commercial sugar production was achieved by black farmers, whose contribution had increased progressively over a number of decades (Vaughan and Xaba, 2004). However, the ecological and economic sustainability of production was relatively low, and involved high external inputs, notably the application of inorganic fertilizers, herbicides and pesticides (Land Resources International 2004).

In contrast, NGOs focus on enhanced food security and ecological sustainability, which they have successfully achieved in the areas within which they operate. However, they are largely unable to offer much assistance to emerging farmers wishing to expand their remunerative production and to access outside markets (Anonymous, 2000a).

Government departments are caught between trying to satisfy all of the above objectives, and being especially subject to the shifting priorities of politicians. Generally, however, the KZNDAEA has interpreted sustainability in a fairly narrow sense. Their aim was to provide short-term remunerative gain to farmers through the use of high external input agriculture (MacVicar, 1993).

In response to the KZNDAEA's perceived insensitivity to local technologies and ecological requirements, NGOs tend to work fairly independently of government in developing alternative approaches. Only recently have opportunities developed for joint exploration and learning. A fairly negative 'us and them' attitude has developed amongst individuals in both camps. It appears, however, that a shift in the government approach, at least at policy level, is taking place which creates a more enabling environment.

An important development in this area is the national government's LandCare initiative. The vision of the LandCare Programme is: 'to have communities and individuals adopt an ecologically sustainable approach to the management of South Africa's environment and natural resources, while improving their livelihoods. This means that people should use the soil, water and vegetation resources in such a manner that their own quality of life is improved and that future generations should also be able to use them to satisfy their needs' (www.LandCare.gov.za).

Although the Programme is certainly not without its problems, as it has become established, it has presented many opportunities. It enjoys active participation of many NGOs, and provides a useful means of increasing the level of collaboration between government and non-government organizations in supporting small-scale farmers (this is explored further in Chapter 4 and Chapter 5, which present two case study descriptions of LandCare projects). In KwaZulu-Natal, the actors, knowledge systems and technologies in agriculture are extremely heterogeneous and the main actors include the following:

- Farmers (ranging from extremely poor to wealthy).
- Extension workers.
- Educators (secondary and tertiary institutions).
- Agricultural researchers.
- Soil and plant analysts.

These actors have varied objectives and operate at a number of levels, from national level to household and field level. Besides agricultural and extension services, farmers also have opportunity for skills development through a number of demonstrations and training courses. Provincial Departments of Agriculture provide high-external-input training in crop and animal production systems. University-affiliated courses provide training on mixed input methods for crop and animal production systems on demonstration farms (www.ukzn.ac.za) NGOs provide sustainable, organic low-external-input training in crop and small-animal production systems using a hands-on approach and working examples (www.TheValleyTrust.org.za). Many factors impact on the sustainability of subsistence farming: land tenure; socio-economic pressures on household livelihoods; and declining natural resources. Despite the efforts of agricultural research and extension services, subsistence farming has remained largely

unsustainable. The poor are still poor or even poorer and sustainable agricultural development remains an essential precondition for the upliftment of the rural poor.

1.5 Research aim and objectives

The aim of this thesis was to identify factors within development programmes that led to sustainable technology development in the context of the farmers' livelihoods. In researching development programmes, and working together with the other actors in the development programme, the aim was ultimately to identify those aspects within the development programme that contributed to sustainability. In other words, the aim was to examine a range of agricultural and rural practices and to specify which practices are realized, why, how and by whom (Wiskerke, 1997), and in so doing provide insights that can be used in the technico-institutional design of sustainable farming systems. This aim would be achieved through adopting a multi-level, multi-actor, and multi-aspect approach used in the field of science, technology and society (STS) studies and applying it through a systems approach. Concurrent with the aim of the thesis was the objective to use concepts and methodologies derived from the sustainability paradigm.

A criticism of the reductionist approach is that researchers are often too far removed from the realities of their research subjects. As a means of addressing this, I was directly involved in the development projects that I researched, to the extent that I was in partnership in the development process. Each of the case studies in this thesis has its own specific aim and objectives for the development project and these will be presented for each case study chapter. However, the overriding aim of all the case studies was to examine the role of plant-use in improving the livelihoods of the rural poor in a sustainable manner. Given the approaches to agricultural development at the time of this study, this aim was seen as innovative in that it sought to improve a situation through embracing sustainability as both an outcome and as a necessary mode of development.

In the following chapter, I discuss how changes in agricultural research and rural development and the development of systems thinking have led to the concept of sustainability and its use in development of the subsistence agriculture sector. I then discuss the implications of the concept of sustainability for agricultural research and development institutions. I conclude the chapter with a description of the problem situation and the conceptual framework used for the analysis of the case studies.

Chapter 2: World view
Conceptual and theoretical frameworks

2.1 Introduction

During the last three decades significant changes have occurred in the field of agricultural research and rural development in developing countries. These changes can be attributed to political influences at the national and the international level. In South Africa the dismantling of the apartheid regime has influenced the changing roles of research and development initiatives, in particular for the subsistence-farming sector. In this chapter, the concept of sustainability is introduced through discussion of agricultural research, rural development and the emergence of systems thinking. The challenges faced by research and development organizations through the concept of sustainability and the operationalisation of sustainability in the research agenda are discussed. The chapter shows that for agriculture and agricultural development to be sustainable, a holistic approach is required, one that embraces complexity through involving all elements within farming systems; and one that is cognisant of the influence of factors that are both endogenous and exogenous to the farming system.

2.2 Agricultural research, rural development and systems thinking

Most public research and extension institutions in developing countries were created or consolidated in the second half of the twentieth century, when the prevailing national policy was to attain self-sufficiency in food production. Researchers and policy makers were mainly concerned with productivity rather than with competitiveness or sustainability. The focus on productivity provided a stable framework that lasted several decades (Ekboir, 2001). Exchanges of information between agents involved in technology development and adoption were unidirectional, and in many cases still are. Reductionism in agricultural research did not embrace an interdisciplinary approach, and this was reflected at the organizational level, where structures were divided into academic disciplines (Ekboir, 2001).

This is still the case in many agricultural research organizations in South Africa. In the 1980s, there was a move from field level research towards research at the household level (see Table 2.1). Extension began to play a more significant role in agricultural research as the household level approach involved people more so than did the field level approach. The farming systems research (FSR) and the farming systems research and extension (FSR-E) movements of the 1980s and 1990s dealt with communities and groups of farmers while research, with the aid of extension agents, focussed on farming systems. However, the linear vision of science still informed interactions between the researchers and extension agents and ultimately, extension provided little input to research (Lynam, 1986; Gray *et al.*, 1997). Interactions were still hierarchical, where the holder of knowledge (researcher) educated the extension agent and the extension agent in turn educated the farmers (Gray *et al.*, 1997). FSR and FSR-E had in practice, not performed as well as was originally conceived: as a vehicle for information feedback to basic and applied research programmes (Lynam, 1986). In developing countries there was an increasing recognition that dialogue between farmers and researchers was essential to the development process (Tourte, 1984). Furthermore, feedback and learning from the farmer's experiences was seen as

essential for the development appropriate technologies and for a sustained dialogue between scientists and farmers (Corbeels *et al.*, *20*00; Pretty and Chambers, 1993).

Extension theory proposed that farmer participation would prevent the 'barriers to adoption' experienced with the linear approach to agricultural research and development, and identified the need to accommodate different perspectives. As a result, in the 1990s, there was a move towards participatory methodologies and farmer-first initiatives. The *farmer first* model proposed involving farmers in the research process, using their knowledge and perspectives on problem-definition and giving them a partnership in the research process. Development 'put people first' by recognizing that goals could be achieved only by participation and planning with farmers and communities (Agrawal and Gibson, 1999).

Table 2.1 Agricultural Research and Development: 1970s to the 2000s*

Activity	*Research Focus*	*Level*	*Decade*
research	crops	plot	1970s
research and extension	crops and livestock	household or farm	1980s
farming systems research and extension	household food security	community	1990s
participatory technology development	household livelihoods	district or sector	2000s

* After Dixon *et al*., 2001.

Scoones and Thompson (1994) argued that the *farmer first* approach did not acknowledge the complexity of participation and that the emphasis on local knowledge distracted attention from the process of knowledge construction. The *beyond farmer first* approach promoted by Scoones and Thompson (1994), acknowledged relationships involving power and conflict found in participatory programmes and gave attention to the process of knowledge construction. Their approach was guided by conflict resolution and by negotiated agreements between different interest groups; because extension activities are inherently political interventions (Leeuwis, 1993).

Participation is associated with the ability of people to move themselves toward a desirable future with dignity and the affirmation of differences. It is associated with shared control and collaborative decision-making through engaging a variety of stakeholders in the generation of ideas, collective analysis, co-operative learning and critical reflection (more often activities believed to be the domain of researchers and experts (Röling and Wagemakers, 1998)). Participatory approaches should enable stakeholders to bring concerns for social justice and democracy to the foreground. But due to the inherent political nature of agricultural development, equal participation remained idealistic. Despite this, by the early 1990s international aid donors and development planners had become heavily committed to participatory approaches (Cernea, 1991). Concurrently, agricultural research changed focus to incorporate rural development, reflecting a move from productivity and efficiency as the dominant goals of research, to include goals that reflected agriculture as a social process (Lynam and Herdt, 1989; MacRae *et al.*, 1989), and in broader terms, a socio-technical process.

A major influence on agriculture and the focus of research and development initiatives was derived from the field of ecology, and in particular the concept of sustainability. Each generation proclaims new criteria for the evaluation of agricultural technology and research. In the past, with reductionism and FSR-E, these have included: production, technology for small farmers; and welfare of low-income consumers. Sustainability is the latest criterion for evaluation and has emerged from the participation of ecologists in agricultural development in the third world (Lynam and Herdt, 1989).

The field of ecology and the associated concept of sustainability emerged from the development of applied systems-thinking. The early development of systems thinking took place from the 1930s to the 1950s. The initial form was the model systems of the 1950s, based in hard systems thinking, or cybernetic models (see Figure 2.1).

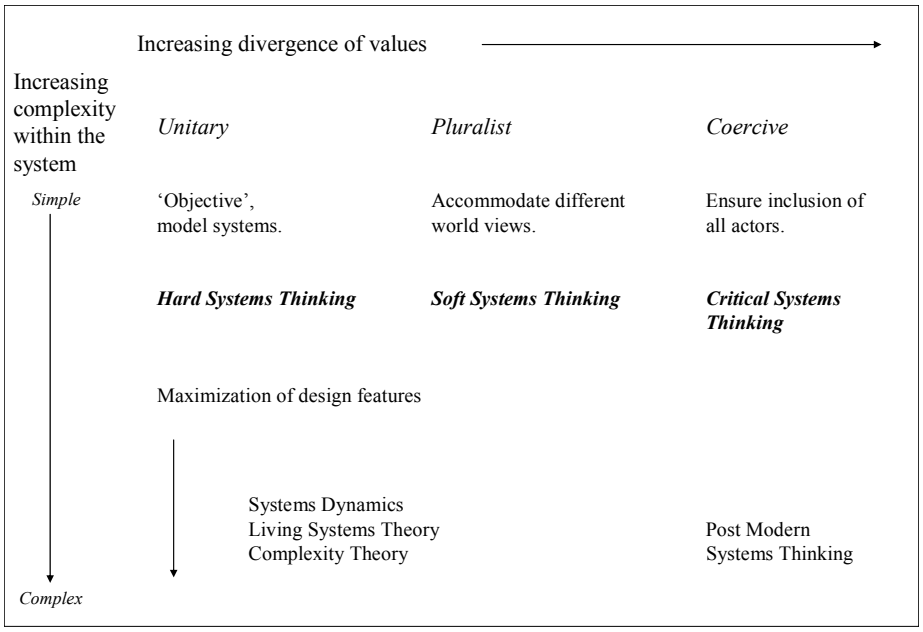

Figure 2.1 The development of applied systems thinking (Jackson,2004)

Addressing increased complexity within the system with concurrent maximization of design features allowed for the development of conceptual models to include Living Systems Theory and Organizational Cybernetics (i.e. ecology and management science respectively). These are the most common applications of systems thinking today (Jackson, 2004).

As was the case in the development of FSR-E and participatory methodologies, in systems thinking, soft systems and emancipatory systems evolved in response to an increased awareness of the role of social systems in defining the complexity of real life situations; and the recognition of a heterogeneous value-system. Soft-systems thinking emerged as a means of addressing the different world views held by various actors in social systems while emancipatory systems-thinking developed as a means of ensuring that all actors, this can include human and non-human actors, in the systems

were included. Thus the political aspect of extension services was also addressed in systems thinking. The concept of systems allows for the development of approaches to help to understand and improve ill-defined, complex situations. Functionality is a property of the whole system of which no particular sub-system is capable of functioning without the co-operation of the others, and all sub-systems receive and give in order to maintain a constant internal environment (Wilson, 1995), or as a Japanese proverb says: *If we ignore the contextual space we miss much of the picture*.

2.3 Agriculture as a system

In the ecological approach, agriculture is viewed as a system, which is driven by production output and the human management of the system. Essentially, agriculture is an ecosystem where the inter-relationships between soils, plants, animals, farmer and climate are crucial to the expected output of the system. The farmer is part of the system and continued and informed interventions by the farmer are necessary to bring production and consumption into balance on a sustainable level (Wilson, 1995). The viability of the farm depends both on the allocation of inter-related resources within the farm and the external environment in which the farm operates (van der Ploeg, 1994). To be sustainable, a farming system should be biologically, technically and socially effective at farm level, within a positive and enhancing external environment (van der Ploeg, 1994; Wilson, 1995). Within subsistence farming in South Africa, research and development programmes and initiatives can be seen as part of the external environment in which the farming systems are located. For this reason, the implication for research and development of sustainability will be discussed in the following section, following a description of the concept of sustainability.

2.4 Sustainability: implications for research and development

Using an ecological definition, Conway (1985) defined sustainability as the ability of a system to maintain productivity in spite of a major disturbance. Sustainability in agriculture refers to the capacity of the agro-ecosystem to remain productive while maintaining the resource base (Reijntjes *et al.*, 1992). As agriculture is an extractive activity and agricultural systems are designed to generate desired products, maintaining the resource base implies considerable reliance on managing the crop environment, and in particular, the maintenance of the soil resource (Lynam and Herdt, 1989). Climate (for example) has a direct impact on agriculture and the crop environment and is a key factor in determining the availability of natural resources, in particular due to seasonal and annual variations in local weather patterns.

A system that is adaptable to both short term and long term changes is more likely to be sustainable, as adaptability is a key factor of system sustainability. To determine the adaptability of an agro-ecosystem, an analysis of both the processes of change affecting the agro-ecosystem and also the agro-ecosystem's response to that change are important (Izac and Swift, 1994). There are two distinct patterns of change: progressive and intermittent. An example of progressive change is soil nutrient status (either increasing or decreasing) and rainfall is an example of intermittent change, in that from year to year, there is a fluctuation around the mean (Izac and Swift, 1994). Maintaining the function of the agro-ecosystem (generation of desired products) in the face of these forces of change is a product of both the inherent ecosystem properties

(natural) and the management activities (human) imposed on the agro-ecosystem. The agro-ecosystem function can thus be seen as a result of the co-production of man's activities and nature's resources (Sonneveld, 2004).

Sustainability is a meta-system attribute, therefore, a sustainable agro-ecosystem is one where the co-production of the ecosystem properties and the management activities, results in non-declining trends in outputs and by-products and non-increasing trends in those by-products detrimental to the system (Izac and Swift, 1994). Sustainability thus implies uniqueness of time and place and incorporates local natural resources and processes (Dundon, 1982; Bennett, 1986; Shearman, 1990). As the management of these resources and processes is a key factor in system sustainability, the sustainability of the farming system can be improved through the strengthening of the capacity of the farmer to respond to change (Richards, 1986).

Sustainability of the farming system can only be determined if the boundaries of the system under consideration are specified, especially as sustainability is a process specific in time and place (Lynam and Herdt, 1989). The farmer is central to the functioning of the agro-ecosystem and system boundaries should include the farmer and aspects of the life of the farmer that impact on agricultural activity. This is illustrated in Gips' (1985) definition of sustainable agriculture, where for agriculture to be sustainable, it should be: ecologically and economically viable, socially just and adaptable. An assessment of sustainability would therefore require examining a variety of levels and aspects. For, although sustainability is considered to be a local process, it requires assessment and evaluation in relation to a larger system (Maru and Woodford, 2001). Sustainability is thus interwoven with the socio-cultural and the politico-economic environment of the farmer (van der Ploeg *et al.*, 2004).

The spatial and temporal scales required for an assessment of sustainability are relevant to and specific for each situation. For subsistence agriculture in sub-Saharan Africa (sSA), the levels selected for research and development should allow for significant integration of ecological, economic and social factors. Izac and Swift (1994) proposed a pragmatic approach to researching sustainability of farming systems in sSA. They proposed that research should be site specific, as sustainability has largely been understood as being contextual; the research should address at least three levels of the meta-system being studied; and the research should include natural, physical, human, social, and financial aspects of the three levels of the meta-system. At least three levels are required for sustainability analysis as the systems at level *n-1* are constrained by systems at level *n*, which are themselves constrained by systems at level *n+1* (Allen and Starr, 1982). Thus Izac and Swift (1994) contended that sustainability assessment of the farming-system level (*n*) must at a minimum embrace the cropping-system level (*n-1*) and the village, catchment or district level (*n+1*). They suggested also that the catchment or district level could be expanded to include the agricultural sector. For example, the agricultural sector could be considered as a system that has an impact on sustainability at the field level. Within the South African context, processes and factors within the agricultural sector are expressed at the district and catchment level through the participation of change agents and extension personnel, where both are influenced to some degree by agricultural policy.

At the level of the farming system, an understanding of the link between resource transformation processes and productivity is essential for an assessment of

sustainability. At the farming system level, farmers' decisions and judgements are made and it is the lowest level where biological, economic and social considerations are integrated. For sustainability, the overall trend at this level should be positive even if certain aspects are in decline. At the proposed third scale for sustainability assessment, the village catchment scale, the interactions are regulated by ecological, social and economic factors (Izac and Swift, 1994). However, as all levels are interrelated, plot-level activities influence and are influenced by: the livelihood options of the farmer; the influence of change agents; and social and economic pressures**.** Figure 2.2 shows the proposed levels required for research into sustainable development in subsistence agriculture and how they are conceptualised as systems. Meta-system sustainability would be a product of the outcomes of all the subsystems and would include both products and impacts (Izac and Swift, 1994).

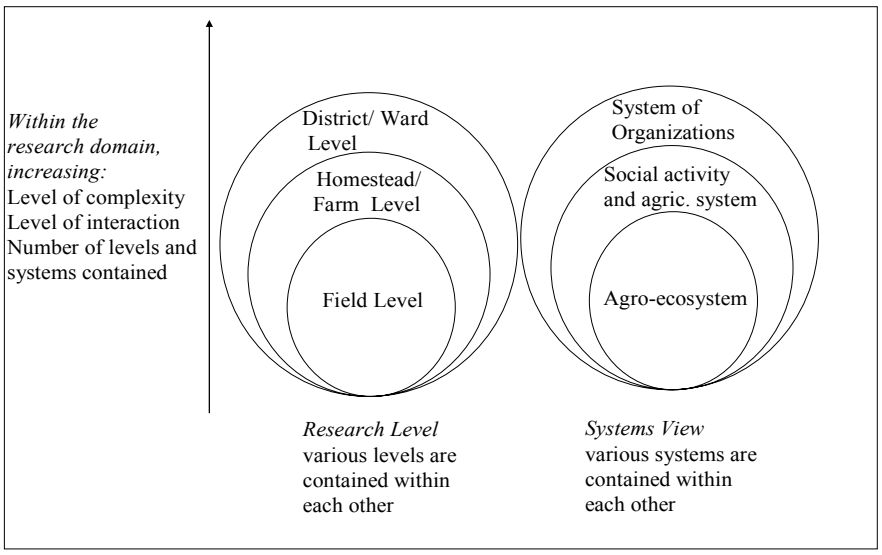

Figure 2.2 Researching sustainable development: required levels and related systems

For example, a cropping system is sustainable if a) it has an acceptable level of production of harvestable yield, which shows a non-declining trend from cropping cycle to cropping cycle over the long-term and b) the process of producing the harvestable yield does not lead to degradation of resources within the farming system during the same period (Lynam and Herdt, 1989; Spencer and Swift, 1992). Essentially, for a farming system to be sustainable, the current generation of farmers should manage the agro-ecosystem in such a way that future generations have the same (or better) opportunities as the present generation.

The challenges facing sustainable agriculture are unlikely to be solved through a technological fix at the field level, as the production system is linked to other systems, which should also be considered (Altieri, 1987; Ekboir, 2001; Lawrence, 1997). In fact, whether a technology works or not, is not an intrinsic property of the technology but depends on the way it is embedded in a specific socio-technical network and includes skills, knowledge, organizations and infrastructures (Rip and Kemp, 1998;

Rip and Wiskerke, 2000; Lawrence, 1997). Churchman's (1982) notion of '*secure improvement ... in terms of the larger system*' reflects the concept of sustainable development, if the larger system includes environmental, economic, social and institutional elements and the relationships between them.

Sustainability concerns the relationships between system elements and researching sustainability requires a different method to that commonly used in agricultural research and development. The multiple dimensions that constitute sustainability are what pose the difficulty to researchers and development agencies. Maclaren (1996) suggested that the need to address the multiple dimensions of sustainability could be realized through using intra- and intergenerational equity as a guiding principle. As already mentioned, sustainability in agriculture is based on an anthropocentric value judgement of non-declining resources where future generations must have the same range of options concerning the use of agro-ecosystems as the current generation (Izac and Swift, 1994). The value judgement implicit in the concept of sustainability is problematic to research and development agencies using the reductionist approach. Objectivity is paramount in reductionist research. However, research into sustainable agriculture is value laden and for it to be socio-politically detached, as in reductionist research, is not compatible with the concept of sustainability (MacRae *et al*., 1989). As the institutional patterns, the technology and infrastructure that shaped and governed research and development in the past are not grounded in the concept of sustainability, investigating these problems also implies a shift in research and development regimes (van der Ploeg *et al.*, 2004).

Sunderlin (1995) attributed the origins of sustainability to a shift in perspective of the international development agenda in addressing poverty and environmental degradation. Lawrence (1997) took this further and stated that sustainability represents a paradigm shift because the various elements of sustainability (environmental, economic, social and institutional) are highly interrelated and that the nature of the interconnections should be appreciated in the design and adaptation of sustainable systems. The relationships between the elements are of primary importance and the objects (boundaries of the patterns) are secondary in importance (Checkland, 1983). Using this view, it becomes possible to determine trends, norms and fluctuations within systems all of which are important aspects in determining sustainability. Integrating the distinct pieces resulting from reductionist enquiry into a whole (or system) is difficult, as the relationships between the objects often remain undiscovered or ignored (Busch and Lacy, 1983; Miller, 1985; Suzuki, 1987) and this is another reason why the concept of sustainability research is considered to be a new paradigm.

As functionality is a property of the whole system of which no particular sub-system is capable of functioning without the co-operation of the others, methods are required that address as many aspects of the problem situation as possible. The functional integrity of the greater system is compromised when the links between the system components are disrupted. Thus if sustainability is the functional outcome of the greater system, it is important to examine systems at a number of different levels (multi-level). The systems examined are likely to be networks of heterogeneous elements (multi-actor), and these systems each have their own functionality (multi-aspect). Particular methods for addressing the multi-level, multi-actor and multi-

aspect approach required for sustainability and sustainable development are discussed in the following chapter, and are conceptualized through a systems approach.

For institutions to address the challenge of realizing sustainable development, agricultural systems need to be viewed from a number of aspects: the technology; the people using the technology; and the changing institutions. Research into sustainability should thus occur at least at three levels: field, household and district; to incorporate economic, physical, natural and social factors. It is important that long-term causes and effects are recognized, as system stability is more easily understood through defining interrelationships (Checkland, 1983). Researching sustainability requires learning new methods and routines. However, many research institutions in developing countries have difficulty adjusting to new learning routines (Ekhoir, 2001). The challenge for agricultural research, extension and planning institutions is to institutionalise approaches and structures that encourage learning. Members of organizations must become aware of their own processes of learning, from both mistakes and successes (Argyris and Schön, 1978). Organizations that succeed in a challenging and increasingly complex world are also those that have the ability to learn from their experiences, and adapt quickly (Pretty, 1995).

Research into sustainability requires a detailed and comprehensive study, one that incorporates both reductionist and holistic approaches. Indicators derived from life and earth sciences should be used to make visible the impact of human activities on the biosphere, while focusing on human activity as the explanation and the area for intervention (Röling and Maarleveld, 1999).

2.5 The 'problem situation': a rich picture

Chapter 1 shows that the main method of agricultural research and development used by government departments in KwaZulu-Natal is the transfer-of-technology approach. Most non-government and faith-based organizations use participatory methods of technology development in seeking ways to improve livelihoods of the rural poor. There are thus two main methodologies, employed in realizing the aim of assisting the rural poor. These methodologies are different with respect to: the development model; the technical intervention; the level of intervention; and the area of intervention (Table 2.2). The different methodologies used for agricultural research and development are directed by the policies of the various organizations.

Within food security studies, two paradigms have been distinguished: the 'production of food' model and the 'consumption of and access to food' model (Maxwell, 2001). In the production model, food security is perceived as an outcome of agricultural production; and economic emancipation will result from the maximisation of agricultural production. The access and consumption model perceives food security as the outcome of livelihood strategies employed by the rural poor, which may or may not include agriculture as a key strategy. Here, agricultural production is seen as one of any number of activities and factors that contribute to the consumption of and access to food within the household.

Table 2.2 Development model and associated methods used for field-level interventions in subsistence agriculture: a comparison of two institutional paradigms

Institutional paradigm	*Transfer of Technology*	*Participatory Technology Development*
Development model: food security	Production of food	Consumption of and access to food
Technical intervention	High External-Input Agriculture	Low External-Input Sustainable Agriculture
Level of interaction	Community-based organizations	Community-based organizations and individuals
Area of intervention	Community gardens/ communal land	Homestead gardens and fields

In the agricultural sector in KwaZulu-Natal, the methods used for technical intervention at the field level are also different for the two institutional paradigms. High external-input agriculture (HEIA) is generally used by government organizations to attain the goals of the production model through the transfer-of-technology; and low external-input sustainable agriculture (LEISA) is generally used by non-government organizations for the consumption and access model through employing participatory technology development. The chosen method of technical intervention is largely the result of funding available to the organizations, where government departments have larger budgets; and is also an outcome of the historical approaches to agricultural development.

With the Government of National Unity, government resources once only available to white commercial farmers are also available to black farmers. As a result, many provincial extension programmes focus on the maximization of production as a means of agricultural development. These programmes promote the use of improved crop varieties and mechanized cultivation techniques. The crop varieties and cultivation techniques are developed on research stations by researchers. Those crop varieties that are determined by seed companies and researchers to be most appropriate for the farmers' cropping area are then introduced to farmers through government-funded trials conducted on communal land. There has been no adjustment to the 'modernization' model for agricultural expansion previously used with white commercial farmers and now used with black farmers. This model of agricultural development is both useful and problematic for a variety of reasons. It is useful for those farmers who wish to expand into the commercial farming sector (i.e. become 'emerging farmers') and who have the resources of land, infrastructure, and financial capital readily available. But, the transfer-of-technology model is not useful to the rural poor who wish to improve household food security and who do not have much land, infrastructure and financial capital readily available.

The use of government-funded trials to introduce these improved technologies to farmers is also politically loaded. For although the KZNDAEA uses the FSR-E approach when working with black farmers, there is still a transfer of technology from the research farm to the farmer's field with little acknowledgement of farmer's knowledge and how this could contribute to the development of technologies

appropriate to the needs of the farmer (MacVicar, 1993). The approach to dealing with black farmers has not changed despite the change in government, where historically, white commercial farmers and black small-scale farmers were treated differently with regard to the content and methods (stimulation *versus* teaching) of extension services (see Chapter 1 section 1.4). Black farmers are still being *taught* the value of improved crop varieties and cultivation methods through the FSR-E approach.

Also, there are social and material gains associated with participation in the trials. The land used for the trials is classified as communal land, but given the nature of communal tenure and the allocation of land by traditional authorities, the land used for trials is often in fact 'owned' by tribal leaders or men with some importance in the community (Ngubane, 2001). The land used for the trials is improved through the application, by the extension services, of lime and fertilizer to the soil to ensure maximum yield of the crops cultivated for the trial. Most often, the trials are conducted for maize varieties only. The owner of the land thus gains improved soil conditions for a number of subsequent cropping seasons and also the stover remaining after harvest of maize is available to him as cattle-fodder for winter feeding of his herd.

The transfer-of-technology method of agricultural development used by the Department of Agriculture through conducting variety-trials on communal land does not address the needs of those households with limited land and financial assets available that have little social standing within the community and who do not wish to (or who cannot) become commercialized farmers. For those households with limited available land and financial resources (mostly female-headed), the KZNDAEA implemented a community garden programme.

In rural KwaZulu-Natal, community gardens consist of an area of land (0.25 to 2 ha) fenced off and secured from foraging animals and are used for growing vegetables. A committee, appointed by the group, facilitates activities within the community garden and the interactions with the extension officers of the KZNDAEA. Extension officers of the KZNDAEA provide a service to members of the community gardens through technical assistance with vegetable production, including soil testing and recommendations, suitable varieties for cultivation, and the supply of required inputs. The services provided by the extension personnel often include the marketing of the produce grown in the community garden. The marketability of the crop is determined by the uniformity and quality of the entire harvest from the community garden, motivating the gardeners to 'follow the rules' with regard to crop type and management techniques. At harvest, the crop is either collected from the community garden by a retailer (identified by the extension personnel) or the crop is transported to a local fresh-produce market for sale. The majority of the produce from the community garden is sold. Community gardens also serve social functions, such as providing a place where new wives can get some peace from the mother-in-law (Shezi, 2000).

The KZNDAEA thus provides an agricultural development service to those households with limited available land and financial resources; but as with the field trials, the transfer-of-technology model is used, in conjunction with high-external-input methods. As previously reported, there is little between- and in-garden variation of vegetables grown in community gardens; the main variation due to climatic constraints (Adey *et al.*, 1998). In community gardens throughout the province, across

seven bioclimatic zones, there found to be uniformity not only of crop types, but also of management practices. Gardeners conformed to the instructions for production given by the extension officers of the KZNDAEA and used little of their own skills and knowledge for cultivation in the community gardens (Adey, 1997).

In a number of areas, assistance provided to community gardens by provincial extension agents is inconsistent and in some cases, non-existent. These community gardens are assisted by non-government and faith-based organizations. In these gardens there is a greater diversity of plant species, and crops in addition to food crops are often cultivated, for example, medicinal and craft plants (Adey, 1997). The community gardens also provide a place where people can learn from each other and share ideas (Haigh, 1996). The crops are usually not produced for sale, but are for home consumption. Sales do occur, but these are marginal compared to the sales of the community gardens producing mostly for market. The non-government and faith-based organizations that assist community gardeners use participatory methods of technology development in conjunction with the low external-input sustainable agriculture approach. The organizations working with gardeners in the community gardens realised that there were members of households that for a number of reasons, were not able to participate in food production in the community gardens. For some, the distance to the community gardens excludes the physically challenged or older, less mobile people, not capable of walking to the community garden. Others are excluded by rules such as those that exclude individuals for a period of one month to a year following a death in the family, as it is considered inappropriate to till the earth during the period of mourning (Alcock, 2001). Some gardeners also do not have the time or resources available to use the community gardens for crop production, and prefer to use their homestead gardens for this purpose.

The non-government and faith-based organizations, active in agricultural development are not constrained by government policies when working with the rural poor and can subsequently work with individuals in homestead gardens using participatory methods of technology development. Most of these organizations attempt, where possible, to work within the constraints of the rural poor in terms of the resources available for their livelihood strategies. Due to the funding available to non-government and faith-base organizations, usually through international aid agencies, the development organizations need to conform to specific modes of practice. This is similar in some ways to the prescribed methods of government policy-driven programmes. The difference for development organizations though is that international aid agencies prescribe participatory methods that aim to promote sustainable solutions to the multi-faceted constraints faced by the rural poor.

Sustainable agricultural practices should ideally be ecologically and economically viable; socially just and adaptable (Gips, 1985). The agricultural development model promoted by the KZNDAEA is unsustainable for the majority of the rural poor given the current socio-economic climate of South Africa. In terms of agro-ecology, the use of homogeneous crop-types and limited genetic variation within each crop-type means that there is restricted potential for crop-response to both progressive and intermittent changes within the crop environment. For example, the use of hybrid varieties precludes the adaptation of crops to changing local climate; and increases the opportunity for new-encounter and re-encounter pests and diseases to significantly

reduce crop yield (Robinson, 1987). Economically, many rural farmers do not have sufficient resources to buy the necessary inputs required for maximizing production output and given the remote location of many villages, infrastructure is often lacking to ensure adequate or continuous supply of the required inputs. The field-trial approach of working with black farmers on communal land is in theory, socially just; but in practice it is unjust as it excludes those farmers who have little social standing, mostly women. For the community garden programmes, the approach of the KZNDAEA also excludes some members of the community from participation.

That is not to say that the intervention by the KZNDAEA is not useful. To many farmers who have the necessary resources, the agricultural development methods are very useful. The concern in this thesis is for the majority of the rural poor who, for whatever reason, fall between the cracks of government agricultural development policies. Many of these people are assisted by non-government and faith-based organizations and this thesis examines the interactions between the rural poor and those organizations that work with them to improve their livelihoods in a sustainable manner.

The term 'subsistence agriculture' used in the title of this thesis is problematic as it infers that the rural poor obtain all their livelihood needs from agricultural production. Given the complexity of their livelihoods, this is not entirely true as remittance, government grants and informal trading also play a role in determining the livelihoods of South Africa's rural poor. However, many people rely to some extent on what they can produce in homestead gardens, and agriculture also has relevant cultural and social functions. The term subsistence agriculture is used here to call attention to and to address the plight of the rural poor who are largely excluded from participation in the government's agricultural development programmes.

All three case studies presented in this thesis concern the use of plants by the rural poor and the opportunities available to the rural poor for sustainable livelihood-improvement through facilitation by change agents from the intervening organizations. The focus is on the socio-technical and technico-institutional arrangements and developments at the field level and how these processes and interactions have the potential to inform change at the regime and landscape level. The conceptual framework used for the analysis of the case studies will now be presented and discussed in light of the problem situation just described.

2.6 Novelties, niches and networks

Discussions within the AGRINOVIM programme profoundly influenced the direction and content of my research. AGRINOVIM was a multi-national and multi-disciplinary research programme that stands for The dynamics of AGRicultural Innovation: studies at the interface of NOVelty creation and sociotechnical regIMes (AGRINOVIM). It is the concept of novelty creation that will be introduced here, as it was used both reflexively and as an analytical framework for the case studies presented in this thesis.

AGRINOVIM opts for a '*technology in society*' perspective, which acknowledges that diverse innovation processes and technology choices at the local level accumulate in technological development at the societal level. There is a focus on the interaction

between technology and society, conceptualised as a process of co-evolution in which the technology and social context interact and change (van der Ploeg *et al*., 2004).

This was considered a valuable and interesting perspective for South African agriculture in 2000, at the beginning of the research for this thesis. South Africa was undergoing major social adjustment and change following the establishment of the government of national unity in 1994. Many challenges emerged both at a technical and social level that were unique to post-apartheid South Africa; and in addressing the challenges, it was important to be aware of the co-evolution of technology and social context.

The application of the concept of novelty creation to agriculture was developed in response to the need for change within agricultural and rural development within the European Union, initially, specifically in The Netherlands. The need for the transformation of modernization as the dominant approach to agricultural development and practice had been realised in many European countries. Agricultural modernisation is dominated by the drive towards the maximization of production, realised through specialisation, intensification and scale enlargement (Roep and Wiskerke, 2004). The development route of modernisation of agriculture has led to the de-legitimisation of alternative options, routes and policy objectives as they are at odds with what had become an objectified fact: the modernisation model is the only route for agricultural and rural development. Due to the institutionalization and the subsequent promotion of the modernisation model through government policies, the modernisation model has been adopted as the unquestioned, accepted method of agricultural and rural development despite its unsuitability to many rural, farming communities (Roep and Wiskerke, 2004). Studies of farming styles showed that farmers were exploring new ways of farming that were opposed to the model of modernisation (van der Ploeg, 1994). But, due to the institutionalised acceptance of the modernisation model, there was little support for their novel approaches. Ideally, the problems created by modernisation had to be countered through reconnecting agriculture to its social and agro-ecological environment (Roep, 2000) and the rebalancing of agriculture with societal needs (Roep and Wiskerke, 2004); an outcome which the dominant technico-institutional regime was both unwilling and incapable of effecting (van der Ploeg, 2003).

New and interesting ideas about alternative technological, institutional and social solutions to modern agriculture were emerging. These were mostly developed by small groups of farmers and involved developing novelties, prototypes and experimenting with promising alternatives to the modernization model. It has been widely recognised that the inventiveness of farmers gives rise to impressive and remarkable novelties (Mango, 2002; Wiskerke, 1997; Wiskerke *et al.*, 2003). The new technologies and isolated practices have not received support from guiding and governing organizations and thus have not yet led to larger changes in the governance and organization of agriculture (Moors *et al.*, 2004). In fact, many of these promising alternatives remain hidden and isolated due to the prevailing and dominant regime. The production of novelties, like sustainability, is a highly localized process which is dependent on ecosystems and local cultural repertoires; and is interwoven with local knowledge (van der Ploeg *et al.*, *20*04).

To further develop and explore these promising practices and to make them more available to other farmers seeking sustainable farming practices, a tool, referred to as Strategic Niche Management (SNM), was adapted from technology-in-society studies at Twente University in the Netherlands. SNM is the creation, development and controlled breakdown of niches for promising new technologies (novelties) and concepts (Moors *et al.*, 2004). Novelties represent new modes of doing and thinking that hold the promise to do better (Rip and Kemp, 1998; van der Ploeg *et al.*, 2004); and ideally embrace sustainability as a preferred mode of development (van der Ploeg *et al.*, 2004). SNM is designed for the establishment and management of institutional environments that enable the further research and development of these promising ideas and practices.

The ongoing production of novelties (sometimes promising) is only possible due to a protected space where these novelties can mature. The protected space is called a niche, defined by Geels (2002) as a space for alternative or radical innovation, created and located within an institutional order (regime) that has rules, routines and vested interests. This protected space makes it possible to determine whether or not the hidden novelties would be a new constellation that not only promises, but also effectively demonstrates that they can work (van der Ploeg *et al.*, 2004).

The niche, in which favourable institutional conditions occur, makes it possible to transcend the difficulties that exist between the production of novelties and the technological regime (van der Ploeg *et al.*, 2004). Within the niche, which is a specific application domain (habitat), actors are willing to invest significant time, effort and financial costs in testing, or making improvement to the promising practice or new technology (Hoogma *et al.*, 2002).

During the testing or developing process, expectations of the potential of the new technology are shared and specified; and the process can generate the emergence of a strong network of actors willing to invest in and carry a new technology forward (Moors *et al*., 2004). Novelties are identified by both farmers and scientists who then facilitate the establishment of the niche; the niche is essentially determined by these actors who manage the institutional arrangements around the promising novelty within the niche. Seeing farmers as developers of new methods, systems or ways of thinking is central to institutional development and innovation. This is core to the niche as it is what separates the novelty and niche from the dominant regime where farmers are passive recipients of the knowledge and ideas generated by scientists and policy-makers (Moors *et al.*, 2004).

In practice, many farmers realise forms of re-balancing in order to adapt their particular farm enterprise to the particular ecological and/or economic situation in which they operate (van der Ploeg *et al.*, 2004). Strategic niches occur in which favourable conditions exist that make it possible to go beyond the impasse that exists between the production of novelties by farmers and scientists on one hand and the technological regime on the other. The long-term goal of SNM policies is to create new rules and routines (institutions). These institutions foster processes that are specifically designed to stimulate learning and reflexivity and create space for experimentation; and facilitate the ability to deal with difficult and complex processes (Moors *et al.*, 2004).

Due to the multi-level aspect of novelty creation and development, strategic niche management (SNM) is an effective approach to conceptualise the transition paths from an existing regime to another regime (Kemp *et al*., 1997)**.**
The multi-level analysis simultaneously addresses:

1. material realities at the micro-level (e.g. fields, animals, grassland production, plants);
2. social realities at the meso-level (e.g. evolution and differentiation of farming styles);
3. patterns of interaction at the macro-level (e.g. interrelations between farms, markets and institutions and interactions and between novelty production and technological regimes);
4. impact of collective actions that aim to secure a definitive shift in techno-institutional designs towards new forms of agricultural development. Here the complex interactions between micro, meso and macro play a role.

These processes should ultimately lead to the development of better technologies and (possibly) a smoother diffusion process as a better fit is achieved between the technology and its social environment (Webster et al., 1999). Thus, scientists have to do more than solve self-defined problems, they also have to explain, negotiate, clarify and build on the novelties they observe. Thus, successful niche development results in the development of complementary technologies, more robust expectations and a broad and strongly aligned network of knowledge and institutions (Hoogma *et al.*, 2002). The focus on patterns and mechanisms rather than on particular technologies is a feature of innovation processes, where innovations are not related to a single technology in need of replacement or alteration, but to a range of technologies that are interconnected with each other and with the social system in which they are put to use (Moors *et al*., 2004).

For South African subsistence farming, novelties are represented by both activities at field-level undertaken by farmers and by the activities of NGOs that assist subsistence farmers. In South Africa, due mostly to the apartheid regime, little recognition has in the past been given to the value of technologies developed and used by subsistence farmers. Through working with subsistence farmers, NGOs and faith-based organizations have however, had more exposure and given more recognition to innovative farming techniques used by these farmers. Novelties would thus apply to practices used by farmers that are not recognised by proponents of the transfer-of-technology model as making a valuable contribution to agricultural production. These novelties can include, for example, traditional crop varieties and the use of kraal manure for soil fertility improvement; which are at odds with the proposed use of hybrid crops and chemical fertilizers.

The recognition of the value of farmers' practices and working with farmers in a participatory way are both novelties in the context of the prevailing and accepted methods of the transfer-of-technology approach where the knowledge of researchers is held above that of the farmers themselves. Also, development organizations are able to work at homestead level and are able to work with individual farmers.

In the 'traditional' application of SNM in agriculture, the niche is established, negotiated and managed by both farmers and researchers. In South Africa, this role is

largely fulfilled by change agents, who are commonly the development facilitators from NGOs. It is the change agents who recognize the promise of the farmers' practices and establish and manage the niche where the potential of the novelty can be explored. As with the traditional form of SNM, other actors are drawn in to assist in the development or testing of the promising novelty. Thus, a network is created within and around the niche with linkages to other organizations and individuals; and the novelties and the rules and routines within the niche become more widely accepted. In South Africa, many of the individuals within the network are from non-government organizations and also use participatory methods of agricultural and rural development and the LEISA approach. So, effectively there is limited exposure to individuals or organizations associated with the dominant regime. This is problematic in terms of institutionalizing local practices as it reinforces the antagonism between individuals of the dominant regime and the promising novelty (this is discussed further in Chapter 7 in the reflection of the SNM of the various case studies).

Once the novelty has shown significant promise and the processes have become institutionalised through the establishment of rules and routines, the niche is dismantled. Dismantling, or the breakdown of protection, is not so much a specific act, but is largely an expansion of the rules and routines within the landscape (Wiskerke, 2006). In traditional SNM, the controlled breakdown of the niche is negotiated by all actors involved in the development and testing of the novelty. In South Africa, there is a key distinction, where the institutional protection is gradually phased-out when the change agent is certain that the technical, social, institutional and market configurations are sufficiently robust. This point often occurs when learning routines are established and when the farmers are able to engage effectively (i.e. without being taken advantage of) with individuals and institutions external to the niche.

The multi-level approach used by AGRINOVIM addresses the fact that although novelty creation is largely a local process, it may be enabled or constrained by its: institutional context; current knowledge and approaches; and rules, regulations and economic conditions. A multi-actor approach is used as institutional embedding is fundamental for a novelty to perform as intended. This demands the involvement of a number of actors, all of whom should be taken into account when trying to understand why (or not) and how novelties emerge, are taken up and become institutionally embedded. A multi-aspect approach is used, as specific technical configurations are not solely explained by technical possibilities. All aspects need to be considered when understanding why a novelty is configured, these include cultural notions, historical issues, social aspects and political priorities.

The '*technology in society*' approach to this research, takes into account the multi-level, multi-actor and multi-aspect dynamics of socio-technical change: linkages, networks and their alignments. The importance of linkages and alignments extends beyond innovations and industry structures to the embedding of technology in society, which includes mutual adaptation with other products and actors, and articulation of acceptability (Rip, 1995). Through the use of the multi-level, multi-aspect and multi-actor approach, the framework attempts to overcome the sociological dualisms of: micro *versus* macro; agency *versus* structure; and material/natural ordering processes *versus* social /institutional ordering processes (van der Ploeg *et al.*, 2004).

In the following chapter, the methodologies used for the research are described and include the application of SNM to the three case studies in South Africa.

Chapter 3: Down to earth
Research methodologies

3.1 Introduction

Despite a shift in the government approach at a policy level, little change is taking place to create a more enabling environment for finding solutions to agricultural constraints faced by the rural poor. The top-down approach and methods of extension based on the transfer-of-technology paradigm are no longer appropriate in the face of the changing nature of agriculture and rural development technologies for reaching poor rural households to facilitate household food security (Mtshali, 2002).

The three case studies presented in this thesis explore the interaction of farmers, technologies and institutions; and probe the notion that practices at the level of the field and also at the level of institutions both have a role in shaping sustainable agricultural systems. The case studies vary considerably in location, culture and institutional arrangements, but processes within the case studies are similar and conclusions can be drawn about the sustainability of agriculture and agricultural development initiatives based on the technico-institutional arrangements. This chapter presents the methodologies used for the three case studies and gives the motivation for using the methodologies.

3.2 Objectives and research questions

The main objective of the research in this thesis was to determine if the technological intervention in each of the case study development projects was sustainable; and to draw out key factors and lessons learned from the case studies to inform the technico-institutional design of sustainable agricultural development initiatives and sustainable farming systems. As farming systems are the result of the ongoing interaction, mutual transformation and dependency between the social and the natural, the sustainability of the intervention was determined at three interrelated levels. At these three levels (field, household, district), the technical, social and organisational functions, and factors both internal and external to the system, were determined. From analysis of the key factors and lessons learned that contributed to sustainability within each case study intervention, the impact of the development project on environmental, economic, social and institutional sustainability was examined. These lessons learned and key factors could then inform the technico-institutional design of sustainable agricultural development programmes and sustainable farming systems.

To understand and improve techno-institutional design it is necessary to understand:

- the co-evolutionary dynamics of interaction between the technical and institutional, in particular, attempts at change;
- the relation between novelty creation, its nurturing or repression, and regime evolution or transformation, in particular with promising novelties which are considered to be weak in respect to the dominant regime and
- the shape and contents of the novelties, niches and confrontations; the co-production of social (social relations, institutional relations, culture, policy, etc.) and material (soil, nature, landscape, technology, etc.) aspects; the multi-level

dynamics of innovation; and the role, shape and context of local knowledge (Rip and Wiskerke, 2000).

The general research questions drawn from the objectives of the research include:

- Although sustainability is specific to both time and locality, what general conclusions can be drawn about sustainability through examining development project case studies?
- What role do institutional factors play in the sustainability of technological interventions in the development sector?
- What methodologies are appropriate for research into the sustainability of development projects?

These questions are expanded upon further for each of the case studies to address the explicit concerns of the case study interventions. Research questions specific to the case studies are presented in section 3.4.

3.3 Methodologies

The research in this thesis was based on the agro-ecological approach. Agro-ecology is the co-evolution of societal and natural factors, and farming systems are the result of the ongoing interaction, mutual transformation and dependency between the social and the natural (Marsden *et al.*, 2001). The social aspects include local knowledge and the capacity to develop and maintain social networks; and the natural aspects include local ecological specificity and diversity of agro-ecological systems. Strategic Niche Management and Critical Systems Thinking were used as two meta-methodologies to address the multi-level, multi-aspect, and multi-actor aspects of the case-study analysis and research.

3.3.1 Strategic niche management: promising pockets and novel configurations

The case study development projects were initially conceptualized as being 'promising pockets' (Adey *et al.*, 2004) as they held promise in finding sustainable solutions. Further along in the research, two of the case studies were defined as novelties, where the sustainability of the process was apparent. In these two case studies the concept of SNM was consciously and actively pursued by the project change agents, especially with respect to linkages, networks and their alignment within the project environment. Traditionally, the niche is created and maintained by the 'innovators' until the novelty is thought to be acceptable to the dominant regime. With development projects in South Africa, the niches were both created and protected by the change agents. This allowed the novelty to be developed without undue external pressures. Once the internal and self-regulating mechanisms were sufficiently well-established, the dismantling of the niche could then be negotiated. The crux of the issue for the participating NGOs is the tension between product and process. That is, to be effective but not to resort to dependency and this is a key issue in the negotiated dismantling of the niche.

The concept of strategic niche management was used in two ways within the case studies: as an analytical framework; and reflexively, as a tool within the development project. The use of SNM had a profound effect on what was investigated in the case

studies and how this was undertaken. For the first case study, the constellation of gardeners' practices and the intervention by the development organisation were perceived as a 'promising pocket'. The agricultural development project was fairly new and the configurations of technical and institutional factors had yet to reveal whether or not they were sustainable.

For the second case study, the development project had been going for some time and a new phase was just beginning. The project was actively managed according to concepts and principles of SNM. The configuration of technical and institutional factors had revealed themselves over time to be promising, and likely to be sustainable. A network of change agents and market agents had been established around the development of the interesting and new technology developed by the crafters. The constellation of promising technical and institutional arrangements was managed strategically, so that the crafters could obtain maximum benefit from the network interactions.

For the third case study, again the project had, over time, revealed itself to be both promising and also potentially sustainable. Initially, SNM was used analytically and the project was seen as a promising pocket. However, through a progressive understanding of the concept of SNM, and the configuration of technical and institutional factors showing promise of sustainability; the project was actively managed according to the concepts of SNM.

The distinction between 'promising pockets' and 'promising novelties' at the conceptual level played an important role in the discussion of sustainability in the case studies, in particular the sustainability of the technical and institutional arrangements and the interface between them. The sustainability of the case studies is discussed in detail in Chapter 7.

3.3.2 Applying critical systems thinking: critical systems practice

Within rural sociology, a methodology that has gained importance in the field of rural and agro-food studies for whole-system research is the Actor Network Theory (ANT) (Murdoch, 2000). Within the ANT, organizations are viewed by sociologists as being social networks, the networks in turn, are composed of heterogeneous elements (Latour, 1999). In the application of ANT, various elements (actors) are tracked through time. This is done in order to identify how different elements, whether social or natural, are defined and associated, (Callon, 1986). ANT is essentially a hybrid of two traditional forms of network analysis, social and technical networks, and was developed as a means of addressing the limitations of social studies of science and technology (Latour, 1987). ANT has been used for the analysis of rural change processes, and to explore the dynamics of networks composed of heterogeneous (i.e. both human and non-human) elements (Foster and Kirwan, 2004).

The ANT is however, more of a method than a theory, as it does not offer a means of interpreting the observations made of the heterogeneous network (Latour, 1999). Critical Systems Thinking (CST) shares many features with ANT, in particular, that CST is used for the analysis of change processes and it is used to explore the dynamics of networks composed of heterogeneous elements. There is however, one key distinction: the ANT adopts a relatively objective approach where the researcher observes and documents the change processes. This differs from CST where the

researcher observes and documents the change processes, but ultimately is expected to act in some way, in response to the research process or findings.

There are three main paradigms of systems thinking: functionalist ('hard'), interpretive ('soft') and critical (Table 3.2).

Table 3.2 Features of the three paradigms of systems thinking (Luckett, 2004)

	Functionalist	Interpretive	Critical
Ontological assumptions about systems and the world	A system exists in the real world as an objective entity which obeys laws that can be discovered through a scientific enquiry process.	A system is a subjective construct by an observer of a complex real world situation.	A system is a subjective construct by observers of a complex real world situation.
Purpose of the intervention	Improve the performance of a system.	Learning amongst participants in order to reach accommodations regarding improvement in a problematic situation.	Improvement towards environmental and social sustainability.
Derivation of the measures for improvement	Pre-determined.	Derived through a consensus building process involving all stakeholders in the problematic situation.	Based on the clarification of and commitment to social and environmental values.
Intervention process	Analysis of the relationship of system elements through the use of formal models of the system. These are either representative of the system or generic templates.	Facilitation of a systemic learning cycle involving stakeholders as determined by the client.	Critical reflection on the inquiry context as well as critical employment of methods in combination.
Intervention agent	Expert systems analyst.	Facilitator and participants.	Facilitator and participants.

Habermas' Knowledge Constitutive Interests[1] influenced the early development of typologies for systems-methodologies and formed the basis for the theoretical foundation of the three systems-thinking paradigms. Critical Systems Thinking (CST) emerged gradually from hard and soft systems thinking (Oliga, 1991) and developed in response to the awareness that there were no systems approaches for critical inquiry and intervention into problem situations characterized by asymmetry of power and resources (Maru and Woodford, 2001). The commitment to emancipation in systems thinking was 'a commitment to human beings and their potential for full development via free and equal participation in community with others' (Schecter, 1991).

At its emergence, CST had three characteristic commitments: emancipation; critical awareness and complementarism (Flood and Jackson, 1991), which through the development of CST, were replaced with: improvement, boundary critique and methodological pluralism respectively (Midgley, 1997; 2000). Methodological pluralism emerged as a result of those system thinkers that challenged the approaches of complementarism, where methods were locked into methodology, which in turn were locked into particular paradigms (Mingers and Gill, 1997; Midgley, 2000). In these approaches, the, the whole methodology had to be used as these approaches subscribed to the notion of paradigm incommensurability where 'paradigm could not speak unto paradigm' (Mingers and Gill, 1997; Midgley, 2000). Methodological pluralism increased the flexibility of critical systems thinking as the methods, models, tools and techniques were detached from the methodologies and could be used in isolation (Jackson, 1997; 2000; Midgley, 1997; 2000 Mingers and Gill, 1997).

CST, through its application as Critical Systems Practice (CSP) was used as a meta-methodology for the research in this thesis. Learning and improvement (Midgley, 2000), also referred to as emancipation (Jackson, 2000) are key aspects of CSP, which had four phases of application: 1. creative assessment of the 'problem situation', 2. choice of methodologies/methods, 3. implementation of methods and 4. reflection on the research/intervention process. These four phases of CSP resemble the learning cycle of Kolb (1984), which has the following four phases: diverging; assimilating; converging and accommodating. These similarities are relevant as systems methodologies are conceptualized as action research processes (Luckett, 2004).

To broaden the application of the methodology to research into sustainable subsistence-agriculture, I used the three levels for examining sustainability: field, homestead, and district. Appropriate methods were then selected for each of these levels and these are presented in section 3.4. I used CST for the research in this thesis, as it was appropriate for a number of reasons. Firstly, it was familiar to me, secondly, being improvement-orientated in principle it was an ideal methodology for inquiring into the subsistence agro-ecosystems of post-apartheid South Africa, in particular as participation is an inherently political process (Gray *et al.*, 1997). Thirdly, CST was appropriate for understanding the complex interaction of technical, social and institutional factors in each of the case studies and fourthly, it had a practical application as Critical Systems Practice (CSP) (Jackson, 2003). CSP has value for research into sustainable subsistence agriculture particularly as the original intention for its development was for use as an emancipatory (improvement) methodology. It is ideal for situations where system improvement is necessary, improvement in the sense of articulating a more favourable system outcome (e.g. increased crop production; natural resource management; wise use of wetlands). The methodology can be seen as a general problem-solving approach to human activity systems, and one that promotes the development of a learning system.

3.4 Case study research questions and methods

As each of the case study interventions varied, specific research questions were required to determine the sustainability of the development projects. These research questions, for each of the case studies, are given in Table 3.2 for The Valley of a

Thousand Hills case study, in Table 3.3 for The Mbongolwane Wetland case study, and in Table 3.4 for The Suid Bokkeveld case study.

Table 3.2 Details of the research questions at the three systems levels used to determine the sustainability of The Valley of a Thousand Hills case study intervention

Level	Research questions
Field	How sustainable are current agricultural practices in homestead gardens?
	Does the SPUP intervention make a significant contribution to the sustainability of agricultural production in homestead gardens?
Farm	Does homestead food-production make a contribution to the livelihood of the gardener?
	What roles do socio-economic and cultural factors play in household food production practices?
District	What impact do institutional factors have on household food production practices?
	Are the activities of the SPUP a reflection of its stated aims?

Table 3.3 Details of the research questions at the three systems levels used to determine the sustainability of the Mbongolwane case study intervention

Level	Research questions
Field	How sustainable is the harvesting of wetland plants for craft production?
	What roles do socio-economic and cultural factors play in the sustainable use of the wetland?
Farm	Does craft production make a significant contribution to the economy of the household?
	How compatible is craft production with socio-economic and cultural factors?
District	What factors in the craft initiative contribute to organizational development?
	What contribution does the strategic management of the intervention make to the sustainability of the intervention?

Table 3.4 Details of the research questions at the three systems levels used to determine the sustainability of the Suid Bokkeveld case study intervention

Level	Research questions
Field	How sustainable are current tea farming practices?
	What role do socio-economic and cultural factors play in the sustainable use of the fynbos biome?
Farm	Do tea production and sales make a significant contribution to the economy of the household?
	How compatible is tea production with socio-economic and cultural factors?
District	What factors in the Co-operative initiative contribute to organizational development?
	What contribution does the strategic management of the intervention make to sustainability?

Through the use of CSP, methods specific to each case study research question were selected for each of the levels investigated. A summary of the methods used for the research project and for the three case studies is presented in Figure 3.1 and shows the use of CSP as a meta-methodology, with appropriate sub-methods used for specific situations.

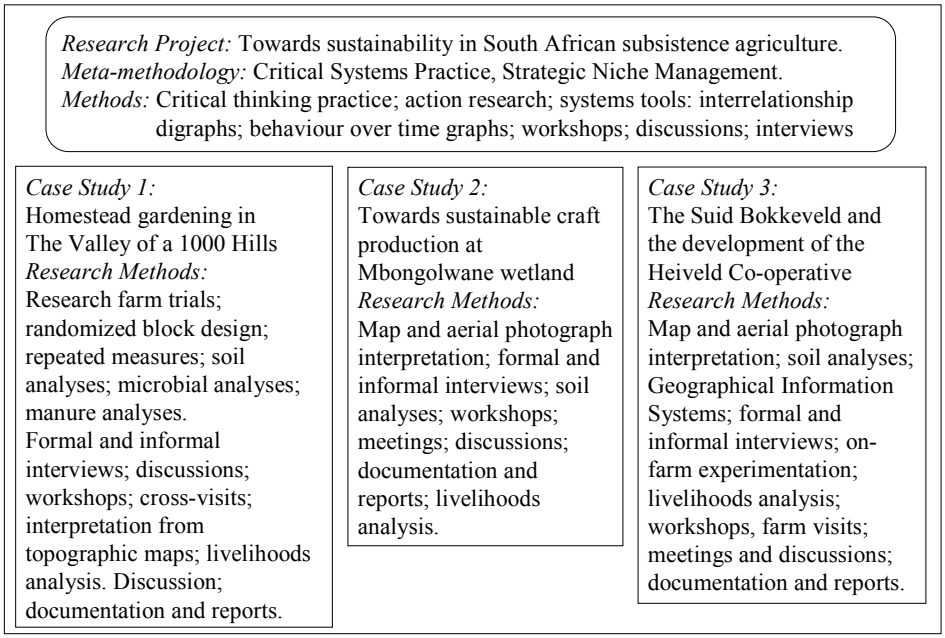

Figure 3.1 Research methods used for the research project and for each of the case studies

3.5 Journey itinerary

The research in this thesis took place at two sites in KwaZulu-Natal and one site in the Northern Cape province (see Figure 3.2). The first case study, presented in Chapter 4 is set in The Valley of a Thousand Hills in KwaZulu-Natal, north-west of Durban. Here the activities of a non-government organization, through their work with homestead gardeners in the Valley, are examined. The sustainability of the intervention is determined through an assessment of activities and outcomes at field, homestead and district level.

In Chapter 5, the second case study is presented and deals with the use of Mbongolwane wetland, which lies to the north-east of Durban. A variety of actors collaborated in the development project at Mbongolwane, which aimed to promote sustainable use and was grounded in local knowledge and traditional practices around the use of the wetland resources. The technical and institutional arrangements and activities within the project were considered to be novel in comparison to the accepted mode of agricultural development for the area.

The third case study, presented in Chapter 6 is set in the Suid Bokkeveld and concerns the development of an agricultural co-operative. This project was grounded in local knowledge and traditional practices of rooibos tea cultivation and the harvesting of wild tea. A variety of actors participated in the development programme that addressed agricultural development through means considered to be novel in the area.

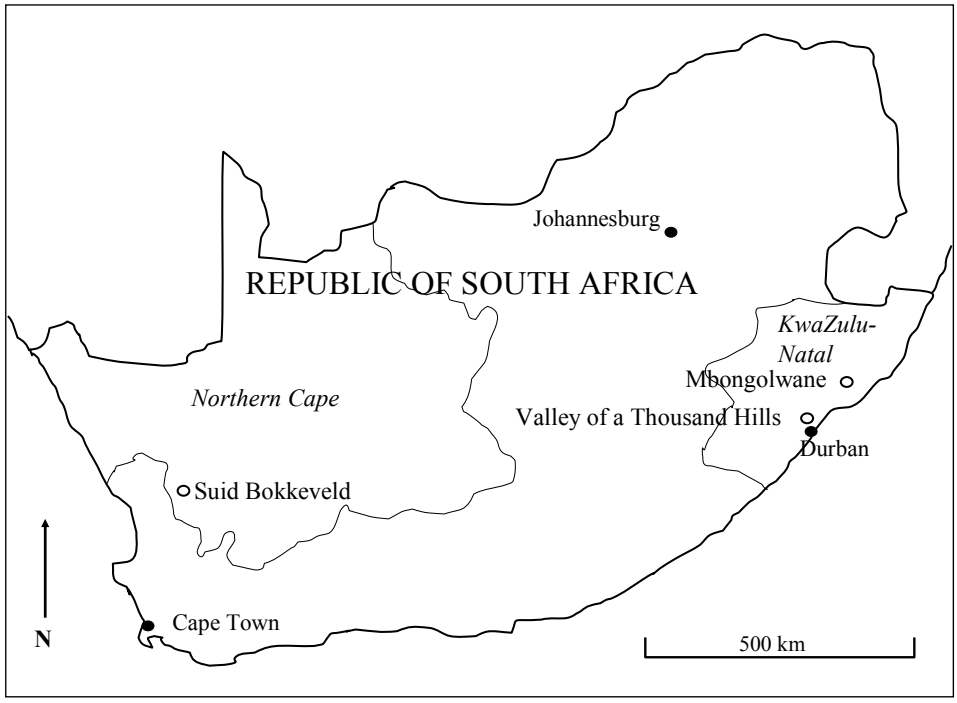

Figure 3.2 Map showing the location of the case studies in relation to the Northern Cape and KwaZulu-Natal provinces

In Chapter 7 the sustainability of the development projects at the levels examined for each of the case studies is discussed. This then leads to an assessment of the environmental, social, economic and institutional sustainability of the case studies. The practical lessons learned from the case studies, the key factors for success and the implications for sustainable agricultural development are discussed, drawing on the sustainability assessments. This is followed by a reflection on the research process and the chapter is concluded with a discussion on the contribution of the research to rural studies.

Endnote

[1] According to the theory of knowledge constitutive interests (Habermas 1984), the human drive to acquire knowledge (cognitive interest) is based on two 'quasi-transcendental' necessities for the existence of the human species: work and social interaction. The first results in the interest in technical control of the natural world and the second in communication or inter-subjective understanding. As communication is distorted by the exercise of power, humans have a third, derivative interest in freeing themselves from the effects of the exercise of power, and is known as the emancipatory interest.

Chapter 4: To the valley below
Homestead gardens in the Valley of a Thousand Hills

4.1 Introduction

Food security is the access by all people at all times to adequate, safe and nutritious food for a healthy and productive life. It depends on sufficient, efficient and sustainable food production, storage and access. Food insecurity is a major concern among a large proportion of the South African population with 30% of South Africa's population considered to be food insecure (Maunder, 2003). Poverty is the root of food insecurity in South Africa. Poverty in KwaZulu-Natal has been addressed in a number of different ways by various government and civil organizations, for example, the anti-poverty expenditure on a number of social security grants and subsidised health care. In terms of addressing poverty through food security, both government and civil organisations have given support to community gardens.

Increasing agricultural output and stimulating rural enterprises offer the most sustainable answers for widespread rural benefits and addressing food insecurity. The key to effective and sustainable food security is an understanding of the constraints and incentives facing actors in the rural economy and effecting change in production patterns, local consumption patterns, and rural livelihood strategies.

Homestead crop production in The Valley of a Thousand Hills, facilitated by the Social Plant-Use Programme (SPUP) of The Valley Trust was documented by this researcher over a period of almost four years (May 2000 – February 2004). The SPUP worked with the gardeners of the Valley of a Thousand Hills in an effort to improve household food security through increasing plant diversity and improving soil fertility. From the beginning of the research, I conceptualized the work of the SPUP with the Valley gardeners as a 'promising pocket', that is, a configuration of technical and institutional arrangements that were novel in the context of prevailing extension methods; and that held promise for sustainable development. Sustainability is the major theme of this chapter, and the concept is explored at a number of levels: field level, farm level and district level.

The sustainability of the development intervention was assessed through the following research questions:

Field level

- How sustainable are current agricultural practices in homestead gardens?
- Does the SPUP intervention make a significant contribution to the sustainability of agricultural production in homestead gardens?

Farm level

- Does food production in homestead gardens make a contribution to the livelihood of the gardener?
- What roles do socio-economic and cultural factors play in household food production practices?

District level

- Are the activities of the SPUP a reflection of its stated aims?
- What impact do institutional factors have on household food production practices?

In this chapter, the bio-physical and social settings of the Valley of a Thousand Hills are introduced; the three levels of research are then presented in turn, with the aims and objectives, methods, results and discussion given for each. The discussion of the chapter follows, and it explores the interaction of the technical, social and institutional arrangements of the case study and their impact on the homestead gardeners' livelihood strategies.

4.2 The Valley of a Thousand Hills

The Valley of a Thousand Hills, in the uMngeni River catchment lies to the north west of Durban (29°40'S; 30°20'E), a tourist city and sea-port on the eastern coast of The Republic of South Africa (see Figure 3.2). The Valley of a Thousand Hills, known locally as Dedangendlale Valley, was included in the former 'homeland' of *KwaZulu* (home of the Zulu people) and as a result, very little infrastructural development took place there during the apartheid years. Most of the valley is rugged with moderate to steep slopes but with gentle slopes in the valley bottom. The valley ranges from 450m to 660m above mean sea level and it is relatively dry with a mean annual rainfall of 595 to 830mm. The vegetation comprises semi-deciduous bush in the dry hot areas grading into grassland dominated by trees of the *Acacia* species. The area is classified as Coast Hinterland Thornveld and also contains areas of Valley Bushveld (Camp, 1995). The vegetation pattern has been altered by disturbance through grazing and cultivation and some areas have eroded to weathering rock (Roberts *et al.*, 2003).

The valley is relatively rural and there are areas that can only be reached on foot, although, due to urban sprawl in the region, the area is not deeply rural by African standards. Some wards in the valley tend towards peri-urban and in these areas many homesteads already have access to electricity and piped water (a ward is an area inhabited by a community that is overseen by an *Induna* (head man) under direction of a local *Nkhosi* (chief)). Most wards in the valley are linked to the surrounding commercial areas, situated on the edge of the valley, by a well-developed infrastructure of recently tarred roads. A number of steep, winding roads, serviced by busses and taxis, take the traffic in and out of the Valley. It is breathtaking to descend into the valley as the view extends down to and across the lake of the Inanda dam, to the hills on the other side. The Valley has a population of approximately 80 000 people, distributed in loosely clustered settlements over about 250 square kilometres, in five tribal areas. None of the settlements is sufficiently dense to be called a village (Friedman, 1993).

The area is peaceful but this has not always been so: a number of settled communities were relocated when the Inanda Dam was constructed; and towards the end of apartheid in the late 1980s, much violence erupted in the province between the African National Congress (ANC) and Inkhata Freedom Party (IFP) supporters. The deserted and burnt-down houses resulting from the conflict (Ncwane, 2001) can still be seen on the hills on the side of the lake opposite the research area.

4.2.1 Setting the Scene

The Valley Trust's SPUP was active with members of community gardens who were unable to purchase the required inputs recommended by the KwaZulu-Natal Department of Agriculture and Environmental Affairs (KZNDAEA) for vegetable production. These inputs included fertilizers and seedlings of improved vegetable varieties. Some of the community garden members also expressed interest in growing traditional crops and medicinal plants (Haigh, 1996), which were seldom grown in the community gardens. Traditional crops and varieties that are suited to the local climate of the valley produce an adequate yield and provide seed for the following season.

The SPUP decided that individuality and associated innovation in low-external-input agriculture technologies would not flourish in the community garden setting due to the high conformity of practice within the gardens (Haigh, 1996; see Chapter 2). The SPUP facilitators also found that it was difficult to promote organic methods of production in the community garden setting as the KZNDAEA extension officers also assisted the gardeners, but promoted the use of hybrid varieties, fertilizers and pesticides. And, the community gardeners, not wanting to lose the infrastructural support of the KZNDAEA, conformed to their rules of practice (Mbelu, 2001). Another motivating factor for the SPUP moving their outreach focus to homestead gardens was that some rules within the community gardens excluded certain members from participating. Those gardeners excluded from the community gardens, for whatever reason, worked in their homestead gardens. The SPUP encouraged homestead gardeners to interact with each other and to form informal groups that could be assisted by facilitators from the SPUP. The first homestead garden group was established at Ngcolosi and the second group at Qadi. The first objective of these gardeners was to improve the fertility of the soil with the intention of increasing crop yield to enhance household food security. Animal manure was used for soil fertility management, as the animals are kraaled during the night and accumulated manure is collected from the kraal and used in the garden.

Livestock keeping is common in Zulu culture; animals provide meat, milk and a continuous supply of manure. Cattle and goats are put out to graze on communal pasture land and kraaled at the homestead at night. During the dry winter months very little grazing is available and cattle are commonly fed on maize stover during this time (maize stover is the leaves and stalks that remain after harvest). The bio-physical constraints to production were identified by the gardeners, facilitators and researcher through gardener-group workshops and included: inadequate fencing; low soil fertility; unavailability of water; weed pressure; and pests and plant diseases.

4.2.2 The Social Plant-Use Programme: 2000-2004

In 1952, a medical doctor, Halley Stott (1911-2004), established a clinic, a non-government organization, The Valley Trust (TVT) at Botha's Hill, on the edge of the Valley. Initially it was a primary health care facility, an intervention in the area to promote good health among the Valley people. He found that the cases of poor health treated at the clinic were exacerbated by nutritional deficiencies. As a result, the vision of the organization was broadened to address household food production. At the time the clinic was established, the Valley represented some of the most eroded and unproductive areas in the country where financial resources of the people were

extremely limited (Stott, 1976). Besides the clinic, which now has government assistance, welfare services, a feeding scheme, home-based occupational therapy and sustainable food production were progressively provided.

The SPUP aimed to assist gardeners in overcoming constraints to food production through creating opportunities for people to learn from each other and become proactive and inventive in problem solving. Its main aim was: *to influence the way in which people realise their potential and utilise the resources they have to improve their lives and self-reliance* (Anonymous, 2000b). They subscribed to low external-input sustainable agriculture (LEISA) principles based on individuals and groups using their existing capacities and resources.

The SPUP had the following objectives:

- to empower families to enhance their opportunities for household food security, focusing on: cropping; vegetable and fruit production; small-livestock husbandry and food processing in a way that people can take control in finding solutions to their problems and realize their potential and
- to empower families to utilise their land productively and sustainably through land-use planning and resource management in a way that is innovative and appropriate to peoples' situations leading to more options for a better life (Anonymous, 2000b).

In 1996 when, through a provincial community garden survey, I first worked with SPUP, they were a small and cohesive department. The SPUP was part of the larger Integrated Technology Department of The Valley Trust. The SPUP group consisted of a manager and a number of facilitators whose roles included: teaching sustainable agriculture; group work facilitation; fieldwork and outreach. The activities of the programme included work in community gardens; two homestead garden pilot projects; a course in sustainable agriculture; maintaining a training garden and establishing a seed exchange and storage facility.

The SPUP group initially worked with members of community gardens but later decided to work at a homestead garden level instead. It was important politically for the SPUP to work with people initially in community gardens. It is a cultural prerequisite that anybody wishing to engage with members of a community should first alert the *Induna* (head man) of the area of their intentions and request a meeting with the *Induna* and then if necessary, with the *Nkhosi* (chief). The SPUP members first received permission from the *Nkhosi* via the *Induna* to work in community gardens, and once their work had become known in the community, they requested permission to undertake the homestead garden pilot projects.

These pilot projects were essential for the development of capacity within the SPUP, as through the development of the pilot projects, the facilitators became more aware of the complexities and challenges of working in a homestead land-use context. This was during 1998 and 1999, and I worked with SPUP and the pilot project gardeners. The aim of the work with the SPUP was to establish trials with a gardener from one of the homestead garden pilot projects at Ngcolosi. Late blight (causative organism: *Phytophthora infestans*) on tomato was very problematic during the humid summer months in the valley, and the gardener concerned was eager to put a number

of potential control methods to the test. The SPUP began working with this gardener as she was considered to be skilled and insightful.

In April 2000, the second four-year funding phase of the SPUP began, coinciding with the beginning of my own four-year Nederlandse Organisatie voor Wetenschappelijk Onderzoek-funded research project and fortuitously, providing another opportunity for me to work with the SPUP and the gardeners of the Valley of a Thousand Hills. The second phase of the SPUP was jointly conceptualized and documented by the programme manager and field workers, thereby initiating participatory processes at the programme level. The processes, procedures and overall focus of the programme that emerged were the result of the evaluation of the process and management of the first SPUP. In particular, a deeper and more frequent reflection on fieldwork and lessons to be learned was to be undertaken in the second phase of the SPUP. To transform a programme through reflection on its predecessor and embracing the lessons to be learned was an enormous task, and the SPUP staff readily admitted that: '*to develop these processes in a participatory way had taken considerable time and energy*' (Haigh *et al.*, 2000).

The evolution of the SPUP as an organization had much to do with the structure of the funding. As only 20% of the core funding was granted by TVT, the rest of the money had to be raised from project funding. Most international aid agencies funded projects for four years, thus non-government development organizations tended to work on four-year project-funding cycles. Often the agencies would provide funding only if the project conformed to specific criteria such as using participatory methodologies when working with the rural poor and promoting sustainable land-use practices. The decision to work at homestead level came from reflection on the work within the community gardens and pilot projects, funding-driven organizational evolution and the normative ideology in post-apartheid South Africa of assisting the rural poor.

At the beginning of the second phase, the SPUP had extended its work through developing learning groups and it had established working relations with gardeners in two other wards (Mgoqozi and Mabedlane) within the Valley. This made a total of four wards where it was active in homestead gardening. Interaction within and between the four groups was facilitated by the SPUP. The basis of this interaction was an interest in low-input agriculture. All the groups had an established and active gardener that assisted the other gardeners with advice, seeds and plants. The SPUP facilitated the gardener-to-gardener learning activities, promoted an ecological approach to production, empowered gardeners with skills to increase production and assisted with the acquisition of plants, seeds and animals.

4.3 State of the earth: homestead crop production

When I started the research for this chapter, the gardeners, with the SPUP facilitators had identified soil fertility management as a key aspect of crop production, and thus soil fertility management was one of the key issues to be addressed at field level. Another issue to be addressed at field level was the diversity of the crop production system. The two aims of the research at field level were: to determine the sustainability of current homestead crop production through investigating plant-use and soil fertility management, and secondly, to determine if the SPUP intervention

made a significant contribution to the sustainability of agricultural production in homestead gardens. Field trials were conducted at the research farm of the University of KwaZulu-Natal to determine, in part, the sustainability of gardeners' practices and to asses a number of interventions for soil fertility improvement, including that proposed by the SPUP.

There were a number of reasons for conducting the research at the research farm. Firstly, the initial proposal for the research project stated that the research would be researcher-driven and that technologies would be developed at the research farm and then be introduced to the gardeners (this is explained further in the **Prologue**). The trials were also used for educational purposes. Students and staff from the Centre for Rural Development Systems (CERDES) visited the site to learn about medicinal plants and to discuss homestead gardening practices represented by the treatments of the trial. Secondly, for my own purposes, it was simpler to conduct the research at the research farm as there were fewer variables at the trial site, than in the homestead gardens. The third reason why the trials were conducted at the research farm was that the SPUP requested that the soil-fertility improvement recommendations supplied by the KZNDAEA (based on the gardeners' soil test results), not be introduced to the gardeners in their homestead gardens. I was very interested in testing the effect of these recommendations on crop yield and the macronutrient status of the soil. The treatments for the trials represent the heterogeneity of the techniques and resources used by gardeners for soil-fertility management in homestead gardens (see Plates 1.and 2.).

The treatments are the key linking the research to the Valley. It is recognised that the trials should have been conducted in the homestead gardens, in keeping with the philosophy of the development approach.

In farming systems, soil fertility is not the outcome of just chemical, physical and biological factors, but is the result also of human action. As Sonneveld (2004) has demonstrated, soil forms are determined by the interaction between man and nature. Thus soil quality can be conceptualized as being a socio-technical configuration (Moors *et al.*, 2004; Roep and Wiskerke, 2004). Similarly, the crop diversity of a homestead garden is also determined by the interaction between man and nature and can also be conceptualized as being a socio-technical configuration.

The socio-technical configuration of the phenomenon of crop diversity in the homestead gardens was recorded and the plant-use practised by the gardeners was documented, in particular the contribution of the plants to the livelihoods of the gardeners. In this way, the sustainability of current homestead crop production would be investigated from a number of aspects; and the links between homestead crop production and the livelihoods of the gardeners could be identified.

4.3.1 Down to earth: plant-use and soil fertility

The methods that I used to conduct research into homestead crop production were two-fold. Firstly I present the methods used by the SPUP, as I participated in the fieldwork explorations with the gardener groups according to the participatory development and sustainable agriculture approaches used by the SPUP. Secondly, I present the methods that I used to research homestead gardening practices and the role of crop diversity in the sustainability of homestead gardens.

The SPUP used the Participatory Extension Approach (PEA) promoted by the Department For International Development (DFID) for fieldwork exploration with gardeners, as its exchange with gardeners was based on mutual interest in sustainable agriculture and a commitment to mutual learning through participation. The PEA is presented graphically in Figure 4.1 and the phases are given here: [1] mobilizing members of the community; [2] planning and implementing activities together with the community; [3] experimenting and [4] monitoring the process through sharing experiences and [5] self-evaluation.

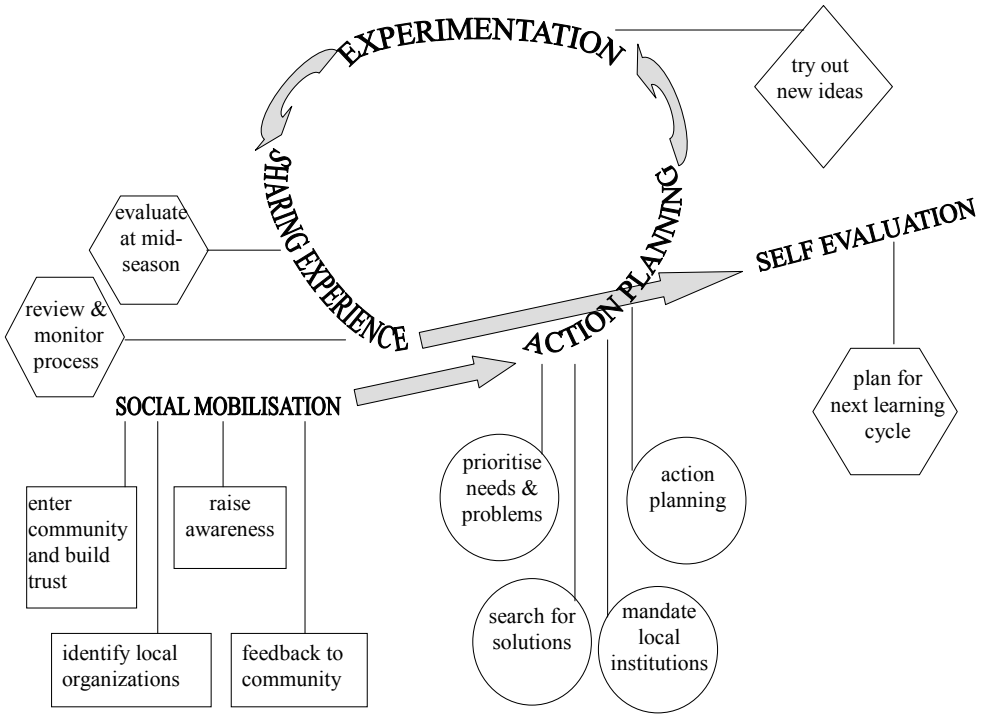

Figure 4.1 The five progressive stages of the Participatory Extension Approach

Through these phases, gardeners were given a central role in shaping and driving the process, being asked to identify their problems and develop and test a range of solutions to these problems (Ramaru *et al.*, 2000). The development of local organizations is seen as a key element of PEA. Learning is seen as another key element, and it was intended to be mutual through active participation. The PEA was used in conjunction with a Low External-Input Sustainable Agriculture (LEISA) approach (Reijntjes *et al.*, 1992), the principles of which were shared with gardeners through discussion, hands-on experience and demonstration. There were five identifiable stages of technical and conceptual awareness of LEISA introduced to the gardeners during the group meetings:

1. Introductory concepts: soil fertility, plant production, crop diversity and seed saving.
2. Land-use as a system: erosion control, pest management and biodiversity.
3. Seasonal land-use: planning, implementing and evaluation.
4. Food throughout the year: planning, implementing and evaluation.
5. Marketing.

A SPUP fieldworker facilitated the PEA and LEISA phases, and the fieldworker translated gardener responses into English from Zulu for my benefit. I manually recorded all interactions and reflection of these interactions. The crops cultivated and manure usage by Valley gardeners were documented for each of the 30 gardeners, at five stages during the research project:

1. at the action planning phase;
2. after the experimentation phase;
3. at the end-of-season evaluation;
4. at the self evaluation and second planning-phase and
5. after the second experimentation-phase, at the second end-of-season-evaluation.

The cropping activities of the gardeners were documented during homestead-garden visits, over a four-year period. In this way the cropping practices at the field level were captured. The final assessment of the number of plant-types cultivated was conducted during the second end-of-season-evaluation which coincided with the end-of-project-evaluation.

The work of the SPUP with Valley gardeners was a pocket of promising activity: working with gardeners on their own land to address the technical challenges of crop production, through sustainable development.

4.3.2 Crop production in homestead gardens

A great variety of vegetables and other plants are cultivated in homestead gardens. Each of the plant types cultivated contributes towards the livelihoods of the gardeners, through providing food security, soil erosion control, animal fodder or soil fertility improvement.

4.3.2.a Vegetables, fruit, herbs and craft plants

In summer, a field near the homestead is planted to maize which is usually inter-cropped with beans and pumpkins or with groundnuts. The area planted to these crops varies from 0.2 to 2 hectares. Smaller gardens are used for the cultivation of vegetables, some of which are grown in the summer months, but most are grown in abundance in autumn and winter. Home consumption was the primary reason all gardeners gave for cultivation, and 43% of gardeners sold surplus produce not consumed by the household.

There is always something in the garden that we can eat with our phutu (phutu is a staple food prepared from ground maize*).*

We eat from the garden first and if there is anything extra, then I will sell it.

This garden helps to feed 15 people, most of them are children.

A number of crops have been cultivated by the Zulu people for many decades and for the purpose of this study have been classified as 'traditional'. There were 12 such crops cultivated by gardeners in the Valley: maize (*Zea mays* L.); dry beans (*Phaseolus vulgaris* L.); pumpkins (*Cucurbita spp.* L.); sweet potatoes (*Ipomea batatas* Poir.); groundnuts (*Arachis hypogea* L.); pigeon peas (*Cajanus cajan* L.); *Imifino* [wild spinach] (*Amaranthus spp.* L.); cow peas (*Vigna unguiculata* L. *Walp.*); madumbes (taro) (*Colocasia esculenta* (L.) Schott.); calabash (*Cucurbita spp.* L.); sorghum (*Sorghum bicolor* L.); millet (*Pennisetum glaucum* (L.) *R. Br.*); and jugo beans (*Vigna subterranea* L.).

The relative percentage of gardeners cultivating each of these crops at the time of the study is presented in Table 4.1. Only one gardener cultivated calabash, sorghum and millet, she was the oldest gardener in her group and had been involved with the Valley Trust from when it started in the 1950s.

Table 4.1 Traditional crops grown by Dedangendlale Valley gardeners, given as percentage of gardeners growing the crop

traditional crop	grown by % gardeners	traditional crop	grown by % gardeners
maize	100	cowpeas	13
drybeans	77	calabash	10
sweet potatoes	63	madumbe	7
groundnuts	33	sorghum	3
amaranthus	17	millet	3
pigeonpea	17	jugobeans	3

Growing traditional crops enhances food security, as traditional crops are adapted to the local conditions, they more drought-tolerant and are better adapted to low levels of available nutrients in the soil than many introduced crop varieties.

I do not add much manure for the groundnuts, they always give a good yield.

In total, twelve traditional crop types were cultivated by gardeners in the four wards of the Valley (Table 4.2). The mean, median and mode values are given for each ward as, due to the small sample size within each of the wards, the data are not normally distributed.

Table 4.2 Minimum and maximum, mean, median and mode of traditional crops grown by homestead gardeners in four wards of Dedangendlale Valley

Ward/ Number of traditional crops grown	*Mabedlane* (n=9)	*Mgoqozi* (n=9)	*Qadi* (n=6)	*Ngcolosi* (n=6)	*Cumulative total (n=30)*
maximum	6	6	6	9	12
minimum	2	1	2	2	-
mean (average)	3.9	3.2	3.2	3.5	-
median (middle)	3.5	3	3	2.5	-
mode (most common)	3	4	3	2	-

Introduced vegetables grown by the Valley gardeners included: Swiss chard (*Beta vulgaris* L.); onions (*Allium cepa* L.); cabbage (*Brassica oleracea* L.); beans (*Phaseolus vulgaris* L.); tomatoes (*Lycopersicon esculentum* (L.) Karst.); carrots (*Daucus carota* L.); chillies (*Capsicum annuum* L.); potatoes (*Solanum tuberosum* L.); beetroot (*Beta vulgaris* L.); brinjals/eggplant (*Solanum melongena* L.); kale (*Brassica sp.*); peppers (*Capsicum sp.*); lettuce (*Latuca sativa* L.); peas (*Pisum sativum* L.); leeks (*Allium porrum*); butternut (*Cucurbita sp.* L.); cassava (*Manihot esculenta* Crantz); fennel (*Foeniculum vulgare* L.); tiny beans (unidentified). Many of these vegetables were cultivated throughout the year as frost was neither severe nor frequent in the winter months.

Throughout the project, gardeners stated that the major problem with cultivating tomatoes was the occurrence of disease (late blight c.o. *Phytophthora infestans*). Despite the obvious constraint, 73% of gardeners continued to successfully cultivate tomatoes, the fifth most commonly cultivated vegetable (Table 4.3).

Table 4.3 The ten most common introduced vegetables grown by Dedangendlale Valley gardeners, given as percentage of gardeners growing the vegetable.

vegetable	grown by % gardeners	vegetable	grown by % gardeners
cabbages	97	carrots	70
Swiss chard	90	pumpkin	63
beans	83	potato	53
onions	80	chilli	53
tomatoes	73	beetroot	50

A total of nineteen different types of introduced vegetable crops were cultivated by the gardeners (Table 4.4). In all wards, at least one type of introduced vegetable was grown that was not grown in any of the other wards.

Table 4.4 Minimum and maximum, mean, median and mode of introduced vegetable crops grown by homestead gardeners in four wards of Dedangendlale Valley

Ward/ Number of vegetables grown	*Mabedlane* (n=9)	*Mgoqozi* (n=9)	*Qadi* (n=6)	*Ngcolosi* (n=6)	Cumulative total (n=30)
maximum	11	13	12	13	19
minimum	6	1	8	3	-
mean	8.6	6.4	9.3	9.2	-
median	8	7	9	10.5	-
mode	10	7	9	13	-

Fruit

Valley gardeners grew a total of thirteen different fruit types which included: banana (*Musa spp.*); peach (*Prunus persica*); citrus (Rutaceae); papaya (*Carica papaya*); mango (*Mangifera indica*); guava (*Psidium guajava*); cherry guava (*Psidium littorale* var. *longipes*) avocado (*Persea americana*); granadilla (*Passiflora edulis*); tree tomato (*Cyphomandra betacea*); apple (*Malus domestica*); pineapple (*Ananas comosus*) and grapes (*Vitis vinifera*). The fruit types grown by gardeners, given as the percentage of gardeners growing the fruit is presented in Table 4.5.

As Dedangendlale Valley falls into a subtropical region, it was not surprising that bananas were the most frequently cultivated fruit type. They are also easy to propagate as they grow from subterranean suckers that can readily be removed from the mother plant, and these suckers enjoy a high transplant success rate (see Plate 3.). Once a plant has been successfully established, it needs little maintenance and will bear fruit for many years. Papaya is also classified as a subtropical fruit, but the seeds need to be scarified (the seed coat must be perforated for germination to occur) and this may account for the lower frequency of cultivation of papaya by gardeners.

Table 4.5 Fruit types grown by Dedangendlale Valley gardeners, given as percentage of gardeners growing the fruit

fruit	grown by % gardeners	fruit	grown by % gardeners
bananas	83	apples	10
peaches	37	avocados	10
citrus	33	tree tomatoes	10
papayas	23	pineapples	7
mangoes	23	cherry guavas	3
granadillas	13	grapes	3
guavas	13		

Gardeners generally saw fruit production as being an addition to the cropping system and only for home consumption. Some gardeners (23%) saw fruit trees as an unwelcome intrusion in the garden, taking up space and light that could be used for the

production of vegetable crops. All gardeners who made this statement had small, steep gardens.

Table 4.6 Minimum and maximum, mean, median and mode of fruit types grown by homestead gardeners in 4 wards of Dedangendlale Valley

Ward/ Number of fruit types grown	*Mabedlane* (n=9)	*Mgoqozi* (n=9)	*Qadi* (n=6)	*Ngcolosi* (n=6)	Cumulative total (n=30)
maximum	6	10	5	10	13
minimum	1	0	1	1	-
mean	3.22	2	2.2	3.5	-
median	3	1	1.5	2.5	-
mode	2	1	1	3	-

However, in Ngcolosi, a gardener had a long-term plan for establishing a mango orchard; she was hoping to sell her mangoes locally. Her soil fertility management strategy was very interesting. In the area she identified for the orchard, she planted a legume-maize intercrop in the first year. When weeding this area, she would place the removed weeds and any other available organic matter into holes where she intended to plant the trees. The organic matter would accumulate over a period of up to three years.

During this time she planted crops in the area around the holes, including a green manure crop (sunnhemp) and other legumes (dry beans, cow peas and groundnuts) with maize. She used this crop rotation system as a means of improving the fertility of the soil for tree planting. In a shady area in her garden she established mango seedlings, grown from the seeds of mangoes that she and her family had enjoyed. Over a period of three years, I saw the orchard take shape from the composting holes to mango trees up to two metres high.

> *I enjoy fruit, it makes you healthy and it tastes good, I want to grow mangoes for selling locally. Also, it is better to have trees, then you do not have to plant every season, I am getting too old to work in the garden the whole day.*

Herbs

Gardeners cultivated three herb species, namely: comfrey (*Symphytum uplandicum*); cannabis (*Cannabis sativa*) and lemon grass (*Cymbopogon sp*.) (Table 4.7). Comfrey was introduced by the SPUP for making liquid manure. Liquid manure is used as a soil conditioner and pest control agent: a variety of plant matter is fermented with other available ingredients (animal manure, bone meal, milk) for up to three weeks, strained and diluted then applied directly to the soil or sprayed on the foliage. Comfrey is an herbaceous perennial plant, which is a useful companion plant (enhances the growth of neighbouring plants) and is also widely recognized as a soil conditioner and activator for compost heaps (Schnabel, 1992). Comfrey has medicinal qualities and can be used for humans and animals to help repair fractures and promote the healing of sprains. The leaves of comfrey are an excellent source of potassium and

contain up to 6% K on a dry-matter basis (Schnabel, 1992). Only two of the gardeners regularly made and used liquid manure, despite the fact that ten gardeners grew comfrey.

Table 4.7 Herbs grown by Dedangendlale Valley gardeners, given as percentage of gardeners growing the herb

herb	grown by % gardeners
comfrey	30
cannabis	23
lemongrass	17

In the Valley, cannabis (*nsangu)* is used as a recreational drug, for traditional ceremonies (by men) and as a tea to ease asthma (Jali, 2000). It is illegal to grow, sell and/or consume cannabis in South Africa. It is however, a valuable plant for improving soil fertility as it has a deep root system. The deep root system of a plant is said to draw nutrients, in particular much-needed phosphorus, towards the surface, making them more accessible to other plants (Hillhorst *et al.*, 2000). Gardeners cultivated the cannabis in the vegetable garden, so any nutrients drawn up became available to the vegetable crops. Gardeners were not aware of the reason for the beneficial effect of the plant on soil fertility, but they did notice its effect:

> *The garden is doing much better in the areas where it grows. I think it helps the soil, look how soft and healthy the soil looks over there.*

The lemon grass grown was used as a tea. All the gardeners that grew it suffered from high blood pressure and were advised not to consume Ceylon tea, and they used the lemon grass as a tasty substitute.

> *The nursing sister at the clinic said I should not drink tea, but rather rooibos or herbal tea, I like lemon grass tea.*

Craft Plants

The use of craft plants was diminishing as only older women still had the skills for weaving. Those that did still use craft plants complained that they no longer had the time for craft making. In terms of soil nutrient management, craft plants do not utilize great quantities of soil nutrients nor do they contribute to nutrient generation through N fixation. They can however play an important role in soil conservation: the spreading root system is ideal for holding soil and the dense, robust stems reduce the velocity of surface water flow (Kotze, 2001a). None of the gardeners used the craft plants for any other purpose than for craft making. Of the two types of craft plants grown, the most common Udolo (*Cyperus textilis*) was grown by eleven gardeners and Imizi (*Cyperus sexangularis*) was grown by only four of the gardeners.

I used to make all my own woven trays (isithebe) and sleeping mats (icansi), I made the one that you are sitting on, but now, there is no time and the young girls are not interested in learning the old ways.

*Only Gogo (*Granny*) still weaves, she makes beer strainers (amavovo), she is too old to do anything around the house, and she makes some money for herself by selling her crafts.*

4.3.2.b Soil fertility management and erosion control

Soil quality is considered a key indicator in ecosystem sustainability. Maintaining good soil quality is an integral part of sustainable agriculture. At the research farm trends in inorganic cations (potassium and ammonium), inorganic anions (phosphate and nitrate) and soil organic matter were examined in the context of subsistence gardeners' soil fertility management systems. The trials also served to test a number of soil fertility improvement interventions. The results of the trials are presented in detail in **Appendix A**. There was considerable variation in the inherent soil quality of the various wards, which is attributed to both the nature of the parent material and its associated soil forms, and the different soil fertility management practices of the gardeners.

Table 4.8 Land capability factors (means) for the four wards in Dedangendlale Valley

Ward	Soil Type[a] (FAO classification)	Erodibility index[b]	Landform setting	Slope[c] (%)	Erosion hazard[d]
Ngcolosi	Hutton (Cambisol)	5.5	bottomland/ midslope	13.6	low
Qadi	Glenrosa (Ochric cambisol)	4.0	midslope/ upperslope	19.8	moderate
Mgoqozi	Oakleaf/Vilafontes (Eutric cambisol/ Glossic Luvisol)	3.5/3.0	upperslope/ scarp slope	35.9	high
Mabedlane	Oakleaf/Vilafontes	3.5/3.0	upperslope/ scarp slope	41.3	high

[a] South African Binomial Soil Classification System (MacVicar *et al.*, 1977).
[b] Basic erodibility indices calculated for South African soils, where a lower value implies high erodibility (Anonymous, 1976).
[c] Mean slope = ((total contour crossings X contour interval (m) X k)/ total grid length) X 100; where contour interval is 20 metres and k (factor) is 1.57 (Ammann and Lindley-Stone, 1991).
[d] Based on the joint consideration of Slope and Erodibility (Anonymous, 1976).

Ngcolosi, one of the pilot projects where the SPUP first worked with gardeners, had the highest inherent soil quality for cropping, owing to the gentlest slopes and the lowest erodibility of the four wards (Table 4.8). Qadi, the second pilot project, had the second highest inherent soil fertility for cropping of the four wards. Mgoqozi had the second lowest inherent soil fertility and Mabedlane the lowest, owing to the steep slopes and the soil types occurring in these two wards. There was also a great

variability in soil fertility within and between the homestead gardens, as show by the results of soil sampling and testing, presented in Table 4.9.

The concept of soil sampling was introduced to all the gardeners through gardener-group meetings in each of the wards during the soil fertility discussions. Gardeners were told that the sampling and analysis would reveal the soil fertility status, and also of what benefit it would be for future soil fertility management decisions. Gardeners then selected areas for sampling within their gardens and maize fields, giving reasons for their choices (see Plate 4.). Sample numbers per farmer varied from one to twelve, depending on the size of the land and the number of soil fertility management practices. All gardeners selected areas that they perceived to have low fertility, and many also selected good areas as a means of comparison of the test results. The results of the analyses of the areas chosen by the gardeners are presented in Table 4.9. Soil texture, crop health and crop yield were the criteria used to assess soil fertility. The areas perceived by gardeners to be of low fertility had lower P, lower K and lower organic matter content compared to the areas gardeners perceived to be of higher or acceptable soil fertility (Table 4.9, Roberts *et al.*, 2003).

These results also correspond to findings of a soil fertility management programme in Kenya where the results of investigating soil fertility issues with gardeners, through mapping and transect walks, showed significant correlations between the perceptions and indicators of soil fertility used by gardeners and researchers (Onduru *et al.*, 1998). Similar finding were reported by Corbeels *et al.*, (2000) in Tigray province of Ethiopia, and by Kanté and Defoer (1994) in Mali.

Typically, gardeners spend more time and effort on increasing soil fertility in the areas used for vegetable production than in the areas where maize (staple cereal) is grown. Roberts *et al.* (2003) reported on the Valley soils and also showed similar findings in another, climatically diverse, area in KwaZulu-Natal. Gardeners' soil fertility management was highly spatially differentiated with different sites receiving different levels of inputs and attention.

For most of the gardeners, P was found to be a limiting factor for increased crop production. For KwaZulu-Natal soils, the crop threshold value (for adequate production) for adjusted soil P is estimated at 27mg/L for vegetables such as tomato and cabbage (Roberts *et al*., 2003). Adjusted soil P (Adj-P) is used for comparison of P levels between soils. Adjusted-P is the AMBIC-2 extractable P transformed to allow comparison with crop requirements. Recommended levels of AMBIC-P for a particular crop vary with soil texture which is estimated using sample density. When the AMBIC-P is transformed using the formula: Adj-P = AMBIC-P X 12/(40 X sample density - 28), then Adj-P can be compared to the threshold value for a crop (Manson, 1995).

Table 4.9 Results of the analysis of homestead garden soils in Dedangendlale Valley, giving soil phosphorus, potassium, pH, organic C, and total cations of good and poor areas for all gardens areas for all gardens

Ward	Phosphorus* (mg/L)		Potassium* (mg/L)		pH (KCl)		Organic C %		TotalCations** $cmol_c/L$	
Ngcolosi (n=6)	good	poor	good	poor	good	poor	good	poor	good	poor
mean	54	14	576	327	6.12	5.47	2.4	2.1	10.5	8.01
median	65	3	615	355	6.49	5.24	2.5	2.2	9.6	7.81
mean all	29		451		5.71		2.2		9.98	
median	6		379		5.50		2.3		9.73	
highest	140		910		6.98		3.3		14.29	
lowest	1		113		4.84		1.5		5.10	
Qadi (n=6)	good	poor	good	poor	good	poor	good	poor	good	poor
mean	29	14	332	251	5.59	5.21	3.3	3.0	8.75	7.74
median	17	8	303	241	5.67	5.02	3.5	3.0	8.29	7.56
mean all	21		285		5.47		3.2		8.56	
median	11		257		5.59		3.2		8.05	
highest	83		546		6.68		4.5		14.60	
lowest	2		169		4.36		1.9		4.26	
Mgoqozi (n=9)	good	poor	good	poor	good	poor	good	poor	good	poor
mean	24	7	452	294	5.49	4.81	3.0	2.7	9.48	8.22
median	18	8	375	203	5.34	4.85	2.8	2.6	9.29	7.95
mean	15		375		5.16		2.9		8.78	
median	10		339		4.94		2.7		8.9	
highest	64		1175		7.13		3.5		13.83	
lowest	1		139		4.28		1.8		6.34	
Mabedlane (n=9)	good	poor	good	poor	good	poor	good	poor	good	poor
mean	18	6	476	331	5.46	4.93	3.0	2.7	11.37	8.56
median	9	3	424	283	5.13	4.73	3.1	2.9	10.08	9.54
mean	13		440		5.30		2.9		10.53	
median	8		364		5.03		3		9.78	
highest	57		855		7.22		4.2		23.25	
lowest	1		145		4.16		1.2		5.49	
All wards (n=30)										
mean	21		396		5.45		2.74		9.53	
median	9		325		5.29		2.6		9.09	
mode	3		599		5.08		2.5		9.07	
std dev	26.75		223.55		0.817		0.728		3.015	

* The results for soil potassium (K) and phosphorus (P) changes are presented here volumetrically, because: 1. the FERTREC laboratory analyse soil samples on a volumetric basis and present the results based on volume (mg/L). 2. the presentation of the results based on volume, circumvents the complexity of variable soil-density which can present difficulties data are presented based on mass. 3. the presentation of the results based on volume, makes for an easier comparison with the manure analyses data.

**Total cations can be regarded as being equivalent to the effective cation exchange capacity (ECEC) of the soil where: total cations = Ca/200.4 + Mg/121.5 + K/391 + Exch. Acidity.

Using the median for all wards (9mg/L AMBIC-P) the Adj-P value is 7.94 mg/L for the median soil density of 1.04 g/ml. This means that the soil P in most gardens falls below the threshold value for vegetables (Adj-P: 27mg/L; AMBIC P: 30.6 mg/L), as the mean AMBIC-P for homestead gardens is 21mg/L and the median 9mg/L. In addition, given that there at least two cropping seasons per year in homestead gardens, at the gardener's median manure-application rate, over time the available soil P is likely to be depleted. This means that in most cases, the soil P in homestead gardens in the Valley is potentially limiting for adequate crop growth

Gardeners in the Valley were aware that declining soil fertility of soil could also be caused by soil erosion.

> *This area is very poor, see how the water washes the soil down this slope? There cannot be much for the plants here, the maize is always small and the beans do not yield well.*

The awareness by gardeners that soil erosion was an important contributor to soil fertility decline was further reflected by the fact that most gardeners in the more erosion-prone areas adopted the soil erosion control measures proposed by the SPUP (see *Erosion Control*).

Animal Manure

Most gardeners in the four wards kept some livestock, usually cattle, goats, chickens or ducks. To increase livestock-keeping by the gardeners, the SPUP facilitators introduced a system by which they supplied gardeners with animals, usually chickens, ducks or goats and when the animal had produced offspring, these were returned to the SPUP as 'payment' for the original animal. This meant that gardeners who could not buy animals would still be able to increase their animal production capacity. Practically, the system was not very efficient as over four years, from the eleven animals supplied by the SPUP, only two offspring were returned.

Kraal manure was used for maize production by twenty of the gardeners. They practised precision placement, whereby manure was added to the seed hole at planting and not broadcast over the entire field. They said that this reduced the amount of manure that had to be transported to the field, and the plant could make better use of the nutrients supplied. In some cases manure was only used every second year. Maize has a relatively low nutrient requirement compared for example to vegetable crops (Allemann and Young, 1993), so using manure every second season will not provide a maximum yield but could still allow for a good yield (approx 3t/ha of maize grain and an estimated 2t/ha of green maize).

By comparison, soil improvement strategies were most apparent in the vegetable gardens where twenty nine of the gardeners used some form of animal manure for soil fertility improvement, including cattle, goat and, in a few cases, chicken manure. The animal manure used by the gardeners was sampled to determine its nutrient values. These values (Table 4.10) were useful when it came to calculating recommendations from the soil analysis results. Composite manure samples were taken from two

gardeners in Ngcolosi ward from cattle and goat kraals and the values pooled for each type of manure.

Table 4.10 Macronutrient content of cattle and goat manure on a dry-matter basis

type	% N	% P	% K
goat (n=6)	1.44	0.18	0.81
cattle(n=8)	1.31	0.78	1.84

It was apparent from the macronutrient content of the manures analysed, that the ratio of N:P:K did not match the ratio of nutrients needed for optimal crop uptake and growth. The results of the soil tests, observations and discussions with gardeners revealed that most gardeners needed to apply at least twice the amount of manure they were applying, to raise the level of P in their soils to the crop threshold level of 27 mg/L of P. An increased application of manure would over time raise the P levels. However, the relatively high levels of K in the manure and in the soil would lead to luxury K uptake by plants (Manson, 2001; Ni and Hardter, 2001). For example: FERTREC recommend that a gardener soil with the median soil P and K values of 9mg/L P and 325 mg/L K should apply 70 kg/ha of P, 0 kg/ha of K and 100 kg/ha of N to obtain a good green bean yield. If the gardener uses cattle manure (0.78% p and 1.84% K from Table 4.10) to fulfil the P requirements (70kg/ha), the manure will provide 143 kg/ha of K in excess of the quantity recommended for application. The relative proportions of the nutrient content of the manure are problematic when fulfilling the FERTREC recommendations for soil nutrient requirements. A number of other factors also contributed to the variations in nutrient content of the manure.

Manure storage methods were not used by Valley gardeners and animal manure was commonly left in the kraal until needed. The animal manure was in most cases left exposed to sunlight and rain. Only two farmers had trees in the animal kraal, which provided some protection to the manure from sun and rain. Volatilization of ammonium (NH_4) from animal manure is accelerated at increased temperatures (Smaling, 1993) and as a result not all N present at sampling is available to plants after application to the soil. Increased temperatures during the summer months and exposure of the manure to sun and rain affect the nutrient content of the manure that gardeners use. From Table 4.11 it appears that during periods of increased air temperatures, increased volatilization takes place resulting in lower values for total N and rainfall causes leaching, resulting in lower values for both N and K.

Table 4.11 Nutrient content of seasonal manure samples from Ngcolosi ward in Dedangendlale Valley

season	% N	% P	% K
winter	1.38	0.57	1.98
summer	1.09	1.50	2.03

The nutrient content of grasses and shrubs would also be a contributing factor to the difference in manure analysis between seasons as manure quality is affected by the quality of the diet of the animal producing the manure (Powell, 1986; Muriwa, 1995;

Miles and Manson, 1998; Lekasi et al., 2001). Findings presented in Table 4.12 supported the fact that increased incoming solar radiation also contributes to the loss of available N through the volatilization of NH_4 and that rain leads to leaching of K from the manure (Kwayke, 1980; Powell, 1986; Giller *et al*., 1998; Miles and Manson, 1998; Muriwa and Nzuma, 1999).

Table 4.12 Nutrient content of kraal manure in Ngcolosi ward in the Dedangendlale Valley under various storage conditions

storage condition	% N	%P	%K
shade	1.58	0.56	2.01
sun	1.19	0.49	1.32

The nutrient concentration in manure is affected by: the quantity and quality of animal fodder (Powell, 1986; Muriwa, 1995; Miles and Manson, 1998; Lekasi *et al*., 2001), the storage conditions before application (Kwayke, 1980; Powell, 1986; Giller *et al*., 1998; Miles and Manson, 1998; Muriwa and Nzuma, 1999; Lekasi *et al*., 2001) and the method of application (Stoorvogel *et al.*, 1993; Miles and Manson, 1998). To increase the relative nutrient content of the kraal manure and to some extent address the relative proportions of nutrients in the manure, gardeners would need to provide additional winter feeding of livestock, and use adaptive storage techniques, such as storing the animal manure in heaps (Kwayke, 1980; Miles and Manson, 1998; Lekasi *et al.*, 2001) .

One of the gardeners, in an effort to increase the amount of N available in the manure/urine mix used on her garden, put bean chaff into the night kraal to absorb the urine, as a means of decreasing volatilization (of NH_4) and thereby increasing the amount of N available in manure/urine mix. Urine is said to contain up to 50% of the N found in the manure/urine mixture obtained from kraals (Reed *et al.*, 1990; Somda *et al.*, 1995) and it is recommended that stover and chaff be used to absorb urine as a means of retaining N in the manure (Reed *et al.*, 1990; Muriwa, 1995).

Fodder crops

As a means of improving the health of their cattle through winter-feeding (and also the improving the quality of the kraal manure) some gardeners in the Ngcolosi ward were experimenting with a number of Napier fodder (*Pennisetum purpureum* Schum.) varieties. They wished to see which of the varieties grew most efficiently and which were most palatable as additional animal fodder. The improvement that the additional feeding was expected to made to the quality of the manure would, when applied to the homestead gardens, make more nutrients available to the crops. Of the eleven gardeners that planted Napier grass, one did not own any livestock. In this case, the gardener used the Napier for erosion control. The gardeners say they feel comfortable using Napier grass as it can be planted as sugar cane is planted. Also, it does not need much attention once established. The gardeners who used it for fodder had different opinions on its palatability for animals and its ease of use.

This Napier is easy to grow, just plant it like sugar cane. Mine came up in 10 days.

I feed it to the cattle and the goats, I feel they are too thin and should have more to eat, they always eat what I give them.

My son cuts the Napier for the cattle, they eat it but the goats prefer to eat it straight from the plant, if he cuts it, they will not eat.

Despite their value as chicken feed, sunflowers (*Helianthus annuus* L.) are grown by only one gardener. The seeds are used as feed for her chickens and pigeons.

Soil Improvement Crops

The SPUP promoted the use of velvet beans (*Mucuna pruriens*) and sunnhemp (*Crotalaria sp.*) as green manure crops, to improve soil N availability in the Valley farming systems. Of the introduced green manures, 27% of gardeners adopted the sunnhemp and 20% of gardeners adopted the velvet bean as a crop (Table 4.13). However, only 3% used the green manure effectively (incorporating green material into the soil) and on a regular basis (annually).

Table 4.13 Green manure crops grown by Dedangendlale Valley gardeners, given as percentage of gardeners growing the crop

green manure crop	grown by % gardeners
sunnhemp	27
velvetbean	20

In the area with the lowest mean soil fertility (Mabedlane), none of the gardeners used the green manure technology as a means of improving soil fertility. Factors affecting this were the unavailability of seed and no long-term programme for working with these gardeners. Mabedlane is situated furthest from The Valley Trust offices and no specific facilitator was assigned to the group.

A Qadi gardener has a good grasp of the benefit of green manures in her cropping system. Her maize was affected by *Striga* (*Striga hermonthica* (Del.) Benth.), a parasitic plant that grows on the roots of the maize. The gardener noticed that maize grown below the kraal had less *Striga* than maize grown in other areas. From this she deduced that soil fertility has an effect on the occurrence of *Striga*, a fact reported by Corbeels *et al.*, (2000). Subsequently, she established a trial in her maize field, planting half to velvet bean with maize and half to just maize. No *Striga* grew in the area planted to velvet bean with maize, but did grown in the area without velvet bean, confirming her impression that *Striga* occurs in areas of low soil fertility.

A number of the traditional varieties grown by the gardeners and other, introduced crops also make significant contributions to soil fertility improvement (Table 4.14). Groundnut, pigeon pea and cowpea have nitrogen (N) fixing potential established at 112-152 kgN/ha; 68-200 kgN/ha and 53-85 kgN/ha respectively (McDonagh *et al.*, 1993; Tilak and Singh, 1996). The amount of N added to the soil by planting pigeon pea in rotation with maize is estimated to be up to 40kg/ha per year, resulting in higher

yields of maize (Kumar *et al.*, 1983; Tilak and Singh, 1996). The microbial fixation of atmospheric N by leguminous plants into compounds available for plant uptake has a residual effect. This means that some N is made available to plants for a number of seasons, giving long-term benefits (Ledgard and Giller, 1995).

Table 4.14 Crops and herbs with soil improvement capacity, grown by Dedangendlale Valley gardeners, given as percentage of gardeners growing the herb

crop	grown by % gardeners	introduced/ traditional
groundnuts	33	traditional
comfrey	30	introduced
cannabis	23	traditional
pigeonpea	17	traditional
cowpeas	13	traditional
jugobeans	3	traditional
lentils	3	introduced
sunflowers	3	introduced

Biological N fixation can be significant in leguminous crops and make a significant contribution to the N fertility of the soil. Up to 60 % of the total N requirement of legume crops can be supplied through biological N fixation (Stoorvogel *et al.*, 1993; Giller, 2001). Non-leguminous crops can benefit from the inclusion of legumes in multiple cropping systems, spatially and temporally.

Beneficial effects include:

- the immediate transfer of N from the legume to the associated crop (as N is mobile in the soil through mass flow and diffusion) and
- a residual effect whereby N fixed by legumes is available to the subsequent crop.

Although most of the soil-improvement crops are grown for the purpose of providing food, their contribution to soil fertility improvement is not insignificant. And, even though the Mabedlane gardeners did not have the opportunity of growing green manure crops, most of the gardeners in the ward grew at least one soil improvement crop (Table 4.15). In the other wards, gardeners also grew at least one food crop or herb with soil improvement potential. In Ngcolosi, one of the farmers grew four such crops, the highest number in all the groups.

Table 4.15 Minimum and maximum, mean, median and mode of food crops and herbs with soil improvement capacity grown by homestead gardeners in four wards of Dedangendlale Valley

Ward/ Soil-improvement crops grown	*Mabedlane* (n=9)	*Mgoqozi* (n=9)	*Qadi* (n=6)	*Ngcolosi* (n=6)	Cumulative total (n=30)
maximum	2	3	2	4	7
minimum	0	0	0	0	-
mean	0.8	1.2	1	1.5	-
median	1	1	1	1.5	-
mode	1	1	0	0	-

Sampling the soil in the gardens up to a depth of 60cm, showed that there were reserves of soil nutrients, including P, present below the rooting depth (20cm) of annual crops (Table 4.16) in some of the wards.

Table 4.16 Results of soil sampling at a number of depths in homestead gardens, giving soil-test P values for two wards in Dedangendlale Valley

sample depth (cm)	median soil-test P value (mg/L)	
	Ngcolosi (n=15)	Qadi (n=12)
0-15 cm	44	21
15-30 cm	23	13
30-45 cm	16	9
45-60 cm	8	3

Erosion Control

Soil erosion is perceived as being the greatest threat to the sustainability of agricultural production in developing countries (FAO, 1994). Most of the plant nutrients available to crops are within the topsoil and litter layer, the most erodible part of the soil profile. As a result, erosion leads to substantial loss in fertility and to deterioration of the physical structure of the soil. Erosion encompasses chemical, physical and biological degradation as it depletes nutrient resources, decreases soil depth (rooting volume) and reduces plant-available water reserves (Carpenter, 1989). Soil erosion is an irreversible process, for although plant nutrients and soil organic matter can be replaced, the replacement of soil material is not possible within the human time scale (FAO, 1994).

In the most erosion-prone area (Mabedlane) all the gardeners adopted the SPUP introduced Vetiver grass (*Vetiveria zizanoides* (L.) Nash) for erosion control. By comparison, in the least erosion-prone area (Ngcolosi) only one of the gardeners adopted the Vetiver grass. The gardener in Ngcolosi who used the grass was considered to be the most sophisticated gardener due to her in-depth understanding of soil fertility management and on-farm nutrient cycling. All gardeners who used Vetiver (53%) were aware of its value as an agent for soil erosion control.

It (Vetiver) is good for holding the soil, you can see here where the plot was washing down the hill, it has stopped the soil.

I use it to stop the soil washing down below the house where it is very steep.

Napier grass was introduced by the SPUP as a fodder plant, but gardeners without livestock also used it as an erosion control measure. The taller, shrub variety of pigeon pea (*Cajanus cajan*) was by four of the gardeners for stabilizing steep slopes. It is also a food crop that is valuable for improving the accessibility of P and N from deeper soil reserves (Giller *et al.*, 1998). These examples highlight the fact that some crop and plant types are not used for singular but multiple purposes and often are not used for the purpose for which they were initially introduced. Gardeners often determined the value of introduced technologies for their situation, which differed in some cases from the intended use of the technology. Gardeners also readily understood concepts and used their own, available resources and technologies as solutions. For example, in erosion-prone Mgoqozi, the proposed, introduced technology was to make terraces, planted with nitrogen-fixing plants to control soil erosion. One of the gardeners did not use plants to stabilize terraces for controlling soil erosion, but used maize stalks instead, to build stabilized beds in her steep garden. The gardener said that as she did not have animals there was no need for her to keep the maize stalks for fodder. She also said that her children readily helped her with agricultural tasks. She therefore decided to use available resources for soil erosion control: maize stalks and labour.

4.3.3 Homestead gardens: promising pockets of sustainability

For homestead cropping systems to make a significant contribution to household food security, it is essential that the production practices are sustainable. Sustainability implies minimizing disturbance and degradation and avoiding destruction through maintaining productivity (Fresco and Kroonenberg, 1992). In the Valley, the sustainability of homestead gardening is largely a function of crop production practices and soil fertility management. Gardeners in the Valley produce a diversity of crops, which in turn serve a diversity of purposes within the cropping system: food production; nitrogen fixation; sequestration of phosphorus (by mycorrhizal fungi associated with plant roots); and soil erosion control. All of these are important contributions to the sustainability of crop production in homestead gardens.

Homestead gardens make a significant contribution to household food security as both traditional and introduced crops are grown; and food crops are grown throughout the year. Some traditional crops are more drought-tolerant than many introduced crops and thus growing both traditional and introduced crops spreads the risk of food production during periods of unexpected or prolonged drought. Crop diversity also provides security from pest and disease outbreaks where some crops may be resistant to or tolerant of the pest or pathogen. Growing a diversity of crops also ensures that food is available from the homestead garden from both winter and summer crop seasons.

Plate 1. Trial site at Ukulinga Research Farm with winter vegetables: onions, beetroot and carrots

Plate 2. Trial site at Ukulinga Research Farm with summer cash crop: green beans

Plate 3. Banana and papaya orchard at Ngcolosi with farmers, facilitators and researcher

Plate 4. Soil sampling and garden-planning discussion with farmer and facilitators at Mgoqozi

Crop diversity plays a key role in cropping-system and livelihood sustainability, in particular as it contributes to the gardener's livelihood at two levels: through food production and household economy (less money is spent on food and/or some produce is sold). A diversity of plants can also turn serve a number of purposes within the cropping system which, in turn, leads to an increase in the resilience (and potential sustainability) of the cropping system (Fresco and Kroonenberg, 1992).

The keeping of seed for subsequent crops provides a level of economic sustainability as seed does not need to be purchased each season. The selection and keeping of seed also assists in the development of varieties adapted to localised conditions. Crop diversity is thus beneficial to increasing sustainability at two levels, namely food production and household economy. For traditional varieties, the preservation of crop material also affirms indigenous knowledge and culture and varieties, which means that at household level, indigenous knowledge plays an important role in rural livelihood security (Mtshali, 2002).Knowledge and skills pertaining to agricultural production are reflected in the localized soil fertility management practices developed by gardeners to improve the fertility status of their soils. These include:

1. Intercropping a green manure with a *Striga* infested maize crop to reduce the incidence of *Striga*.
2. Always intercropping maize with a legume crop.
3. Increasing the amount of manure applied before planting (soil P test increased from 32 mg/L to 126 mg/L over 2 seasons).
4. Composting weeds in heaps within the field.
5. Composting in tree-planting holes for up to one year prior to planting the tree.
6. Planting a green manure crop during the summer season for the winter food garden.
7. Using termite soil as a fertilizer (termitarium soils have more organic matter and a higher clay content than the neighbouring top soil (Swift and Palm, 1995)).
8. Deep-trenching beds within the garden (soil P test of 49mg/L compared to 10mg/L for non-trenched area in the same garden).
9. Collecting manure from tethered goats (following a discussion on manure nutrient content).
10. Using maize stalks to terrace a steep garden.

However, the soil fertility management practices listed above are not used by all gardeners, and my field trials at the research farm indicate that the crop production methods used by the majority of gardeners are potentially unsustainable. The yield results from my field trials, described in Appendix A, show that the amount of manure traditionally used by gardeners produces a lower yield than the manure application rate recommended by FERTREC. The amount of manure traditionally used by gardeners also does not significantly increase the macronutrient (N, P, K) content of the soil compared to the manure application rate recommended by FERTREC.

In terms of the SPUP intervention proposed for increasing soil fertility, i.e. growing a green manure, the yield results from the field trials show that the green manure crop

uses quantities of nutrients that significantly affect the yield of crop plants and that the application of additional manure will be required to satisfy the nutrient demand of the green manure crop. This means that the green manure as a technological intervention is not beneficial in the short term for increasing crop yield, given the soil fertility management practices of the gardeners. In some cases, the cultivation of the green manure crop significantly reduced crop yield compared to the yield obtained with the gardeners' own technology.

However, the soil erosion control methods introduced by the SPUP and adopted by the majority of gardeners are crucial to conserving nutrients in the soil and ensuring the on-farm cycling of soil nutrients. This is due to the fact that organic sources of plant nutrients (manure) release nutrients slowly and if runoff is not controlled loss of N and K can occur through runoff and leaching, and loss of P through run-off (Mills and Fey, 2003).

In the case of The Valley of a Thousand Hills for many gardeners, there is insufficient P and N available in the immediate soil profile to provide a continuous and adequate supply for crop requirements (Manson, 1996). Soil fertility can be restored through the integration of nutrient management. This means that most gardeners will have to import P and N, whether in the form of high-quality manure, or fertilizers. Leguminous species within a cropping system are essential for increasing the amount of plant-available N within the system (Giller, 2001). The trials show that sufficient P needs to be made available for both the vegetable crop and the green manure. In fact, P is a major limiting factor of N fixation and biomass productivity of legumes in cropping systems (Giller, 2001; Mpfumo and Giller, 2001). Some gardeners have very fertile soil and the nutrient levels are sufficiently high for sustainable crop production through the use of animal manure and reduced tillage methods.

Using adaptive storage methods to retain the nutrients in manure would be a valuable intervention for most farmers as much N is lost through the volatilization of NH_4 from manure and also from leaching, and K is lost through runoff.

Another significant intervention within the LEISA framework used by the SPUP would be the adoption of reduced-tillage methods and also the non-removal of weeds from the cropping area. In Kenya, recommendations to improve nutrient supply in traditional systems include the use of green manure crops and animal manure, used with conservation tillage and the mulching of residues after harvest (Lungu, 1999).

A study of soil fertility management through Participatory Technology Development (PTD) revealed that LEISA management required more labour than conventional, higher-input systems (Onduru *et al*, 2001). These results indicate that LEISA technologies may not be the sole means of improving soil fertility management, and that the way forward may lie in combining locally available inputs with external sources of nutrients. The use of external-sources of nutrients would greatly affect households affected by AIDS, where labour and financial inputs are scarce.

Recommendations for improving the sustainability of the homestead crop-production system include adding nutrients to the garden, reducing nutrient loss from the garden, maximizing the cycling of nutrients and increasing efficiency of uptake (Hilhorst *et al.*, 2000). Leached nutrients can be recaptured by planting trees in the gardens and fields and by using deep-rooted green manures that scavenge nutrients

from the subsoil making them available to subsequent crops (Giller *et al.*, 1998; Sullivan and Diver, 2001). Increasing soil organic matter content would also be beneficial as it contributes to the water-holding capacity and the cation exchange capacity of the soil, which in turn, increases the amount of nutrients potentially available for uptake by plants (Mills and Fey, 2003).

The long-term sustainability of homestead gardens can be promoted through increasing the plant-available nutrients in the soil and the organic matter content of the soil.

4.4 State of the nation: livelihoods of homestead gardeners

From the SPUP vision statements it was evident that their aim was to improve the livelihoods of the subsistence gardeners in the Valley: '*to influence the way in which people realise their potential and utilise the resources they have to improve their lives and self-reliance*'. The aim was to achieve this through sustainable land-use and resource management with the short-term aim of enhanced food security for the household.

Farming systems are dynamic and evolve as a function of the environmental, historical, social, economic and political conditions of their time and place. As a result, the un-sustainability of homestead crop production can be seen as a socio-economic problem as much as it is a technological problem (Gameda and Dumanski, 1995). Technologies and practices that are not economically beneficial or do not conform to social or cultural requirements of the farm community are unlikely to be adopted by gardeners (Smyth and Dumanski, 1995). Sustainable agriculture thus requires that socio-economic concerns and environmental principles be integrated into new policies, technologies, and activities designed to improve agricultural systems. However, understanding the role of people and society in the adoption of conservation strategies is more difficult (*and more relevant*) than only providing the technological solutions (Swader, 1994).

The objective of the research at the farm level was to investigate the livelihoods of the gardeners and to understand better the roles of socio-economic and cultural factors in homestead crop production. The productivity of the homestead gardens depends on the condition of the natural resource base; the amount of available land, labour and resources; the gardener's knowledge, motivation and skills; the degree of market orientation; the prices of inputs; and agricultural policy. Thus, farm level activities are also influenced by relationships at the institutional level, in particular for this case study, the community-based organizations (gardener groups), formal employment opportunities and the SPUP.

4.4.1 State of the nation: an approach to livelihoods

When I first started doing field-work in the Valley of a Thousand Hills, I used the sustainable livelihood framework (SLF) as a methodology for the research at homestead-level. The framework was offered in a course by CERDES to post-graduate students. I attended the course as a means of learning more about the methods of participatory development. The SLF was an appropriate concept and method to improve my understanding of the operationalisation of research into sustainable agricultural development. And also, as Hebinck and Bourdillon (2002) stated: …*for*

technical scientists, the livelihood framework serves the purpose of linking their specific work and capacities with what rural people are capable of doing, ... and how they perceive their own needs. The livelihood framework thus provides a guide for research and intervention. The SLF sought to improve a researcher's understanding of how people use the resources at their disposal to construct a livelihood (Swift and Hamilton, 2001). It was however, the core principles of the SLF that appealed to me most, in particular the recognition given that rural people not only have needs but also have resources and assets (Ashley and Carney, 1999). In this way, the livelihood framework provided a respectful and positive method for working with rural people.

I initially used the SLF to gain a grasp of the degree of heterogeneity between the households and also within and between the wards. I used the framework, not so much as a means of measuring the 'capitals' needed to achieve a sustainable livelihood, but rather to identify the diverse resources that contribute to peoples' livelihood strategies. The ability to pursue different livelihood strategies is dependent on the basic material and social, tangible and intangible resources that people have in their possession (Chambers and Conway, 1992). The term sustainable livelihoods relates to a wide set of issues (Scoones, 1998).

Household food security is embedded in the livelihood system of the household. It is the outcome of processes taking place within the household for which resources and assets are used and managed (Niehof and Price, 2001). At field-level, my investigations into the sustainability of crop production showed that resources played a multifunctional role in crop production for food security. The plants fulfilled a number of functions (food, fibre, medicine, erosion control, nitrogen fixation) in contributing to the food security of the household. In the same way, it became apparent at homestead level that a variety of resources contributed in a number of ways to the livelihoods of the homestead gardeners.

Over time, the 'measurement' and categorisation of the various types of resources became problematic in the interpretation of my research. People did not all use the resources in the same way and also just because there were resources available, it did not mean that people used them. It also became clear that it was difficult to make *a priori* distinctions between social, economic, natural, physical and human resources as the meaning and value given to the available resources was largely specific to time and context. Essentially, resources are not one-dimensional, but have multiple meanings for different people (Long, 2001).

Hebinck and Bourdillon (2002) stated that the SLF was problematic, as resources, defined as various 'capitals' in the SLF, in fact play a multifunctional role in peoples' livelihoods. Resources are dynamic, in that they can be used as they are and can also be combined and transformed into new or alternative resources. The use of the term 'capital' was also problematic as it is an economic metaphor and does not do justice to the multi-faceted nature of peoples' activities, which may not necessarily be orientated toward gain (Hebinck and Bourdillon, 2002). The notion of livelihood also incorporates the non-commoditized, non-material, and cultural aspect of life and sets of values that are embedded in local cultural repertoires where the use of rural resources is re-configured within the farm and between agriculture and other rural activities (Van der Ploeg, et al., 2000). The concept of 'livelihood' thus concerns both the resources available to people and the way in which the resources are used by

people in co-operation and competition with others. Essentially, 'livelihood' provides a framework for a holistic interpretation of the dynamics of development and the different rhythms of change (Hebinck and Bourdillon, 2002).

It became clear during the research at homestead and district level that rural development cannot be understood in terms of mono-causal relations and hierarchies. The complex network dynamics come together in what has been called processes of 'co-evolution' (Norgaard, 1994). Understanding how resources are used and combined with others, and what social, cultural and economic values and roles are attributed to these resources by rural people, is essential for understanding life in contemporary rural South Africa (Hebinck, 2007). For this reason, the analysis of the sustainability of the intervention at homestead level, moved from the SLF towards a more holistic interpretation of the dynamics of the livelihoods of the gardeners.

The methods for the collection of data on some the resources used by the gardeners for the construction of their livelihood strategies include: map and aerial photograph interpretation; field observation; discussion with gardeners; and questionnaire responses. The data, from which the findings under discussion are derived, are presented in **Appendix B.1,** for all 30 gardeners.

4.4.2 Homestead gardeners' livelihoods

The resources available to the homestead gardeners for their livelihood strategies are described here and are discussed in relation to the contribution that these resources make to household food security.

The size of land available to the Valley gardeners for crop production varied from 0.2 to 2.5 hectares, and this area included land planted to maize. Few of the gardeners had over 1.5 hectares of land, while most gardeners had 0.5 to l.5 hectares of land and some gardeners had less than 0.5 hectares of land available for crop production. Most families owned livestock, which grazed freely in the Valley grasslands and foraged on the natural vegetation. In most wards, there were still sufficient communal, natural resources available for the collection of firewood, thatching grass and for the grazing and browsing of livestock. However, pressure on natural resources was increasing and from the onset of the project the rate of urbanization in Ngcolosi and Qadi had notably increased, and in Mabedlane and Mgoqozi, human settlement was still increasing.

They are new to Mabedlane, they moved here from an area across the dam. They came at the end of summer last year.

I know her from the area where we used to live, we were at the same church. She also moved here because of the violence, she came some months after us.

Her family from Ndwedwe heard that she has land here, so they asked the Nkhosi for land and moved here, I don't know if they will have a garden or just build, there is not much space in this area anymore.

Despite the rate of urbanization, most gardens in the two more-urbanized wards (Ngcolosi and Qadi) were 0.5 to 1.5 ha in size, compared to only some of the gardens this size in the two more-rural wards (Mgoqozi and Mabedlane). The size of land available for cultivation was a result of a number of interconnected factors that include: the relative availability of land; the terrain within the ward; and the social status of the gardener within the community. In all four wards the larger gardens (more than 1.5 hectares) were situated on the gentler slopes. These gardens were adjacent to the homesteads of families who had lived in the area for a number of generations. The men of these families were often senior members of the traditional authority and homestead gardening was undertaken by their wives and daughters. Homestead gardens of a moderate size (0.5 to 1.5 ha) were often situated on slightly steeper slopes and many gardeners had sufficient skill, available labour and materials to construct effective soil erosion control measures. The smallest homestead gardens (less than 0.5 ha) were situated on the steepest slopes. The homesteads were those of poorer families or those who had been resettled from other areas.

Some of the gardeners (all women) undertook all of the agricultural activities themselves, while most were assisted by women and/or children within the homestead. The children were often not interested in the farming tasks they were assigned, but social etiquette demanded that they should help without protest. Men rarely assisted with farming duties, but there were two exceptions. Only one male gardener regularly attended the gardener-group meetings.

The children help me in the garden with the watering and weeding, I know they are not interested, but at least they help me.

I want to terrace the area below the house as the soil is washing away, but my grandchildren say no, they will not help me, so I am going to expand the area on the other side of the garden instead.

Fortunately my husband helps me a little with the garden, especially the fodder as his interest is the animals, before the fodder he used to help me sometimes with holes for the trees and picking the papaws (papaya).

My son cuts the Napier for the cattle.

The agricultural skills of the gardeners included a significant understanding of crop cultivation and soil improvement techniques, and an ability to grasp nutrient-cycling concepts and apply them to the farming system. The older gardeners had knowledge of traditional crops and their cultivation; and the care and management of small livestock.

Health of the gardeners was of concern especially as the gardeners contributed labour, skills and knowledge to the crop production process. The incidence of diabetes and high blood pressure was prevalent among many of the older gardeners, this was openly discussed at meetings and gardeners said that their health had a direct impact

on the amount of time they were able to spend in the field and the tasks they were able to undertake.

I used to do more in the garden but since my blood pressure problem arose, I get tired quickly and I get too hot.

The plot down near the river was my main garden, but I'm too tired now to walk that far, so I am redeveloping this garden here, close to the house and the children collect water.

A diet high in complex carbohydrates and vegetables with a low glycaemic index is recommended for diabetes and high blood pressure (Walters, 2001). This has implications for the types of crops that should be cultivated to enhance the health of the gardeners suffering from diabetes and high blood pressure. Many traditional vegetables have a low glycaemic index (Kruger *et al.*, 1998).

Within the gardener groups in the Valley, the effects of AIDS were obvious; although not openly discussed, they were readily observed. Economically active people were dying; the graves were there to be seen. The number of young children present in the households had also increased especially in cases where the parents were ill or had died and the grandmother became the provider for the children. Some gardeners were cultivating smaller areas, as their time was taken up looking after the children.

To address the issue of HIV/AIDS, the SPUP promoted organic farming with the incorporation of immune-system-boosting herbs, and the food gardens would help to alleviate the sense of helplessness faced by many families affected by AIDS. The SPUP also worked with Traditional Health Practitioners (*Sangomas*) to establish which traditional medicines could be grown by homestead gardener for safe use at home.

Other health problems included physically and intellectually challenged people, mostly children. In Mgoqozi there was a higher incidence of these disabilities than in the other wards. The affected children needed a high level of care, which also took time that was previously used for other tasks.

Those people with the sick children have a hard time, they have to watch all the time, or the children will hurt themselves or walk away. The social workers do not help as much as they used to in the past.

We could get a disability or a child grant, but my daughter did not register this child at birth and I cannot leave him when I go to get the papers fixed.

It is hard for me, sometimes I lock her in that room so I can get some work done. I know it is not right, but what can I do?

Gardeners had craft and beadwork skills, which they used to supplement their household income. The craftwork undertaken on a commercial scale did not make use of local craft fibres, but was related specifically to developed, mainstream products woven from imported craft fibres. The beadwork consisted of traditional patterns and modernized items for the international market. Most of the crafters and beadworkers were resident in the most remote ward, Mabedlane, and relied heavily on public transport to get their goods to the businesses that commissioned the work. The craftwork and beadwork made significant contributions to the household income.

With the money from the beadwork, I can send all the children to school and buy their uniforms.

If I did not have this weaving job, we would suffer. I make good money from this thing.

Despite the financial gains from craft and beadwork, the gardeners felt that their gardens made a significant contribution to the household; they saw the garden as a safety net, should the sales of the crafts lessen they would still be able to provide food for the family.

The living conditions of the Valley residents were being steadily improved through government-funded development projects. These changes were noticeable over the years during which I worked in the Valley. When I first started working in the Valley in 1996, there were dirt roads, not always adequately maintained; communal stand pipes for water collection; few houses with electricity and no public telephones. By the project end in 2004, certain areas of the Valley had been transformed with well maintained tarred roads; water taps in some individual properties; electricity available to those who could afford it and public telephones on most street corners. This development was mainly in the less-remote wards, Qadi and Ngcolosi.

All gardeners had access to piped water, many gardeners collected water from a communal standpipe or borehole but most gardeners had their own water taps. Those with their own taps paid for the water they used as it is treated water.

I have a tap, but I must pay for the water I use, so the children still collect from the stand pipe for washing and sometimes for watering the garden.

No gardeners have rainwater collection tanks, as there is the fear that evildoers can easily poison the water, and thus pose a risk to the members of the household.

*No, we don't collect rain water as it is easy for a tsotsi (*scoundrel*) to poison the water.*

All the wards were serviced by minibus taxis and some wards by both taxis and busses. The state of the dirt roads varied from season to season: in summer the roads were in the poorest state due to wash-away by rain, particularly in those wards situated

in the steeper part of the valley. Only two wards, Ngcolosi and Qadi, are accessible on tarred roads. Gardeners whose husbands held well-paying positions in urban centres have their own motor vehicles for transport and four of the gardeners were in this position.

Traditionally, 'round huts' (*rondavels*) with thatched roofs are constructed using locally available materials, such as wood, mud and grass. Due to the influence of other construction methods, the availability of modern construction materials and the decline in the availability of traditional construction materials, the use of traditional building methods and materials has declined. Gardeners in the peri-urban wards are also able to acquire modern construction materials more readily than gardeners in the rural wards. All gardeners have at least one traditionally constructed building, used as the kitchen and as a place to pay homage to the ancestral spirits. A building without corners is required for paying homage to the ancestral spirits as one with corners can, it is believed, house evil spirits that tend to hide in corners (Mbele, 2001). The other homestead buildings are often of a more modern construction style: rectangular in shape with corrugated iron roofs, metal window and door frames, and plastered and painted walls. Most homesteads had four to five buildings, some had three buildings, and a few had only one to two buildings. In a few cases where homesteads consisted of four or five buildings, wealth played a role in the number of buildings, but mostly the number of buildings was an indication of the number of family members or members of the extended family living in the homestead.

Most of the gardeners were members of groups other than the four gardener groups. These groups included: savings clubs, brick-making clubs, church groups, funeral clubs and food clubs. Only the poorest gardener was not a member of any other group. Many gardeners felt that belonging to a group was an important aspect of their lives as it gave them a safety net in times of hardship, either through material or emotional support.

With the savings club, we pay the money into an account and whenever somebody needs money for something big, they can ask. We take turns in getting money from the club.

The food group is very helpful for those who cannot afford to buy maize meal, we get something every second month from the group.

I enjoy spending time with my church group, we talk about all sorts of things that are important to us, but not farming, we only talk about that in the gardener group.

I used to belong to the concrete-block-making group, but now that I have finished building my house, I don't need blocks anymore. I sometimes still visit to give advice to the younger women.

When my husband died, the funeral group also paid for the headstone, some of the women even came to the funeral.

Cohesion between the gardener group members was more apparent in some groups than in others. In two of the groups (Qadi and Ngcolosi) unresolved tensions between the members slowed the rate of progress of work with the SPUP. Decision-making difficulties in the Ngcolosi group affected the marketing initiative of the SPUP to such a degree that the key gardener actually withdrew her produce for sale.

I will not be selling anything this season, I would rather save my groundnuts and let the family eat them during the year. This group does not appreciate my contribution or my knowledge. If I am there, they do not make a proper effort, they expect too much from me without doing for themselves.

Trust within this group was tested when it was discovered that the member entrusted with the group's finances, had spent the money extending her house. She was excluded from the group when this came to light, and the group was unable to recover the defrauded money.

She is no longer welcome in our group she has the most money of all of us. Her husband works in Verulam, how can she steal our money like this?

The attendance by members of the Qadi group fluctuated significantly from meeting to meeting and the SPUP and gardeners had to re-evaluate the working relationship. One of the key gardeners in the group was a widow, excluded from her community garden when her husband died. The SPUP assisted her at her homestead garden, but this caused other community garden members to become jealous and vindictive. The gardener told us how her garden fence had been torn down and a herd of cattle chased into her garden and there was nothing left when they had finished. She said it was an act of vandalism by other members of her community as they thought the SPUP was giving her handouts. The gardener invited the community members to join the group and once they realized there were no handouts, they no longer attended meetings nor vandalized the widow's garden. Towards the end of the project, only one gardener from the Qadi group was still active and the SPUP decided to cease working with the group, as it was no longer practical to continue.

Group cohesion in the other two groups (Mabedlane and Mgoqozi) was stronger and gardeners said that through being part of the group, they should help each other.

It is very difficult for those with sick children, I give them what I can from the garden, even seedlings for their gardens.

During the gardeners' visit to the Ukulinga Research Farm, a plant breeding company, Proseed, gave the gardeners seeds and seedlings to be shared with the other group members not attending the visit. Only Mabedlane and Mgoqozi gardeners shared these with the other group members, highlighting the greater sense of social cohesion within these, the more rural groups.

Deaths of group members affected the other group members in significant ways, especially in the two more rural wards (Mabedlane and Mgoqozi). In Mgoqozi, an inspiring young gardener died. The young woman had been thought by her mother to be incapable of achieving very much in the garden as she was mentally-challenged.

With the encouragement of other gardeners in the group and help from the SPUP, the gardener had made a productive and innovative garden. She had worked very hard and had deep-trenched two beds in the garden and had terraced all the beds as her garden was on a steep slope. She had tried a number of crops that other gardeners in the area had not tried before and employed novel soil covering methods.

I grow pumpkins here on the edge so that they can grow over the path, it keeps the ground cool and it is easier to walk here in summer. Also, it leaves more space in the garden for other vegetables.

It is encouraging to see what she achieved in her garden she was an inspiration to us who are healthy. She was not afraid to try new things in her garden.

Can you believe that she deep-trenched two beds in her garden? She was very hard working!

Due to the social and economic climate, social support systems were often tenuous. The death of gardeners and the complex group dynamics reduced the level of sharing within the gardener groups and also reduced access to skills and knowledge of other gardeners. In Mabedlane, the wife of the local councillor and co-ordinator of the gardeners' group died. This was quite a blow to the group as the gardener played a significant motivational role in the group.

She used to call us together for meetings even when SPUP was not coming. It will be difficult now in the group without her help and encouragement.

Social cohesion was also expressed through the interaction of gardeners with other members of the community, including those who provided a service to the community. For example, the Ngcolosi group stated that one of the reasons they could not market their produce outside the Valley was due to the expense of public transport and the chance of theft. They said they had to accompany their goods to the retail outlet, which further added to the cost of transport. In contrast, the beadworkers and crafters of Mabedlane readily used public transport to get their goods to Durban and the beadwork and crafts often went unaccompanied on the taxis, to be collected at the taxi rank in Durban by the company that commissioned the work. On occasion, when driving to Mabedlane for a meeting or workshop, I would see bundles at the side of the road, under a tree. When I asked what they were, the crafters said that because of the meeting or workshop, they could not wait with their work, but the taxi driver knew where to stop and pick up the work and they would pay him on his next round. The crafters were not concerned about theft as they said they knew everybody in the

community and they would soon discover who had stolen their work. From this, it appeared that there was potentially more social cohesion and trust in the two less-urbanized wards.

Poverty is widespread within the province of KwaZulu-Natal, particularly in rural areas. The Valley gardeners' wealth was assessed based on financial resources through comparison with other gardeners within and between groups, the poverty rating was localized and determined through observation and discussion with the SPUP fieldwork facilitators (Table 4.18).

Ideally wealth ranking should be conducted with participating gardeners, but social etiquette did not allow for this to take place, it being inappropriate to ask sensitive and personal questions of others, particularly older persons. The wealth ranking was conducted by observation, from discussions within the group and also from discussion with the facilitators.

Table 4.18 The rating scale used to define the wealth of gardeners in Dedangendlale Valley

Rating	Characteristics
Extremely poor	very little to no income; disabled people within the family unit; 1 dwelling only; no water tap; small plot size; inability to recover from major shock; no livestock
Very poor	little to no alternative income; disabled people within household; more than 1 dwelling; may have water; sufficient plot size for cultivation; inability to recover from major shock; small livestock
Poor	some alternative income; sufficient dwellings for entire household; access to water and/or electricity; sufficient plot size for household food production; ability to recover from major shock; livestock
Not poor	mostly alternative income; many dwellings; water and electricity; large plot size; ability to recover from major shock; livestock

In the Valley, of the gardeners sampled, a few lived in extreme poverty, some were very poor, most were poor and a few were considered not poor. Those considered not poor had at least one family member formally employed in a nearby urban centre. Families considered poor, sometimes had one family member employed locally, but generally there was little external income and any external income was often received irregularly.

Some degree of income was provided through localized manual labour projects, pensions, disability grants and part-time or full-time employment. The localized manual labour projects were a local government initiative aimed at the poorest of the poor.

The councillor came to speak to the Nkhosi, he said we should chose who here is the poorest for they will be working on the road-cleaning project.

She asked to be excused from the meeting as she was selected for the project and will be busy for the next two weeks.

This gardener was indeed the poorest gardener in the area: she lived with two of her adult children, her brother and one of his children in a single-roomed house. Two of the children were mentally challenged and her brother was unemployed. She relied heavily on her garden to produce food to feed her extended family and was grateful for the employment.
Most of the older gardeners qualified for government pensions, which they said provided a major part of the household income.

I have a pension from the government, it means that we can buy food and pay for a few things for my grandchildren.

We cannot have the meeting on the Tuesday, it is pension day and most of the group will be collecting their pension.

Other government grants that contributed to gardeners' livelihoods included disability grants and child grants. As already mentioned, some gardeners also derived significant income from the sale of crafts and beadwork. Agricultural produce did not raise much financial input, and sales were sporadic. Money raised from the sales of produce was usually used to buy less-expensive household items.

I sold some carrots to the school last season, we had a good crop. I used the money to buy paraffin for cooking.

Sometimes I sell vegetables, and use the money to buy candles and matches or batteries for the radio.

I don't sell much, mostly people want you to give to them, they do not want to buy.

I sold my groundnuts through SPUP to a peanut butter factory near Richmond, but I was disappointed at how little money I received in return. The transport took most of it.

The greatest financial contribution to the livelihoods of gardeners was through family members who were formally employed in urban centres. In the Valley, increasing numbers of people were living at home as a result of HIV/ AIDS and the high level of unemployment. Consequently there were more mouths to feed, with fewer economic resources. The spread of HIV/AIDS limits rural livelihood options as agricultural production as well as incomes are reduced (Ory, 1999).

The variations within and between wards of resources available to gardeners and used by gardeners highlights the interconnectedness of the resource-types and that a multi-dimensional approach is needed for the assessment of livelihoods.

4.4.3 Cropping strategies and livelihoods: towards sustainable production

The analysis of livelihoods of the gardeners leads to a social analysis of the patterns of adaptation to changing conditions and hence the livelihood strategies of the gardeners. Analysis of data from all 30 gardeners of the four wards in the Valley, revealed a number of correlations between the resources available to and used by gardeners in livelihood strategies (see Table 4.19).

There was a positive and significant correlation (see **Appendix B.2**) between the total number of crops cultivated and the knowledge and skills of the gardeners, availability of labour and networking. Also, gardeners with access to networks and labour and those who were active in groups and community-based organizations (CBOs) grew a higher number of plant types (erosion control, green manure, traditional crops, food) than those gardeners who were less socially linked in the community.

Water availability, land size and sale of produce were also positively correlated to number of plant types grown and access to labour. This means that gardeners with agricultural skills, agricultural knowledge, land, water and access to labour grew and sold more crops than gardeners who had less land, water and labour available and who were less well-connected socially. The implication is that crop production makes a worthwhile contribution to household food security, as much is invested through the interaction of these factors (land, water, labour, social support).

Gardeners who are physically or mentally challenged or who had such people in the household grew fewer traditional crops than other gardeners (negative correlation between disability and traditional crops). These gardeners were within the lower economic classes (very poor and poor). Many of the seeds from traditional crops were distributed from gardener to gardener and as there was also a correlation between economic class and membership of groups and community-based organizations, the implication was that gardeners with disability had reduced access to the seeds of traditional crops as they were less socially connected through organizational and group activities.

Table 4.19 Correlation matrix showing significant positive and negative correlations of resources available to and used by Valley gardeners for their livelihood strategies

	buildings	craft plants	disability	economic status	electricity	erosion control	food crops	gov. grants	green manure	group membership	agric. knowledge	labour	Land size	manure use	networks	salaries	agric. sales	agric. skills	slope	soil fertility	total crops	traditional crops	transport
craft plants																							
disability	-																						
economic status			-																				
electricity			-	+																			
erosion control																							
Food crops		+				+																	
gov. grants	-		+				+																
green manure crops		+					+																
group membership				+	+		+																
agric. knowledge		+					+			+													
labour					+	+				+													
Land size		+		+	+						+												
manure use																							
networks		+			+		+			+	+	+											
salaries				+	+			-		+			+										
agric. sales						+	+			+	+	+			+								
agric. skills		+			+	+	+			+	+	+			+		+						
slope	+																						
soil fertility																							
total crops		+				+	+		+		+	+			+			+					
traditional crops		+	-			+	+				+	+			+		+	+			+		
transport						-			+														
water				+	+		+	-		+		+				+		+			+		

Many gardeners were reliant on food production, which was evident in the positive correlation between number of food crops grown and government grants, implying that those who access government grants (very poor and poor) were reliant on homestead food production as a contribution to their household livelihoods. Generally the very poor and poor grew more crops than those gardeners not dependent on government grants.

There were three distinct strategies that emerged from gardeners' crop production practices and these were influenced by options for livelihood diversification. The first category are those gardeners who were in a desperate state. They were often female-headed homes which relied on their own labour for food or income. Land was

considered to be an important resource as it provided an area for food production and a place for dwellings. These gardeners were dependent on off-farm natural resources such as grass for thatch, firewood, timber and soil and sand for building. Their food production systems were characterized by low land productivity and few fertility management interventions. This livelihood category, where gardeners relied on labour as a source of income is similar to that observed by Birch-Thomsen *et al.* (2001) in livelihood studies in Tanzania and is called *peasant labour strategy.* There was an exception to this category, being those gardeners who were disabled (mentally or physically) in some way. These gardeners tended to use their labour resource for their own food security, rather than hire out their labour, and as a result, their soil fertility was good to very good through significant fertility management interventions (soil erosion control, cultivation of a soil-improvement crop and the application of animal manure). For these gardeners, labour was not a source of financial income to the household, but played a significant and direct role in household food security.

The second category of livelihood strategy practiced by Valley gardeners was characterized by those gardeners for whom the local economy was a significant source of financial income. Agriculture provided an indirect source of income for these gardeners, either through the sale of fresh produce or beer made from home-grown maize. Other sources of income included contract work, crafts, and local business. Income from agriculture was generally lower than that from contract work, crafts and local business. Soil fertility was either not a priority for these gardeners or they did not have the resources available. Few of these gardeners had very fertile soils. This category, again similar to that observed by Birch-Thomsen *et al.* (2001) is called *peasant strategy*. Livelihood diversification for these households was largely an attempt to maintain living standards, as there were seldom opportunities and/or resources for change. Households practising this strategy had difficulty in recovering from situations where major financial resources were required at short notice (death of an income-provider and/or funeral costs).

The third category of livelihood strategy practised by gardeners in the Valley was that called the *accumulating strategy* (Birch-Thomsen *et al.*, 2001). These gardeners had diversified their commercial activities through hiring labour and expanding their agricultural output. The homestead-garden soils of these gardeners were of good to very good soil fertility due to significant fertility management interventions. The households of these gardeners usually had skilled and able family members. Gardeners of this strategy were the only ones that had sufficient resources to survive a shock requiring major financial resources.

Birch-Thomsen *et al.* (2001)'s findings showed that land conservation was not a strategy of accumulation nor survival. Findings in the Valley were different in that gardeners recognised the importance of land conservation, which in many cases was due to the awareness created by the SPUP of soil erosion processes and the SPUP's assistance to gardeners. Land conservation was a strategy of accumulation and in many cases also of survival for the Valley gardeners. The accumulating-strategy gardeners adopted the soil erosion control measures most readily, as did the gardeners in the peasant-labour strategy who were disadvantaged in some way and used their labour for their own soil fertility management. The differences between these two strategies are: [1] the economic status of the gardeners' families (very poor and not

poor); [2] the technology used to improve soil fertility (disadvantaged gardeners had fewer traditional and soil-improvement crops, but more food crops); and [3] the available social resources, the level of networking and membership of community-based organizations. These differences have important implications for intervention strategies with regard to both technical and organizational aspects.

There was considerable diversity of practice and means among the Valley homestead gardeners. The resources and processes that contribute to the gardeners' livelihoods are closely interlinked; and understanding the connections better requires rigorous participatory research. Many of the connections were linked to social isses and thus, interventions should not only focus on technical solutions, as a number of social interventions are also required (health-care, capacity building, skills development) to improve the livelihoods of Valley gardeners. Participatory learning and action can lead to a better understanding of the factors affecting sustainable crop-production systems; and the contribution that homestead crop production can make to the livelihoods of the Valley gardeners.

4.5 Being connected: organizations and networks

When considering rural development, from a systems viewpoint, the influence of institutions and networks of organizations on the rural poor cannot be discounted. For example, many rural development organizations are still driven by management-directed action. The ideals of the organization are usually based in the sustainability paradigm. As a result of the dichotomy of focus between the organizational vision and the outcomes of the organization, the stated aims and objectives are often not achieved. In systems terms this is addressed simplistically with the question: is the system doing what it says it does? Sustainability in the organizational process is a function of the system doing what it says it does (Checkland, 1983).

The aim of the research at the institutional level was to determine if the activities of the SPUP reflected its stated aims. The sustainability at the level of the field was considered with reference to the processes at higher hierarchical levels to determine if sustainability had been realized. The strength of the linkages between the various system levels was examined, as the strength of the linkages also affects the potential sustainability of the system.

4.5.1 Getting connected: networking and learning

Critical Systems Practice (Jackson, 2000) was used as the methodology to determine organizational sustainability. A number of systems tools were used for the four phases of the methodology. These four phases are: [1] *creativity* about the problem situation; [2] *choice* of methods; [3] *implementation* of change proposals; and [4] *reflection* and learning about the research process. For the first phase, rich pictures and concept maps (Beissner, 1992) were used to identify the elements (human and non-human) pertinent to the research and the relationships linking these elements. From the rich pictures and concept maps, causal loop diagrams (Goodman *et al.*, 1997) were constructed, identifying the constraining and enabling factors. Further clarification of these factors was obtained through the use of interrelationship digraphs (Hardman, 2001).

For the second phase of the methodology, behaviour-over-time graphs (Goodman *et al.*, 1997) informal interviews, questionnaire responses and documentation were used to investigate processes within the institutional environment. The calculated values used for determining the contribution of the various resource-types used by gardeners for their livelihood strategies were used to assess the SPUP response to these strategies to determine institutional learning and the sustainability of the development process.

4.5.2 Staying connected: organizational development

In this section, the activities of the SPUP and its interaction with the gardener groups will be presented, followed by a discussion on the institutional behaviour over time and its application to the sustainability of the farming system activities of the gardeners. Interactions between, firstly, fieldwork facilitators and management and secondly, fieldwork facilitators and gardeners, will then be discussed with reference to organisational learning.

4.5.2.a Activities overview

During the first year of SPUP's involvement in the Valley, there was a notable increase in the number of interested gardeners who joined the various groups, and in the number of homestead gardens established or renewed (Musane *et al.*, 2001). Both the training and knowledge sharing were well received within all the groups and the SPUP welcomed the involvement of the tribal authorities in promoting its work amongst the people of the valley (Haigh *et al.*, 2001).

At the beginning of the second year of the project, expansion of the garden areas showed that the lack of adequate fencing was a major constraint to production. Generally gardeners construct fencing from any locally available material. Often, established trees and shrubs are used as support for additional thorny branches to strengthen the fences, but the additional branches eventually rot away and gardeners have to redo the fencing, which is time consuming. Also, the branches are browsed on the outside of the fence by animals that then push through into the garden through the gaps they create. The fencing issue was an ongoing problem and by the end of the project had not been completely resolved. Gardeners initially appealed to SPUP for assistance in buying fencing material. SPUP responded by purchasing a barbed-wire-making machine that the gardeners would hire and take turns to use, the gardeners would be subsidized by the SPUP in buying wire. The gardeners felt that the SPUP should have consulted them first as they did not want barbed-wire fences. At the practical level, it was not effective in keeping animals out, cattle owners would steal the fencing for making kraals and making the barbs was considered a time-consuming process. The gardeners requested financial support in the form of a subsidy. It was very difficult for the co-ordinator to negotiate the terms for the wire subsidy. The Valley Trust's policy was to not give handouts as this was thought to create dependency, which is contrary to long term sustainability. The subsidy was finally negotiated: a gardener would be matched on her contribution by the SPUP up to an amount of ZAR400 (approximately 50 Euro).

The gardeners requested other help from SPUP: those gardeners with larger areas of land and good crop-production skills expressed interest in selling their excess produce. At an end-of-season evaluation, gardeners said that the local market did not offer much

hope, as it was saturated by commercial traders from the city. Compounding this was the fact that many people in the area grew some of their own produce. The SPUP began to make enquiries outside of the valley to determine if any retailers would buy produce from the Valley gardeners, and would also be prepared to pay a premium price as the SPUP intended to finance the certification of gardeners as organic producers.

A challenge to the marketing initiative was the internal organization of the gardener groups. They were unclear about who would have what produce ready when, and whether they could collectively ensure a continual and adequate supply of quality produce. Financial arrangements within the group also had to be considered. It was thought risky for gardeners or retailers to carry large amounts of cash within the valley, so the gardener groups would need to arrange payment into a bank account. Whether this account was to be a group account or a private account also had to be decided on by the group. At this stage, I felt that the SPUP should not certify the gardeners as organic producers as there were still numerous challenges to be faced in terms of soil fertility management, increasing the level of crop production and ensuring an adequate supply of produce throughout the season. Certifying the gardeners as organic producers added to the managerial complexity at farm level and limited the options available for soil fertility management.

The SPUP through efforts to scale up its work became more involved in Midnet (Midlands Development Network) activities and shared ideas with other organisations within Midnet. SPUP also planned to become more aligned with government initiatives but found this difficult as '*the SPUP approach does not fit with the handout-based initiatives of government in poverty alleviation*' (Musane *et al.*, 2002a).

As the SPUP became more active with the homestead gardens, the co-ordinator acknowledged a need for the facilitators to work together with the various gardener groups as issues other than agriculture were beginning to become more prominent. At the technical level, members of the Ngcolosi group were beginning to see the value of increasing the organic matter content of their soils and some were changing their production practices accordingly. An improvement in the physical characteristics of the soil and an increase in yield of the crop following the green manure were changes observed by one of the gardeners. Another gardener said that she had learnt a lot about keeping seed and growing seedlings from 1 of the other gardeners and the soil fertility project had shown her the value of adding kraal manure before planting. Yet another gardener said that she had noticed an improvement in her crop yield after she had increased the amount of kraal manure applied before planting. Within the Qadi and Mgoqozi groups, gardeners who had tried the recommended application of kraal manure said that they had noticed an improvement in their crop production yields and perceived that the additional kraal manure had improved the fertility level of the soil. A follow-up testing was undertaken and the results showed that there had indeed been an increase in the macronutrient content of the soil. This is reflected in an increase in soil P from 32mg/L to 126mg/L over two cropping seasons.

The organic-produce marketing initiative gained momentum and the SPUP led a Midnet (Land-Use Interest Group) workshop for stakeholders on the marketing of organic produce. The aim of the workshop was to discuss options and processes, form a working group and develop a proposal in partnership with the Department of Trade

and Industry's Rural Economic Development sector. The stakeholders involved were three NGOs and a local pack house. Within SPUP, the marketing efforts were focused on the Ngcolosi group (the initial pilot group). Two workshops were held during which gardeners explored needs and made suggestions about marketing. Transport of produce to the potential buyers was identified as being the main need for the group. The group decided that they would not be able to supply the buyers themselves as transporting produce out of the Valley was prohibitively expensive on public transport. Within the group, the husband of a gardener had a vehicle, but the gardener stated that the vehicle was private and not available for use by the group. A sub-group of the Ngcolosi gardeners (Emuseni Gardeners Group) who felt that they were ready to market and sell their produce were certified as organic gardeners at SPUP's expense, contrary to the no-handouts policy of The Valley Trust.

Despite the observation by Taylor and Cairns (2001) that the expansion of farming based on traditional crops was unlikely to make a significant contribution to poverty alleviation, there was an increasing trend by more affluent consumers to buy traditional crops in supermarkets. However, the problem lay in ensuring an adequate, continuous supply to these outlets. Gardeners within the groups worked together to ensure that a variety of vegetables was available and that a sufficient number of gardeners were growing vegetables to ensure a continuous supply. However, the issue of market-availability was not fully resolved: the gardeners felt that the SPUP should assist them in establishing market linkages, but the SPUP felt that unless the gardeners themselves addressed these factors, the initiative would not be successful or sustainable. There was no significant development with the market initiative by the end of the project.

An end-of-season evaluation at Mgoqozi showed the positive involvement of SPUP at the field level, with gardeners producing sufficient quantities to sell excess produce locally. The gardeners identified four potential local markets for sale of excess produce, but due to changes in weather conditions (late rains, high temperatures), production declined and few sales were made to the local markets. The gardeners learned a number of skills from each other including: making liquid manure, making compost, saving seeds and using local materials for fencing. Some gardeners said that they had noticed an improvement in crop yield when increasing the amount of manure applied before planting. In emphasising the value of evaluations the SPUP stated: '*we need to be passionate and persevering as even though we have raised awareness of our clients and shown them why something is important, it may take time for them to change their behaviour'* (Musane *et al.*, 2004).

Two dismissals and the death of a SPUP facilitator during 2002 changed the working atmosphere within SPUP and resulted in an increased workload for the remaining facilitators. No great achievements with the gardeners were realized for the final few months of the project. A major contributing factor was the weather; the main summer rainfall was very late and temperatures were unusually high. The Qadi group was reduced to one active gardener, a gardener at Ngcolosi withdrew for health reasons and many of the Mgoqozi group stated poor health as a reason for decreased involvement with the group.

In February 2003, I assisted the SPUP with their combined end-of-season evaluation. It was the first time in my three-year involvement with SPUP that I was

involved in formally questioning the gardeners. It was difficult devising a questionnaire to gain an understanding of what had changed, what gardeners were doing differently and what their visions for the future were. The difficulty was compounded by the fact that there was no baseline information for comparison. The evaluation was also physically and intellectually demanding: visiting all the gardeners; checking the answers; going back to some gardeners for clarification; and sifting through the compliant answers to get to the core answer. February was the hottest and most humid month of the year and as a result, the enthusiasm and concentration of gardeners and facilitators were below par.

Another factor that increased the difficulty of performing the evaluation was that the manager who had not been actively involved with the Valley gardeners for the past three years accompanied the group. The gardeners were suspicious of the manager's presence and many answers were merely compliant and not a true reflection of the issues we had previously discussed with the gardeners. The gardeners felt that due to the presence of the manager, they should say only positive things about the SPUP. There was one positive outcome as a number of gardeners challenged the manager on the fencing issue, stating that they would rather have ready-made fencing as they did not have the time for making barbed wire, and it was not their chosen fencing-type. The manager promised to raise the subsidy issue anew with the director and resolve the fencing issue.

The SPUP formally stopped working with the Qadi group, and in Ngcolosi and Mgoqozi member numbers continued to decrease. The SPUP decided to reduce their involvement at Mabedlane as other work pressures increased. Another dismissal of a SPUP facilitator increased the level of difficulty in managing the work with the gardener groups. By March 2004, the second phase of the SPUP had formally ceased to exist and a move was made towards group-facilitation by the field workers and the associated third phase of the SPUP. The activities of the SPUP with the gardeners over the four-year time-span of the project are valuable in determining if the aims and objectives set at the beginning of the project were achieved. The following section examines in detail the activities of the SPUP with the four gardener groups and discusses the relative impacts on the gardeners' livelihoods.

4.5.2.b Institutional behaviour-over-time

One of the objectives of the SPUP was to improve household food security through increased homestead garden production. In the first year of the project, establishment of new gardens and expansion of existing gardens was a key focus of the work of the SPUP. The establishment and expansion of homestead gardens is reflected in the number of crops and soil improvement measures (use of manure, compost and the cultivation of comfrey) adopted by gardeners in the first and second year of the SPUP's involvement with Valley gardeners (Table 4.20). New crops and/or soil improvement methods were adopted by 73% of the gardeners. In Mgoqozi, only 44% of gardeners adopted new crops and soil improvement measures, which was the lowest of all the wards. In Mabedlane all the gardeners adopted new crops and soil improvement measures, which was the highest gardener adoption-rate of all the wards.

Table 4.20 Number of adoptions of new crops and soil improvement methods by gardeners in four wards of Dedangendlale Valley

Ward/ number of adoptions by gardeners	*Mabedlane* (n=9)	*Mgoqozi* (n=9)	*Qadi* (n=6)	*Ngcolosi* (n=6)	Cumulative total (n=30)
total	38	7	30	16	91
maximum	7	4	14	7	14
minimum	2	0	0	0	-
mean	4	1	5	3	-
median	4	0	4.5	3	-
mode	3	0	0	3	-

The SPUP green manure intervention proposed prior to the start of the soil fertility project was adopted by 27% of gardeners over a five-year period with only 3% of gardeners using the technology properly. My suggestion to gardeners that they increase the amount of manure used for crop production, introduced one year into the project, was adopted by 47% of gardeners over a three-year period. Possible reasons for the greater adoption rate of the increased manure intervention than the adoption rate of the green manure are:

- manure application was a technology familiar to gardeners and manure was readily available to most gardeners;
- increasing the manure application rate showed more rapid results than the green manure crop;
- the recommended green manure crops had no perceived value to gardeners other than increasing the nitrogen content of the soil (adoption of green manures is more likely when benefits other than fertile soil are provided, as gardeners prefer multiple-use technologies (Bunch,1997);
- the green manure crops were used properly by only 3% of gardeners and thus the benefits were not apparent to the majority of gardeners and
- green manure seeds were not readily available to gardeners due to administrative bottlenecks in the SPUP seed exchange programme.

In the first year there were 85 (93%) adoptions of crops and soil improvement methods with only 6 (7%) in the second year. The highest number of crop adoptions was for vegetable crops and the second highest, the introduced soil erosion control plants (Table 4.21). The vegetable crop adoptions reflect the establishment of new gardens and the expansion of established gardens, as food production is the central motivation for homestead cropping.

Gardeners in erosion-prone areas readily adopted the soil erosion control measures proposed by the SPUP and the contribution of erosion control measures to soil quality management should not be discounted. A very interesting example of conceptual understanding of soil erosion control was that of the Mgoqozi gardener who used maize stalks to terrace her steep garden.

Table 4.21 Number of plant types and methods of soil improvement adopted by gardeners in four wards of Dedangendlale Valley

Crop type	Number of adoptions	Soil improvement measures	Number of adoptions
vegetables	36	kraal manure	5
soil erosion	18	comfrey	3
fruit	10	compost	1
traditional	7		
green manure	6		
craft	5	**total adoptions**	**91**

Other than green manures and soil erosion control, the most common soil improvement method adopted by gardeners was the use of kraal manure (five gardeners) and the cultivation of comfrey (three gardeners) the second most common.

Mgoqozi had the fewest adoptions which is a reflection of the fact that most gardeners had well-established gardens which they did not expand. Mgozoqi also had the highest number of physically- (due to polio, rickets and diabetes) and mentally-challenged (due to schizophrenia) gardeners who did not want to take risks in adopting unknown crops and who were unable to expand their gardens due to financial (cost of fencing materials) and labour constraints.

Another method of determining how effective the SPUP work was in increasing the contribution to household food security through homestead production was to assess the progress in the different wards of the PEA and LEISA activities facilitated by the SPUP. Both the PEA and the LEISA activities consist of five phases (see section 4.3.1 Down to earth: plant-use and soil fertility). The institutional behaviour-over-time was examined through plotting the development of the PEA and the LEISA phases over the project time frame (Figure 4.2). The behaviour-over-time graphs plotting PEA and LEISA stages are given for each ward and are discussed in relation to the homestead gardeners' livelihoods. The aim of this approach is to determine if 'the system is doing what it says it does', i.e. to determine the sustainability of the SPUP development approach.

At a first glance, there is a noticeable difference between the two pilot groups' trajectories (Ngcolosi and Qadi) and the other two groups' trajectories (Mgoqozi and Mabedlane). This was due in part to the earlier start of the social mobilization phase of the pilot sites, which were established during the first phase of SPUP. By the time the second phase of the SPUP was formally established, most of the social mobilization had already taken place through the community gardens work and the raising of awareness about LEISA concepts and PEA processes.

The behaviour-over-time graph for Mabedlane shows that the technical intervention phases (LEISA) proceeded more rapidly than the participatory extension approach (PEA) phases for most of the project time frame. Mabedlane gardeners had strong social cohesion and ready availability of labour which was reflected at the field level, through the immediate adoption by all gardeners of the proposed soil erosion control measures and the sharing-out of chilli seedlings to all group members. Gardeners in this ward made substantial achievements in their gardens considering the inherently

low soil quality, showing that the gardeners were skilled and technically proficient. Greater impetus could have been achieved by the SPUP with this group through an accelerated PEA as the gardeners had both the capacity and willingness to develop their homestead gardens. The SPUP, through a lack of available human resources (only two fieldwork facilitators, busy with training and field-work with other groups), was unable to respond to the ability and eagerness of the Mabedlane gardeners to address soil fertility improvement measures, other than the introduction of the soil erosion control measures.

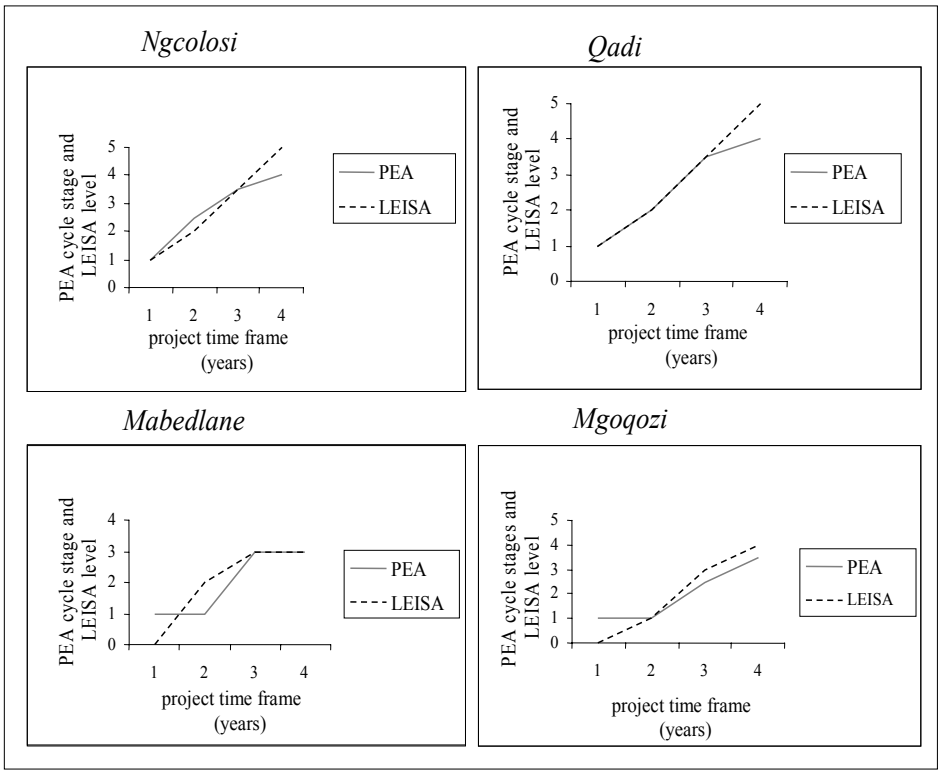

Figure 4.2 Behaviour-over-time graphs for the Participatory Extension Approach and Low-External-Input-Sustainable-Agriculture activities of the four wards

In Mgoqozi, the LEISA and PEA phases progressed almost concurrently, and considering the availability of labour and skills in this group, this can be seen as being ideally suited to the capacity of the Mgoqozi gardeners. Of all the wards, I most enjoyed the activities of the Mgoqozi group, because there was good interaction and the activities flowed well.

For Ngcolosi, the LEISA and PEA phases also progressed almost simultaneously up to a point in the third year. The technical advance was slightly slower than the PEA advance, which, given the social cohesion and conflict within the group, can be considered appropriate. From the point in the third year where the LEISA and PEA trajectories separated, the marketing and organic-certification initiatives were introduced. Reflection by the SPUP at this stage ideally should have led to a renewal

of the PEA process to assist with the group with overcoming the conflict around the marketing issues.

The Qadi behaviour-over-time graph reflects a concurrent advance of LEISA and PEA until a point in the third year. From here, the PEA phase slowed remarkably with the technical phases advancing as before. Again, given the level of social cohesion in the group and the fact that few gardeners had the motivation or skills for developing their homestead gardens, focussing anew on the PEA approach would have been useful for the group. The Qadi group had reduced to one active, skilled and motivated member at this stage, so in a sense the SPUP's intervention was appropriate for this gardener, but not for the rest of the initial group.

In terms of the participatory approach used by the SPUP, its proposed intervention into gardeners' livelihoods through the initiative of marketing organic produce to retailers is contradictory to the paradigmatical approach of LEISA and PEA. Marketing implies an increase in production and the availability of an excess of fresh produce at the field-level. This requires a maximization of output at field-level through an increase in field-level inputs (nutrients, labour and management). The LEISA approach however is based on the notion of sustainability, which is based on using available local resources and farm-level recycling in a sustainable manner. LEISA was interpreted by the SPUP as being strictly organic, and, given the livelihoods of the majority of gardeners, field level inputs such as nutrients, labour and soil fertility management were not available in sufficient quantities to significantly increase field-level output. The notion of marketing in the context of homestead gardening was thus not a sustainable option for most gardeners.

In addition, a livelihoods-based intervention should have considered the strengths and weaknesses present within the gardener-groups. The gardener-groups had a flooded local market, unreliable transport infrastructure, few financial resources and an increasing dependence on the natural resource base, due in particular to the effects of AIDS and unemployment. Increasing farm-level output requires an increase in inputs such as labour, soil fertility management techniques and natural resources for increased crop output, all of which are in short supply. A preferred and more appropriate intervention would have been a focus on the sustainability of plot level activities and their increasing role in farm-level activities. Implied in this would be interventions aimed at securing household food security through improving the nutrient content of animal manure and reduced labour technologies through the use of improved storage techniques, and the additional feeding of animals)cover crops to reduce weeding; reduced tillage or no-tillage options to reduce labour requirements etc).

Due to the adoption of erosion control measures by the majority of gardeners, loss of P through run-off was better-controlled and using external sources of phosphate would thus be a beneficial intervention. Only one purchase and application of phosphate fertilizer would be required to significantly raise the soil P levels to a point where they could then be managed through the use of (improved quality) animal manures (Katusic, 2001). This would increase productivity in a short time period and would be less labour intensive than using increased amounts of manure and planting green manure crops. In the context of the Valley gardeners, the only external input was the technology and knowledge of green manure crops. Given the abundance of

crop species, in particular traditional crops, able to contribute positively to soil fertility management, the intervention of the green manure crop was not entirely appropriate for the situation and was not a sustainable solution for gardeners to increase their soil fertility levels. An integrated approach to improving N input is recommended, and includes: higher levels of animal manure use; improving the N content of the animal manure (improved storage methods that reduced the volatilization of NH_4); and greater use of existing traditional N-fixing crops such as cow peas. As there is increased pressure on available land, grazing for cattle is likely to become less nutritious and adaptive storage techniques to improving the nutrient content of animal manure will become essential in providing N and P from animal manure.

Some of the discrepancy between what was needed at field and group level and the response to the needs by the SPUP was due to misunderstanding between field staff and programme management. Office-based management was not always aware of the time and effort it took to work with the gardener groups in the field.

I often wonder what the facilitators are doing in the field? They seem to make so little progress.

The field staff felt that the office-based management did not appreciate the time and resources required for fieldwork.

It's really difficult to sustain progress with some of the groups, there are other issues, not just agriculture. If there is a problem with the group dynamics, it takes time to sort it out and we can't carry on with the season's planning until it's sorted out. I don't think management really understands the constraints we face in the field, they say we are lazy or not facilitating properly.

Over the duration of the project, open and constructive communication between the field facilitators and the manager lessened. The level of participation by field staff in programme decision-making and planning was initially high, but over time became much lower. Towards the end of the project, the field facilitators asked me to intervene on their behalf and discuss their grievances with the manager. This implied that the participatory management structures established during the project time frame had not been adequately maintained, and in terms of organizational development, this indicates that learning routines were not functional within the programme.

At the level of field facilitator and gardener, although technical progress was at times hindered by social and economic issues, the relationships were less strained. Gardeners openly expressed their gratitude to the SPUP facilitators.

We are so grateful for the SPUP facilitators, we have learned a lot from them and each other and we get to see things we would not normally be able to see.

The facilitators in turn also expressed their enjoyment of working with the gardener groups and their willingness to go beyond the call of duty.

It's hard sometimes, but I enjoy working with the gardeners, its (sic) encouraging to see how they have developed over time, their gardens and their social skills.

Please stop here, I need to collect a food parcel from the social worker before we go. One of the gardeners is in difficulty this month and the social worker said I can take a food parcel for her. Please don't tell anybody, I will get into trouble, we are not allowed to help on social issues.

There was a good level of trust between the field-work facilitators and the gardener groups. The level of trust appeared to decline over time, in part due to staff changes in the SPUP and the deaths of the gardeners. The SPUP staff changes included the death of a key field-work facilitator and two contract-posts unfilled for the second phase of the project. The SPUP's development projects ran in four-year phases, coinciding with four-year donor-funding. As a result, it was not always possible for field-work facilitators to stay-on with the SPUP once the four-year project was complete. So the gardeners had to re-establish relationships with new field-work facilitators at the beginning of each project cycle. Some field-work facilitators were permanently employed by the SPUP and continued their interaction with the gardeners through-out the four-year funding cycles.

The SPUP intervention affects sustainability at field-, homestead-, and district-level. Organizational concerns are expressed more readily at the district level as they include both field and homestead level activities and processes. An organization able respond to unexpected outcomes of its' field level interventions, is a learning organization. The results of the research at the organizational level will be discussed in the following section in terms of organizational learning.

4.5.3 Organizational learning: a key to sustainable development

The tension between product and process is at the core of many development projects and this was also a key issue for the SPUP during the project time-frame. The SPUP subscribed to the PEA of which learning was a key process. At the programme level, participatory learning was also a key feature of the interaction among and between the facilitators and management and the SPUP stated that its effectiveness would be enhanced through working as a learning organization (Anonymous, 2000b).

A learning organization builds and improves its own practice by consciously and continuously devising and developing the means to draw learning from its own (and other's) experience (Senge, 1990). Taylor (1998) defined a learning organization as one which learns consciously, as learning can often take place at an unconscious level. If learning is not conscious, the learning will be ineffectively captured and will in turn not lead to improved future practice (Talyor, 1998). Conscious learning does not have to lead to change at all, but it hopefully would be more change-inducing than 'unconscious' learning.

To assess whether the SPUP is a learning organization or not, means that we need to determine if the SPUP met its stated objectives and whether it was able to respond reflexively to unexpected outcomes over the time frame of the project, and to adapt its response appropriately and effectively.

The SPUP had the following objectives:

- to empower families to enhance their opportunities for household food security, focusing on: cropping; vegetable and fruit production; small-livestock husbandry and food processing in a way that people can take control in finding solutions to their problems and realize their potential and
- to empower families to utilise their land productively and sustainably through land-use planning and resource management in a way that is innovative and appropriate to peoples' situations leading to more options for a better life.

From the results of the intervention process at field level reflected in the behaviour-over-time graphs and given the socio-economic context of the gardeners' livelihoods, the response of the SPUP to gardeners' needs was varied. There was tremendous heterogeneity with regard to resources and skills within and between the gardener-groups and the SPUP was only able to respond to a sector of these.

Part of the tension between product and process for the SPUP was related to its 'no handouts' policy. The tension between product and process was problematic at the field level as the 'no handouts' policy foreclosed an easy solution to the fencing issue, and the issue remained unresolved. This resulted to some extent in the first objective of the SPUP: *empowering people to find solutions to their problems* not being entirely achieved. It also indicates that projects, funded to run for four years, need an alternate time-frame for learning routines to become well-established. Learning routines enable participants to become self-mobilizing, which enhances their options for sustainable livelihoods.

The narrow interpretation of LEISA by the SPUP also foreclosed the easy solution of using fertilizer to increase soil P in the homestead gardens. The proposed intervention by the SPUP of using a green manure to increase available soil N was a technology introduced from outside of the cropping system and it was not appropriate for the majority of gardeners. The green manure intervention ultimately only served one gardener, and did largely not fulfil the second objective of the SPUP of *empowering people to utilise their land sustainably through innovative and appropriate means*.

Ideally, learning should go beyond remembering and understanding to improved action. The learning organization thus needs to find the balance between action and reflection which is right for it and produces learning which continually improves its practice. The SPUP was not able to effect behavioural change within its programme for the entire duration of the project as towards the end of the project, learning within the programme became limited and as a result, did not provide a challenging, supportive and trusting environment in which the facilitators could risk and learn. This highlights the fact that learning should not only be a conscious, but also a continuous process (Reeler, 2001).

Within the NGO sector, the continuity of learning processes is vital, as often long periods of time can elapse between a service becoming irrelevant, inadequate or

inefficient and the threat looms of funds being withdrawn. This can remove a critical pressure for learning and provides further motivation for keeping learning in NGOs conscious and intentional (Taylor and Soal, 2003).

4.6 promising pockets and novel configurations: plants, people and process

The pocket of promising activities of the SPUP remained just a promise, and one that did not fulfil the notion of long-term sustainability. Long-term sustainability was not visibly expressed as a meta-system outcome by the end of the research project. However, the limited time period of the research does make it difficult to draw definite conclusions about intergenerational sustainability.

I will now return to the research questions framed at the beginning of this chapter regarding sustainability. At the field-level, the agricultural practices of the gardeners are in some respects sustainable. Sustainability is however constrained by a number of factors. As land for the expansion of the cropping system is becoming scarce due to the rate of urbanization, more pressure is being put on land already under cultivation. The productivity of the majority of homestead gardens is under threat due to declining levels of soil macronutrients and organic matter, and the processes of soil erosion.

Significant inputs of labour and soil nutrients are needed to raise the soil fertility of many gardeners' lands. However, these inputs are not readily available. Labour from within the households is decreasing due to the effects of the HIV/AIDS pandemic, either directly through death or through the reallocation of tasks. Also, children are becoming less responsive to requests of assistance with agricultural tasks. Less manure is available to gardeners due reduced stock numbers in response to insufficient grazing land or due to the sale of livestock for financial reasons. Coupled with the decline in manure availability is the decline of soil macronutrient levels in the majority of gardeners' fields. The research farm trials show that under the gardeners' management regime, there is a trend of declining soil fertility over a two-year period and that without a significant technological intervention, the trend is likely to continue. This is the case for the majority of gardeners in the study. The research farm trials also show that the green manure intervention proposed by the SPUP leads to a significant decline in soil phosphorus levels, compared to the gardeners' manure-application rates. The improvement of declining soil fertility was constrained by the technology (an unfamiliar plant for an unfamiliar purpose) offered by the SPUP to the gardeners for the process of participatory technology development. A better understanding of the role of the crop diversity in the farming systems is needed, in particular the role of traditional crops. Ideally, the technological intervention by the SPUP should focus on solutions within the technological knowledge base of the gardeners. Increasing the manure application rate (recommended by FERTREC, tested by me at Ukulinga) was adopted by some gardeners and was found to be effective. The 'technology' of manure-application was already used by 97% of gardeners. The green manure 'technology' is useful to a few gardeners, but the focus should be on using existing and familiar crop species (e.g. cowpeas, pigeonpea) as the green manure.

The erosion control measures proposed by the SPUP have been adopted by most of the gardeners in the most erosion-prone ward. These results imply that the contribution made by the SPUP intervention is mixed, as the green manure intervention does not make a significant contribution, whereas the erosion-control intervention does make a

significant contribution to the sustainability of agricultural production in homestead gardens. For this reason, the sustainability of the intervention in the crop production system is rated as low to moderate at the field-level.

At the household-level, socio-economic and cultural factors significantly influence soil fertility management regimes. Also, the skills and knowledge of the gardeners enable them to produce sufficient crops to make a significant contribution to household food security. Household food security is constrained by available land, access to water, labour availability and sources of seed. The unresolved conflict within some of the gardener groups is also a limiting factor to sustainability. It indicates that learning is not a sustained theme in the groups. Another factor limiting the potential sustainability of the development intervention is the fact that for some gardeners, agricultural intensification is not a viable livelihood option. These gardeners do not have the required agricultural resources (labour, land, N, P, water) for increased food production. Many of these gardeners rely on their homestead gardens to supplement household food security, while pursuing other options for household food security. To increase the potential for the diversification of livelihood options of these gardeners, skills development and training in alternative income generating activities would contribute to the sustainability of the homestead. However, the development project of the SPUP was not successfully aligned with networks of organizations that could assist in providing skills development and training to the gardeners. Both government and non-government organizations provide small-business and skills training. Linking with these organizations would also increase the potential sustainability of the intervention as gardeners would have links to the network after the end of the four-year development project. In this way, gardeners would be self-mobilized to diversify their options for sustainable livelihoods. The social, economic and institutional sustainability of the development programme at the household-level is rated as low to moderate.

At the district-level, the activities of SPUP are not a complete reflection of its stated aims, which in turn implies that the institutional factors have a significant, albeit at times a negative, impact on household food security. At the level of organizational interaction, the intensity of participation experienced in the SPUP activities, particularly at the level of manager and fieldwork facilitator indicates low potential for institutional and social sustainability. Pretty (1994) gave seven typologies for participation ranging from passive participation to self-mobilization. He stated that if the objective of development is to achieve sustainable development, then nothing less than functional participation (position 5 of 7) is necessary (Pretty, 1995). Functional participation can be defined as: *participation in groups to meet predetermined objectives related to the project, which can involve the development or promotion of externally initiated social organization*. These groups tend to be dependent on external initiators and facilitators, but may, ultimately become self-dependent (Pretty, 1994). Participation by consultation (position 4 of 7) is characterized by the definition of both problems and solutions by external agents, and this consultative process does not concede any share in decision-making to the community (Pretty, 1994). The consultative participation at the level of manager and fieldwork facilitator trickled down to the level of gardener and fieldwork facilitator. Although the LEISA five-phase framework used by the SPUP can be seen as participation by consultation due to

its directive focus on training, initially functional participation did drive the gardener and fieldwork facilitator interactions, but with ongoing pressure from management to produce results from the fieldwork, participation moved towards consultative participation.

Other constraining factors within the project were:

- the narrow interpretation of LEISA by the SPUP to mean organic agriculture;
- the limited recognition of the potential contribution of local knowledge and scientific knowledge to the project;
- the restricted time and opportunity available for reflection and discussion by field facilitators (linked to the four-year funding time-frame) and
- the decline in conscious learning processes at the programme level.

From the points mentioned above, the efforts of the SPUP may have had more benefit to the project outcome and the livelihoods of the gardeners if:

- a baseline study had been undertaken when the SPUP first became active with the gardeners;
- each visit and reflection had been thoroughly documented and shared through discussion with other field facilitators and also with gardeners;
- more reflection had been undertaken after each visit, workshop and meeting;
- greater opportunity had been created for the potential value of contributions made by local knowledge; and research and government departments;
- better linkage with government departments had been established, to achieve continuity of the programme after four years;
- LEISA had not been interpreted to mean organic agriculture, but had rather allowed for short term concessions in using external inputs to improve soi fertility and
- learning was a conscious and continuous process throughout the project time-frame.

Sustainable development requires heterogeneous sources of knowledge and skills; a multi-level approach to development; and the establishment and maintenance of learning routines within and by organizations. Participatory technology development confirms the potential for synergy through the complementarity of knowledge held by gardeners, fieldwork facilitators and researchers. The potential sustainability of the intervention in this case study is compared with that of the interventions in the other two case studies, and is discussed further in Chapter 7. This case study is also discussed in Chapter 7 in the light of the concepts and outcomes of strategic niche management.

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Chapter 5: Back to our roots

The sustainability of craft production at Mbongolwane wetland

5.1 Introduction

The sustainability of natural resource use is challenging because the supply of natural resources needs to be sustained concurrently with the maintenance of the integrity of the natural system delivering the resources. Wetlands are well known for the abundant natural resources that they offer but are also vulnerable to human impacts on the integrity of the system (Dugan, 1990). Thus, wetlands provide interesting systems within which to explore the concept of sustainable use of natural resources. Wetlands are transitional between terrestrial and aquatic systems (Cowardin *et al.*, 1979) and are often strongly linked with other elements in the landscape, including those located both upstream and downstream within the wetland catchment. Thus, the functioning of wetlands is influenced by processes occurring locally at the wetland (e.g. cultivation of the wetland soil) and by processes operating at broader scales across catchments and landscapes (e.g. the abstraction or pollution of water upstream of the wetland). Similarly, wetlands supply ecosystem services locally (e.g. a household living alongside the wetland harvests reeds) as well as to distant beneficiaries (e.g. water users downstream benefit from the water quality enhancement provided by the wetland). Therefore, wetlands are often subject to conflicting land-use demands (e.g. they are recognized as having high biodiversity value, while at the same time providing potentially fertile lands for cultivation, particularly for farmers lacking resources for irrigation and fertilizers).

The production of crafts from wetland plants has the potential to support the livelihoods of local communities and to generate multiple benefits to society (Table 5.1). In KwaZulu-Natal, for example, approximately 60 000 harvesters and weavers of indigenous fibre derive their livelihoods from trading in fibre products (Mander and McKenzie, 2005).

Table 5.1 Multiple benefits from crafts woven from sustainably harvested wetland plants (Kotze, 2001)

Economic benefits A source of revenue for poor/ unemployed people	*Cultural benefits* Maintenance of traditional skills (weaving) and practices (use of mats as wedding gifts)	*Empowerment benefits* Opportunity for dis-empowered people to use their existing skills to increase their level of empowerment and self-esteem	*Social exchange* Opportunity for socializing during the production of crafts	*Utility benefits* Low-cost sitting, sleeping and eating surfaces and storage containers	*Environmental benefits* Maintenance of native wetland vegetation and associated indirect benefits (sediment trapping toxicant assimilation, habitat provision)

Despite the considerable contribution to livelihoods by crafts from natural fibres, there are many constraints that restrict the income that individual crafters receive from their products. These constraints include: a limited diversity of product types, poor access to appropriate communication, transport and infrastructure, and limited support from government in order to increase competitiveness in trade (Rogerson and Sithole, 2001; Mander and McKenzie, 2005). Thus, there is a clear need for intervention in assisting crafters to address these constraints through access to new markets and through the development of higher-value products that build on indigenous knowledge and locally available materials.

Following some initial research (Kotze, 1999), a small-scale project in support of sustainable use of craft plants at Mbongolwane, near Eshowe, was initiated in 1997 by Donovan Kotze, with the support of the Institute of Natural Resources, and continued to evolve, through until 2004. The research based at Mbongolwane was grounded in indigenous knowledge, traditional authority, local government agencies, and the participatory intervention of NGOs and research institutions. The project was conceptualized as a niche and the intervention as a novelty once the practices at field level appeared to be sustainable. As was elaborated upon in Chapter 2, novelty production is a highly localized process: it is dependent on local ecosystems and local cultural repertoires in which the organization of the labour process is embedded. In the research programme, the interaction of change agents, researchers, extension personnel and community members was actively and strategically managed to maximize the synergistic effects of the various interactions.

Research question and methods

The ecological, social and economic sustainability of the production of crafts from wetland plants at Mbongolwane was the key objective of the initial development intervention. My research on the sustainability of the intervention was explored through the following research questions:

Field level

- How sustainable is the harvesting of wetland plants for craft production?
- What roles do socio-economic and cultural factors play in the sustainable use of the wetland?

Household level

- Does craft production make a significant contribution to the economy of the household?
- How compatible is craft production with socio-economic and cultural factors?

District level

- What factors in the craft initiative contribute to the organizational development?
- What contribution does the strategic management of the technical and institutional factors within the intervention make to sustainability?

As described in Chapter 2, a number of elements contribute to sustainability, and three are examined here: environmental, economic and social. The methods used for assessing sustainability were tailored for each of these three elements of sustainability:

- Ecological sustainability was assessed based on observations of the extent, timing and mode of resource harvesting in relation to: (a) the extent of the resource available and (b) ecological sustainability criteria given by Cunningham (2001) which identify key traits of the resource harvested (e.g. perenniality, whether annual or perennial growth is harvested, height of growing points relative to height of harvesting, etc.).
- Economic sustainability was assessed based on (a) an economic assessment of the income derived by the craft group and its members over the two-year period 2003 to 2004 and (b) focus group interviews with craft group members in 2003.
- Social sustainability was assessed based on (a) focus group interviews with craft group members in 2003 and (b) identification of issues emerging out of a series of approximately 12 craft group meetings over a five year period 2000-2004.

The analysis draws on the following sources of information.

- An ecological description of the wetland including a hydrological zone determination and the distribution and extent of the wetland's dominant vegetation types (Kotze, 1999; Kotze and O'Connor, 2000).
- A description of the extent of transformation of the wetland (e.g. through cultivation) conducted in 1995 and again in 2002 (Kotze *et al.*, 2002).
- A questionnaire survey relating to household utilization of the wetland conducted in 2002, for 50 households within 1.5 km of the wetland. This represents 21% of the total number of households in the area examined. Households were sampled at each of five locations, distributed widely across the length of the wetland.
- Interviews with focus groups (including the craft group, cultivators and tribal leadership) and key informants having a good historical knowledge of the wetland.
- Minutes of project meetings.

Before examining the project in relation to sustainability, a broad overview of the wetland and its utilization is provided, followed by a brief description of the history of the project.

5.2 Biophysical characteristics of Mbongolwane wetland

Mbongolwane wetland, situated 40 km west of Eshowe, KwaZulu-Natal (see Figure 3.2), at the headwaters of the Amatikulu catchment, meanders for 12 km through the Ntuli Tribal Ward. The mean annual rainfall for the Mbongolwane area is approximately 900 mm, and this occurs predominantly in the summer months (October to February). Owing to the moderately high rainfall and mild winters, the potential for dryland cultivation is moderately high.

Most of the wetland has no clearly defined stream channel and is characterized by diffuse flow and predominantly permanently to seasonally saturated soil and herbaceous, emergent marsh vegetation. However, for some of its length the wetland comprises a floodplain with a well-defined, stream channel, having temporarily wet soil and grassland vegetation on either side of the main channel. Comparison of

photographs shows that since at least 1953 the extent of diffuse flow areas has been increasing owing to the deposition of sediment in some channel areas and the spread of water flow (Kotze, 1999).

The wetland provides a wealth of life-sustaining resources to the Ntuli community, including water, plant material for craft making and thatching, grazing for cattle, medicinal plants, and land for cultivating crops. Added to these resources are the cultural value of the wetland and its hydrological importance to the Amatikulu catchment. The wetland is 395 ha in extent and is surrounded by approximately 4000 ha of the upper Amatikulu catchment. The principal land-covers in the catchment are: sugar cane (51%); natural vegetation (29%); cropland (16%); and infrastructure, including houses, roads and tracks (<5%). The agricultural and domestic activities in the catchment are likely to have increased the amount of sediment and nutrients entering the wetland, placing increasing importance on the wetland's functions for sediment trapping and pollutant assimilation. Although there are some boreholes in the catchment and there is limited pumping directly from the stream, there are no dams, limited irrigation and few timber plantations in the catchment. Thus, the quantity and timing of the wetland's inflow is unlikely to have been greatly altered from its natural state (Kotze 1999). In addition, it is one of the few large wetlands in the KwaZulu-Natal coastal zone outside of a protected area that has not been highly transformed by agriculture. From a landscape perspective, it is significant to note that the wetland occurs within Veld Type 5 (Acocks, 1953). This veld type in South Africa has been highly transformed, resulting in less than 10% of its native vegetation remaining and only 1% occurring in protected areas (Scott-Shaw *et al.*, 1996). Native vegetation areas in this region, such as at Mbongolwane, have particularly high conservation value.

The wetland provides a diversity of habitats including: reed marsh in the permanently waterlogged areas dominated by the tall reeds *Phragmites australis* (Car.) Stend.(*uMhlanga* in isiZulu), to a lesser extent *Phragmites mauritianus* Kunth and bulrush *Typha capensis* (Rhorb) N.R. Br.(*iBuma* in isiZulu); sedge marsh dominated by *Cyperus latifolius* Poir (*iKhwane* in isiZulu) in the seasonally waterlogged areas; and wet grassland in the temporarily waterlogged areas. There are also some open water areas, one of which is home to a crocodile (*Crocodylus niloticus* L.). The different habitats support a diversity of bird species and the wetland occasionally supports breeding crowned crane (*Balearica regulorum regulorum* Bennett), a threatened species, as well as a wide range of other wetland-dependent species such as the purple heron (*Ardea purpurea purpurea* L.) and marsh owl (*Asio capensis capensis* A Smith). The natural features, together with the peaceful rural atmosphere, scenic surrounding hills, sites of historical significance, and the local people's close relationship with the wetland make Mbongolwane a potential tourist destination, although the site is well outside of any tourist route.

5.3 Multiple uses of the wetland

More than any other, poor rural communities are dependent on wetlands and the great variety and abundance of resources that they provide, including fish, places for cultivation (see Plates 5. and 6.), a source of water, grazing for livestock, and plants for crafts and construction (Dugan, 1990). From a food security point of view, wetland

cultivation is particularly important, especially during periods of drought (FAO, 1998). Wetland soils are better supplied with water and are often inherently more fertile than associated non-wetland soils (Scotney and Wilby, 1983). At the same time, however, wetland cultivation may have very high impacts on catchment water quality and biodiversity (Kotze *et al.*, 1995). Thus, in order to be able to promote management that would meet the needs of the wetland users and would maintain the integrity of the wetland and its catchment, it was useful to gain a better understanding of how the wetland was being used and the benefits it had for local people.

Over the past 50 years, the human population at Mbongolwane has been increasing, particularly in the area around the wetland. Based on aerial photograph interpretation, the number of dwellings within 1.5 km of the wetland increased from 301 in 1937 to 470 in 1972, 566 in 1991, and 601 in 2002, which indicated that the human population around the wetland had nearly doubled over approximately 60 years. However, recently the population growth at Mbongolwane appears to have been impacted upon negatively by HIV/AIDS-related deaths amongst young adults in the area.

The wetland falls within a tribal area, the KwaNtuli Tribal Ward, which has twenty-two sub-wards, nine of which include portions of the wetland. At the time of the study, users of the wetland were predominantly local residents from the nine sub-wards surrounding the wetland. Some members of the other thirteen sub-wards made less frequent use of the wetland due to the greater distances travelled to reach the wetland. Use of the wetland by individuals outside of the ward was rare but occasionally outside people were known to harvest wetland plants.

In the household survey conducted in 2002, 88% of the households interviewed made frequent use of the wetland, indicating that Mbongolwane wetland had some use and value for the majority of people interviewed. The types of use varied considerably, including those relating to basic food, water and household needs and also including spiritual and cultural uses (Figure 5.1).

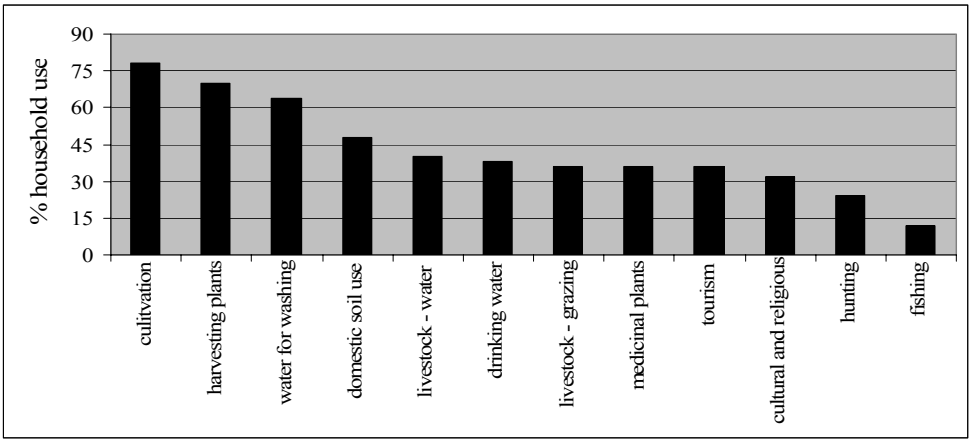

Figure 5.1 Multiple Uses of Mbongolwane Wetland (% of households)

Of the households not using the wetland, the reasons given were: no need (i.e. other income and water sources available); fear of contracting cholera; and one household's members said they used to use the wetland but they were now too old and the wetland was too far. Cultivation was the most popular use of the wetland by the nearby community and approximately 12% (45 ha) of the wetland was used for crop production in 1995, with the extent slightly lower in 2004.

A number of crops were cultivated, with madumbes (*Taro, Colocasia esculenta* (L.) Schott) being the most widely cultivated. *Cyperus latifolius* (*iKhwane*) was the most widely harvested wetland plant of the various wetland plants harvested. Soil use included sand for building and mud for plastering and building. Less than 50% of the households interviewed kept livestock, using the wetland throughout the year for grazing, but predominantly in winter and early spring when little grazing was available elsewhere.

Borehole standpipes were the preferred means of water supply, but the distance to these was too great for some households, which then made use of the wetland for water. Culture-related use included cleansing after burials, bathing when young women came of age and religious baptism.

A number of medicinal plants were used from the wetland, the two most frequently used wetland plants were *Ranunculus multifidus* Forsk. (*uXhaphozi*) which was extremely abundant in the wetland and *Gunnera perpensa* L. (*uKlenya, uXobo*) which was very rare in the wetland, possibly due to over-harvesting. Visits by tourists were infrequent (less than monthly) but when visiting, they joined in the community events (e.g. craft days and weddings). Thus, many people had some involvement and interaction with tourists even though they did not benefit financially. Hunting was an activity undertaken mostly by boys. Open water habitat for fish was limited in the wetland, reducing the opportunity for fishing.

5.3.1 Cultivation within the Mbongolwane wetland

Kotze (1999) determined to what extent cultivation of the wetland had changed over the years. Obtaining an accurate estimate of the extent of cultivation from air photographs alone was difficult as many cultivated areas were too small to be visible on the photographs unless present as several contiguous patches. Extensive ground verification was undertaken in 1995 to obtain an accurate estimate of the situation. For preceding times, an approximation was obtained from aerial photographs alone, allowing for under-representation. Prior to the 1960s, *ca*. three hectares of the wetland were cultivated; by 1973 this increased to *ca.* eighteen hectares and by 1995, *ca.* 46 hectares of the wetland were cultivated for crop production, with ca. fourteen hectares (30%) of this being fallow land. Local informants with a thorough knowledge of the area's history said the extent of cultivation had more than doubled in 25 years, confirming the trend revealed in the aerial photograph analysis (Kotze, 1999). Increased human population in the area and less alternative cropland due to the increased cropping of sugar cane in the surrounding catchment were other factors that contributed to the increase in wetland cultivation. Farmers began planting sugar in the catchment in the 1970s.

Although cultivation occurred predominantly in the temporarily wet areas, the expansion of cropland had largely been into iKhwane marsh areas with the rate of

conversion accelerating in the early 1990s owing to a combination of several consecutive dry years and increased human population in the area (IPS 1996; Kotze 1999). However, during 1996 and 1997 the extent of cultivation within the iKhwane marsh areas declined, owing in part to intervention from outside organizations but mainly due to the fact that these were above average rainfall years, that resulted in favourable conditions for dryland cultivation outside of the wetland and resulting in less favourable conditions in the wetland due to prolonged soil saturation. The annual rainfall for 1996 and 1997 was 1056mm and 1006mm respectively, compared with the mean of 742 mm in the preceding dry period (1990 to 1995) (Kotze, 1999). The mechanisms by which farmers decided on the relative extent of wetland and dryland cultivation in a particular year were not fully investigated but appeared to depend on factors such as the late or early arrival of the spring rains (September/October) and how well the crops performed during the previous year.

Vegetable crops are cultivated in raised beds in the wetland. The beds vary in size from 10 to 100m^2 and are generally raised 0.05 to 0.5 m above the original soil surface. A shallow furrow is made around the bed, particularly in the seasonally wet areas of the wetland. Generally, cultivation is undertaken without major drainage channels, although the raised beds and shallow furrows increase the height of the soil surface relative to the water table, and to some extent diminishes the level of waterlogging through localized drainage.

In the wetland, *madumbe* (taro) was the most frequently grown crop, followed by cabbages and onions. While the other crops were grown predominantly in the temporarily wet areas, *madumbes* are more tolerant of waterlogging than the other crops and are grown in the seasonally wet areas of the wetland. An estimate of the average yield of *madumbes*, based on interviews with *madumbe* growers and measurements was 25-35 tonnes per hectare (Adey and Kotze, 1997; Kotze, 2001), comparable with estimates reported in the international literature where yields of up to 65 t/ha are reported for other varieties (O'Hair and Asokan, 1986). The madumbe crop was used for home consumption, local sales and as seed for the subsequent production season.

Madumbes are considered to be a traditional crop in South Africa and knowledge of cultivation is passed on from generation to generation, largely through a hands-on approach. Within the wetland, where wetland conditions preclude the use of tractors, the crop was cultivated manually using hoes. Soil fertility management for the cultivation of *madumbes* was based on cattle manure and cultivators said that the use of fertilizer produced a less palatable, watery crop with reduced keeping quality (Adey and Kotze, 1997).

5.3.2 Mbongolwane wetland as a source of craft material

Mbongolwane wetland has an abundant supply of harvestable material for crafts in the form of approximately 80 ha of sedge marsh dominated by *Cyperus latifolius* (*iKhwane*). Of all the wetland species used for weaving in KwaZulu-Natal, *iKhwane* is probably the most widespread and abundant. *iKhwane* occurs from just above sea level to altitudes of up to 1000 m, and many wetlands within this altitude range support large stands of this plant. In KwaZulu-Natal, based on the extent of wetlands in the province (Begg, 1989; Kotze, 1999), it is estimated that collectively there are at least

30 000 ha of dense stands of *iKhwane*. Despite the occurrence and abundance of *iKhwane* in a range of wetlands (Kotze and O' Connor, 2000), currently most of this *iKhwane* is not being utilized. The leaves of *iKhwane* are well suited for a diversity of weaves, particularly those made from thick plaited rope, and *iKhwane* has a high resilience to harvesting (McKean, 2001). At Mbongolwane, 62% of households interviewed utilized *iKhwane* (see Plate 7.) and the skill of weaving was prevalent within these households. The distribution and extent of different vegetation types, cultivated land and sensitive areas within Mbongolwane wetland are presented in Figure 5.2.

5.4 Towards the wise use of Mbongolwane wetland

With the increasing human population, the Mbongolwane wetland is under increasing pressure, in particular through the expansion of cultivation (Kotze, 1999). Also, the institutional capacity, both local and traditional, for controlling the use of the wetland and promoting its long-term sustainability, is declining (Kotze, 1999). An intervention was identified as being needed to promote the sustainable use of the wetland, as many households were dependent on its services. In 2000, two community workshops, organized by the Farmer Support Group of the University of Natal, were held in which the long-term vision of the community for the wetland was explored. The workshops were attended by a broad spectrum of community members including: the tribal authority and different interest groups such as sugar growers, wetland farmers and crafters using material from the wetland. A project was formulated using the information from the two visioning workshops and from previous studies. The project had the following broad objectives:

- to build capacity of local people for sustainable management of the wetland;
- to promote effective conservation of the wetland and other water resources;
- to promote ecologically sound agriculture and
- to develop rural enterprises, in particular those which used wetland resources in a sustainable manner and those which gave added value to the wetland.

5.4.1 A philosophy of conservation through production

The philosophy underlying the Mbongolwane intervention was the re-configuration of modes of production through creating incentives to pull producers in a direction of more benign land-uses. Simultaneously, disincentives were required to push producers out of old and less sustainable modes of production (i.e. 'pushing' and 'pulling' working together synergistically). The overall goal of enhanced sustainability of use of the wetland could only be achieved and have practical application if the new modes of production that were acceptable to the majority of producers. For example, tourism is often cited as being an alternative mode of production to large-scale transformation of natural systems, but if the new tourism enterprises involve only a few of the original producers, it is unlikely to have the desired effect, even if the net benefits at the level of the district are greater than those of the existing production.

Plate 5. Madumbe cultivation in Mbongolwane wetland, showing drainage channel

Plate 6. Community gardens within the wetland contribute to household food security

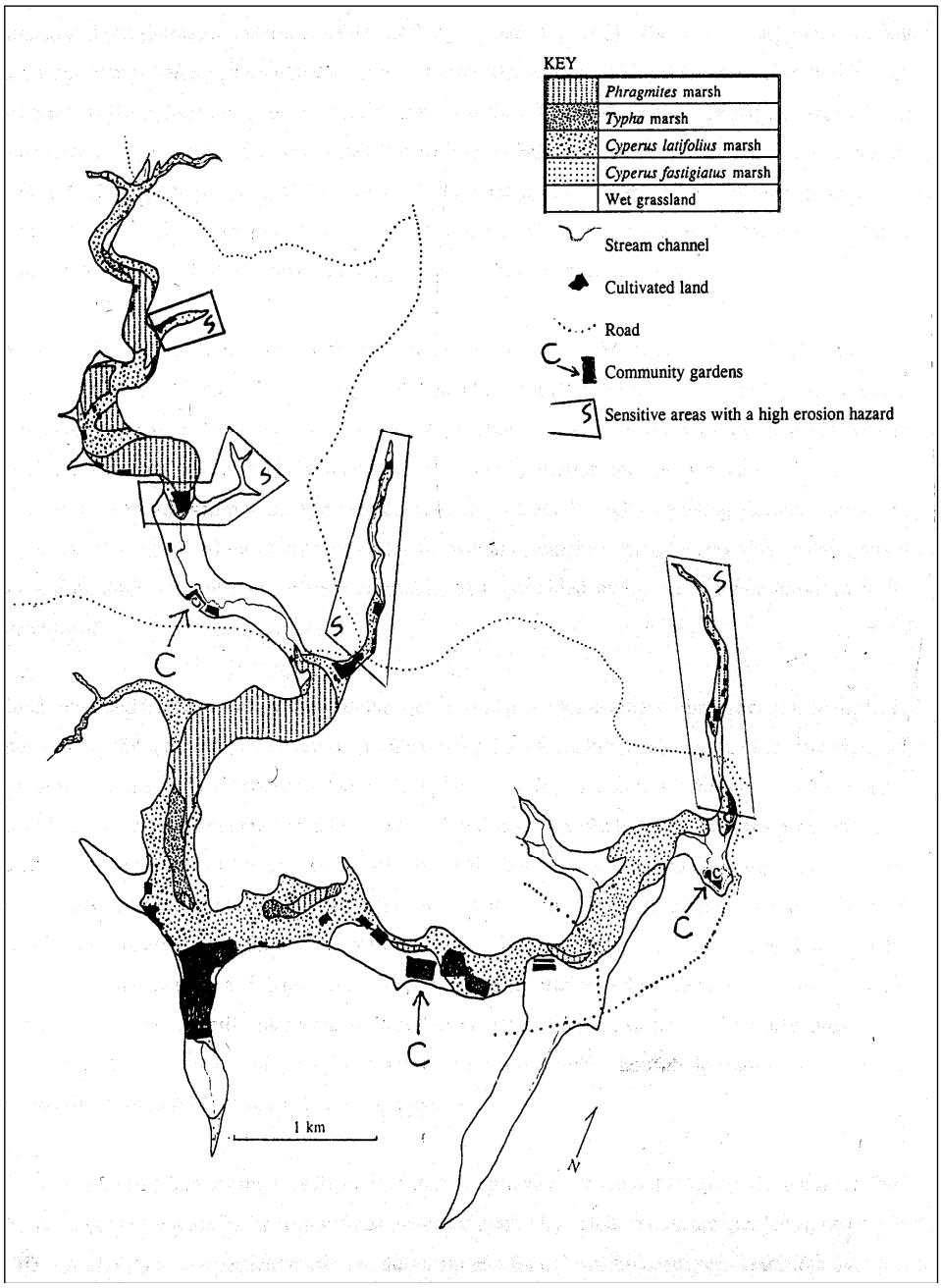

Figure 5.2 The distribution and extent of different vegetation types, cultivated land and sensitive areas within Mbongolwane wetland

Nationally, the philosophy of agricultural modernization, which was instituted after the Second World War, directly affected the ecological functioning of wetlands.

Wetlands were extensively transformed through drainage and cultivation and in the KwaZulu-Natal hinterland this was particularly the case for sugar cane plantations. The government supported the transformation of wetlands through technical advice e.g. how to effectively ridge and furrow a wetland (Hill *et al.*, 1981) and through subsidies for development (Kotze *et al.*, 1995). During the 1980s, with the increased awareness of environmental issues, government support for wetland development rapidly declined and legislation was enacted for the protection of wetlands. This strongly protectionist approach, which represented an almost complete about-turn from the previous approach to agriculture and wetlands, left little middle ground for promoting more sustainable modes of crop production within wetlands.

In the context of Mbongolwane wetland, *madumbe* production in the less sensitive areas is seen as a potentially sustainable mode of crop production due to manual cultivation, use of small quantities of cattle manure as fertilizer and the limited scale of production, primarily for home use and local sales. Although *madumbe* production within the wetland is potentially sustainable due to the methods of production, any substantial scaling up of production would negatively impact on the functional integrity of the wetland, and affect factors such as flood control, nutrient cycling, nutrient assimilation, erosion control and wildlife habitat (Kotze, 1999). This conclusion is based on the fact that (1) cultivation involves the complete removal of all native vegetation from the cultivated area and a high level of disturbance owing to the fact that it is a root crop with tillage occurring twice a year at planting and harvesting, and (2) the greater the extent of cultivated areas relative to intact areas, the smaller are the opportunities for resting areas in order to recover fertility and control erosion, as recommended by Dixon and Wood (2003). Local farmers at Mbongolwane report that after two to three years of cultivating a given madumbe plot, the fertility declines, requiring the resting of the area for several years. Much of the *Phragmites* marsh is too wet for *madumbe* cultivation and the wet grassland too dry, with cultivation being confined to areas of intermediate wetness, namely the *iKhwane* marsh, which limits the area available for *madumbe* cultivation.

Given that the Mbongolwane wetland is subject to frequent stormflows, it is exposed to the hazards of excessive erosion, particularly in the sensitive areas (see Figure 5.2), which have an average longitudinal slope of 2.81% compared with the less sensitive main body of the wetland with a slope of 0.06%. Many wetland soils in southern Africa have a high erodibility and erosion is one of the most common causes of degradation in the wetlands of southern Africa (Scotney and Wilby, 1983; Whitlow, 1991; Kotze et al., 1995). Gully erosion was evident in the sensitive areas of Mbongolwane.

In contrast to the situation for *madumbe* production, the scaling up of *iKhwane* harvesting was considered to be much more environmentally sustainable, as will be elaborated on in Section 5.5.1. As there are many crafters at Mbongolwane skilled at weaving *iKhwane* and with ready access to the abundant raw material, the development of craft products with income-generating potential is considered to be an appropriate intervention at Mbongolwane. Craft production is also considered to have much greater potential than *madumbe* production to promote 'Conservation (of wetlands) through Production (of crafts)' as is elaborated upon in the following section, where the sustainability of *iKhwane* harvesting is assessed. Following this

assessment, the activities of the Thubaleth'ehlihle craft group and how innovative *iKhwane* products were developed with the group are described and then implications for livelihoods and institutional sustainability are examined.

5.5 Thubaleth'elihle Craft Group: 1997-2004

5.5.1. An assessment of sustainability at field level

Based on the ecological survey and focus group discussions with crafters, a better understanding was gained of the plants that were growing in the wetland, which could be used by Thubaleth'elihle Craft Group. This understanding included the local knowledge associated with each plant, the types of weaves for which each plant was suited and their abundance in the wetland. Based on the above understanding and an assessment of the potential market, the project then guided the crafters in experimenting with developing new products using their existing skills and available materials. *iKhwane* was chosen as the ideal plant for craft production and many Mbongolwane crafters were skilled in its use. At the field level several factors were identified supporting its choice from an environmental sustainability perspective.

Firstly, considerable areas (80ha) of *iKhwane* were available within Mbongolwane wetland of which only a small proportion is used annually. Secondly, the method of harvesting did not significantly affect the functional integrity of the wetland as the leaves of the plant are cut above ground level, leaving the roots in place for plant re-growth. This contrasted markedly with *madumbe* production that requires a high level of disturbance of the soil for both planting and harvesting. Thirdly, based on the criteria given by Cunningham (2001), *iKhwane* is considered to have a high level of resilience to harvesting. It occurs in dense almost monospecific stands, it has a perennial root system, annual above-ground production is harvested, harvesting is above the growing points of the plant, and the plant has a very broad geographic distribution and moderately low habitat specificity. Fibre-producing wetland plant species are generally suited to sustainable harvesting and cope well with regular and intensive levels of harvesting as they are generally fast growing and have high regenerative capacities (Cunningham, 1987).

Traditionally in rural communities there are often taboos and beliefs that govern sustainable harvesting practices. At Mbongolwane a locally held rule is that the harvesting of *Phragmites* reeds should take place after the end of April. This is when the plants naturally die back, resulting in minimal impacts from harvesting activities. If repeated harvesting takes place earlier and on a larger scale it would be likely to weaken the plants. These harvesting practices are supported by the traditional belief in *iNkanyamba*, the seven-headed serpent spirit that lives in the wetland. According to the belief, if harvesting takes place too early, *iNkanyamba* is disturbed and causes a violent storm. Although harvesting of *iKhwane* is not governed by such a clearly defined closed season rule as *Phragmites*, primarily because leaves need to be harvested before die-back takes place in order to be suitable for weaving, it is generally held in practice that harvesting takes place in the latter part of the growing season, after January.

5.5.2 Overview of activities

Before assessing the economic and institutional sustainability of craft production at Mbongolwane, an overview of the craft groups' development will be given. The Thubaleth'elihle Craft Group was established in 1997 (see Plate 8.) and by the end of the first year had developed several marketable craft items. These items included pin boards, beverage can coolers and shoulder bags. A number of these were tested for marketability on local and provincial craft markets. The shoulder bags had the greatest potential and were developed and marketed as document folders for conferences (see Plate 9.). Increasingly, conferences were seeking practical gift items that reflected South African culture. With their *iKhwane* Conference Folder, Thubaleth'elihle craft group developed a new product, tailored for conferences and which reflected their local culture. The folder design was a novelty as it was both functional and it was made using indigenous technology. These features did not fall into any of the 4 categories of craft production identified by Preston-Whyte (1983): [1] functional objects for indigenous use rather than for sale [2] African craft work of a modern and traditional genre, but consciously African and reproduced indigenous items (e.g. pots, beer strainers, beadwork) [3] a break from purely ethnic craft forms (e.g. knitted shawls, crocheted items) [4] ethnic but non-African designed (e.g. rugs, cushion covers, factory production).

Several younger members of the group were inexperienced and although the quality of their production had improved, it was still not of a marketable standard. A formal training programme was undertaken and through the training, the group was able to significantly improve the quality and design of their conference folders. In addition to the formal training, experienced members of the group trained less experienced members on a less formal basis. This training was ongoing and continued for many years. It was very encouraging that several young women became active and skilled members of the group and this is reflected in comments from two of the younger members of the group.

> *Before I was not interested in weaving crafts. It was something for the grannies to do. But then I saw that the members of the group were making money, and so I got interested and joined the craft group.*

> *When I started my bags where poor quality and many were rejected, now look at how neat they are!*

Members of the craft group also received guidance and training in basic business principles through the Institute of Natural Resources (INR). The INR is a non-profit organization that administered the funds for the intervention into the wise use of the wetland (the intervention was a component of the PhD studies of D.C. Kotze). In 1999, the activities of the craft group became associated with the LandCare South Africa programme. This government-funded project was initiated at Mbongolwane in recognition of the complexity of sustainable use of the wetland and the need to involve all people associated with the wetland. The LandCare project was driven by the Farmer Support Group (FSG) of the Centre for Rural Development Systems

(CERDES) of the University of Natal (the name of the University of Natal changed to University of KwaZulu-Natal in 2004). As the project expanded, a number of other organizations became involved joining the traditional authorities, the regional department of agriculture, the local conservation authority, and the local users and affected parties that had been involved from the inception of the intervention. The organizations involved through the LandCare programme included: the INR; Working for Wetlands; and the Mondi Wetland Project (MWP).

At the end of 2001, a key member of the group, the secretary, fell ill and died. She was in her late twenties and left behind two children with no father for support. The group responded by collecting donations for her children from the craft group members.

With the increasing number of orders and the associated amount of money handled by the group, the stock control and financial management systems were shown to be inadequate. This was further aggravated by the death of the group's secretary and the resignation of the craft facilitator from the FSG. In response, selected members from the craft group were formally trained in bookkeeping, a course conducted by the INR and sponsored by LandCare. The trained bookkeepers then worked for the craft group and were paid from the profits made from the sale of the conference folders.

The Thubaleth'elihle Craft Group had long articulated its need for a craft centre and in 2001, through the LandCare programme, the support of the German Development Service (DED) was gained for this initiative. At an introductory meeting between DED and Thubaleth'elihle, DED agreed to assist the group financially with the construction of the craft centre. The craft group in turn would provide the necessary labour and material resources. The initiative was used as an opportunity for training local young men interested in learning building technologies. The Integrated Technology Department of The Valley Trust contributed funds towards the project, provided the training in appropriate building technologies and facilitated the building of the craft centre. In July 2003 the Thubaleth'elihle craft group opened its craft centre, through the financial support of LandCare and the German Development Service (DED) and the technical support of The Valley Trust. The craft centre serves several important functions for the craft group; it provides a central meeting place, a storage facility and a sales outlet. The centre contributes significantly to the objective of promoting rural enterprise development. It also serves as a focal point for the tourism initiative. A number of other activities of the craft group assisted in promoting their activities in rural enterprise development.

During the World Summit for Sustainable Development (WSSD) in 2002, two members of the craft group showcased the work of the craft group at the Mondi Wetlands Project stand. They attracted the attention of two politicians, the provincial Minister of Agriculture and Environmental Affairs, and the national Minister of Traditional Affairs. Also in 2002, the group received an award for the Best Community Conservation Project in the national Green Trust Environmental Awards. In 2003 on World Wetlands Day, a member of the craft group, with support from the Mondi Wetlands Project, represented the group in Parliament in Cape Town, showcasing the benefits that the Mbongolwane community were obtaining from the wetland.

Plate 7. A crafter harvesting raw material (*Cyperus latifolius*) from the wetland

Plate 8. Thubaleth'elihle craft group at Mbongolwane

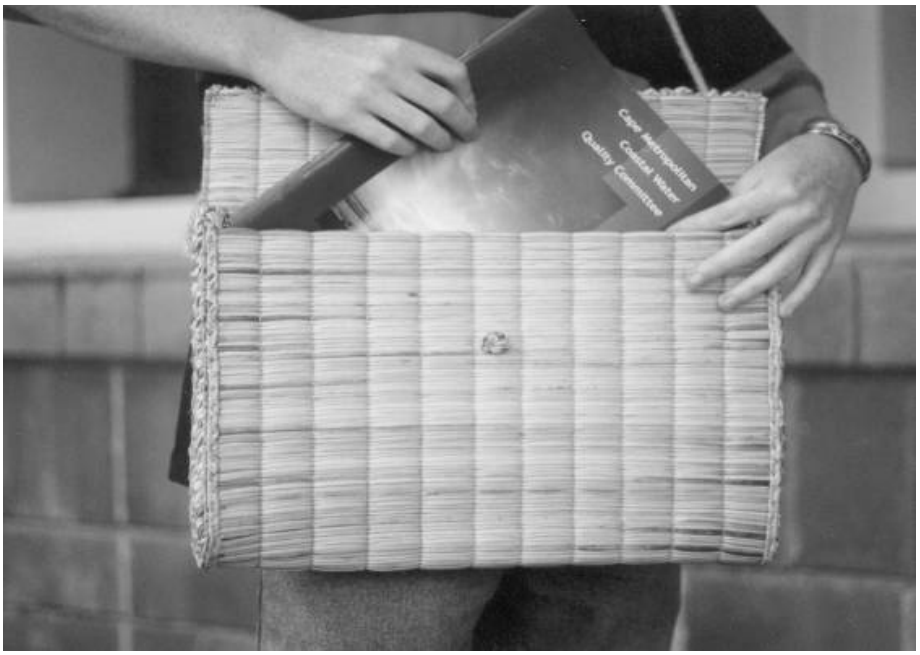

Plate 9. The innovative conference folder produced by Thubaleth'elihle craft group

Plate 10. Crafters making crafts at a craft group member's homestead

However, while the group was receiving acclaim nationally, and the sale of their craft continued to increase, problems were emerging from within the group. In the second half of 2003 the group experienced mismanagement of craft group funds. A number of group members were questioned on decision-making and fund expenditure and it was revealed that not all expenditure had been recorded as few receipts had been issued. It also transpired that the chairperson had made decisions on a number of issues without informing the committee. The craft group declined the offer of the FSG to facilitate a meeting to investigate the alleged misuse of funds and abuse of power, and the craft group did not immediately recover the mismanaged funds from the person involved. In December 2003 a new committee was elected and new bookkeepers were trained and mentored. The group stabilized and all outstanding debts to the members were paid, but the mismanaged funds were not recovered.

The INR performed most of the marketing functions for the group and the group members were mentored in business development by the FSG. Both processes proved important in keeping the craft group operational. It was decided that new market linkages should be established by the group and new products developed, as the group relied only on the conference folders. A craft development consultant based in nearby Eshowe worked with the group with the aim of establishing an overseas market and developing new product design with the most experienced crafters in the group. Unfortunately, although the group developed new products, no successful market linkages were established but the process was a useful learning experience for the group.

The project faced ongoing difficulty with the distribution and marketing of the conference folders. Initially, the FSG transported the crafts as fieldwork facilitators travelled to and from Mbongolwane from Pietermaritzburg, via Durban, almost on a weekly basis. This was an efficient method, as organizing special transport would have added significantly to the cost of the folders and using the transport opportunity available from the service provider increased the amount of money each individual crafter would make per folder. This method of transport was also more environmentally sustainable in terms of the reduced transport requirement and in the reduced associated carbon emissions. The disadvantage was that the group was dependent on this service. At the end of the LandCare project, the INR still marketed the craft group's folders, but had introduced a commission per folder, and the group relied on organizations sympathetic to their cause, to transport the folders.

5.5.3 Impact on the livelihoods of the Mbongolwane community

Members of the Thubaleth'elihle Craft Group generated significant income from the sale of their conference folders. Deducting the cost of materials (which were proportionally very low given that the bags were predominantly from natural fibres) and the group's administration and other costs, the group members were paid ZAR 107000 for 2002/3 and ZAR 219000 for 2003/4. The calculation, based on 65 active members in 2002/3 and 90 active members in 2003/4, gives ZAR 1646 per crafter in 2002/3 and ZAR2 433 per crafter for 2003/4. This income compares very favourably with income derived by other crafters in KwaZulu-Natal, where for example Marcus (2000) and Krüger and Verster (2001) examining two other craft groups in KwaZulu-Natal, reported earnings on average of less than ZAR 500 and ZAR 200 per annum,

respectively (figures adjusted to 2003/4 by accounting for inflation). The income derived by the Thubaleth'elihle crafters is considered particularly significant in that none of the craft members had formal employment, and many were from households with meagre sources of alternative income. This is highlighted by comments from craft group members.

> *No one else in our family is earning any money. The money from selling my bags is very, very important to us.*

> *Without the money I get for the bags I don't know what I would use for my children's school fees and their uniforms.*

The significance of the financial contribution from the craftwork is also more apparent when the contribution is compared to the cash value of the *madumbes*, which prior to the intervention was by far the greatest source of income from the wetland. Calculations based on three surveys (1995, 1997 and 2002) (Kotze *et al.*, 2002), estimated that 5 ha cultivated under *madumbes* with a yield of 30 tonnes per hectare (150 tonnes), and a retention of 25% of the crop for seed and the sale of 34% (the remaining 41%, 31 tonnes, used for home consumption) of the crop at ZAR 2/kg (the price for 2002/3), gives ZAR 102 000 gross income generated from local *madumbe* sales per year (with 31 tonnes per year available for home consumption). Given that there are an estimated 181 households at Mbongolwane that grow and sell *madumbes*, this gives ZAR 530 per household per year from sales (and ZAR 86 per household per year towards household food security) less than a half of the household income from crafts. Also, money generated from *madumbe* sales comes from within the Mbongolwane community and money from craft sales is from national and international organizations, thus increasing the amount of money within the local economy.

At the field level, craft making is less labour intensive than *madumbe* production. The soil is not tilled for the harvesting of craft material as it is for *madumbe* production. Bed preparation, planting, weeding and harvesting of *madumbes* all involve tilling the soil. Most craft production activities are done at the homestead (see Plate 10.). While requiring skill and dedication, crafting is not strenuous. It is thus available for old and young, the physically challenged, those caring for the sick and even the sick themselves (Kotze, 2001). The contribution of crafts to the livelihoods of several local households was significant and tangible. Most of the crafters came from the poorer households, as these were the people who still had traditional skills in making crafts, and many of them were already generating some income from locally sold crafts. Crafters often work together in the relaxed environment of a home, and the work provides the women with the opportunity for social exchange (Kotze, 2001).

An important constraint faced by many crafters in South Africa, is access to raw material and many crafters who are involved in weaving natural fibres invest a significant proportion of their resources in the transport of raw material (Rogerson and Sithole, 2001; Heinsohn and Cunningham, 1991; Mander and McKenzie, 2005). However, at Mbongolwane the *iKhwane* resource is abundantly available, free of

charge to local crafters from a nearby locality, thus contributing to the economic sustainability of their enterprise, as they do not need to pay for transport of the raw material.

The craft group grew from being a small pilot project benefiting a few individuals to being a larger group, drawing members from much of the 12 km length of the wetland. The number of young women who joined the group increased steadily during the project, increasing the level of skill within the community and engendering a sense of pride in traditional, local knowledge. Not only did craft group members hone their weaving skills, but they also became more skilled at matters indirectly related to craft production. The capacity for facilitation, local employment and financial matters was developed. The benefits gained by members of the craft group were also realized at the community level: the craft group members provided food and accommodation for The Valley Trust contractors during the building of the craft centre; they provided storage and security for building materials; they facilitated the training in building techniques and subsequent employment of the local youth; they harvested and delivered the grass and reeds for thatching the craft centre. The construction of the craft centre led to a significant increase in skills of both the participating contractor and the trainees.

The extent to which the group can continue to deliver such benefits to the broader community will depend on the extent to which organizational, marketing and distribution issues threatening the sustainability of the group's activities are addressed. This is discussed in the following section.

5.5.4 Sustainability at institutional level

Within the institutionally protected space created through the LandCare project, those configurations at the organizational level that were showing promise in promoting a more sustainable mode of production, were tested. The three primary change agents involved were the Centre for Environment and Development (CEAD) of UKZN, the INR and the FSG (CERDES, UKZN). Technologically, the intervention was focused on, and restricted to, developing crafts made from plants growing in the wetland. The technological development that took place was based on the existing knowledge and skills and was concentrated on developing further, those craft products with a limited market potential. These skills and knowledge were used to develop new and innovative items with much greater market potential but using modes of production compatible with the functioning of the wetland.

From 2001, near the beginning of the LandCare programme, the project was managed strategically by the change agent (development practitioner). An attempt was made to manage in parallel both the technical and the local institutional changes and to enhance the rate of diffusion of these changes from a small number of individual crafters to a much larger population of crafters in the ward and, in turn, to the broader outside world. This strategic management (the outcome of which is discussed in section **5.7 Conclusions**) was considered to be vital to the success of the project as the crafters consisted mainly of illiterate women, most of whom could not speak English. In particular, the marketing capacity of the group was very limited, and entrepreneurs did not readily emerge from the group.

The capacity for self-governance (e.g. through mechanisms for conflict resolution) of the group was also low. The change agents working with the group were faced with

a dilemma. On the one hand, should the change agents help the group to develop until they were able to engage the market on their own (i.e. 'should we let the group develop at their own pace?'), by which stage much of the market opportunity might have been lost? On the other hand, should the change agents play an active role in marketing so as to seize the opportunity while at the same time working with the group to assist with building capacity but running the risk that the group would remain dependent?

The second option was chosen. In one sense, development was too fast for the crafters. While the outcome has been positive from the point of view of wetland conservation, poverty alleviation and gender equality, it created problems of conflict amongst group members and a dependency on outsiders. The input needed from the change agents in order to address the local institutional issues was underestimated. Many valuable lessons were learnt and progress was made in addressing these issues. However, by the end of 2004 a number of key organizational issues still needed to be addressed by the group in order to improve its capacity for self-governance. These included:

- the day-to-day procedures for the group's functioning needed to be more explicitly developed and understood by the group members as a means of reducing the frequency of misunderstandings that arose, as it was often the misunderstandings that led to conflict;
- conflict resolution mechanisms needed to be improved;
- leadership and responsibility needed to be better distributed among the committee members, rather than being concentrated in a few individuals and
- improved financial controls were needed to ensure that the necessary checks and balances were in place.

The project began with a small group of loosely organized local producers. CEAD identified some promising possibilities and the INR was soon drawn in with resources from LandCare. As the initiative grew, the FSG was also drawn in with further resources from LandCare and there was continuing involvement from CEAD and INR. Attempts were made to enrol actors from within or very closely associated with the craft industry. This resulted in short focused interventions that proved to be valuable learning experiences and which generated some business opportunities. However, the interventions failed to result in the group developing meaningful long-term business relationships with any of the actors in the craft industry. This was very disappointing from the point of view of the group building self-reliance and being ready for the dismantling of institutional protection.

Within the Mbongolwane area, the project expanded, with an increasing number of individuals utilizing their craft skills for economic emancipation. At a technical level, the adaptation of existing knowledge and skills contributed to the success of the craft initiative. The expansion of the project was recognized at a national level through the award for the best community-conservation project in the national Green Trust Environmental Awards in 2002 and through the national LandCare programme adopting Mbongolwane as a best-practice project. Through the project the community became more aware of the importance that ecologically sound practices had for the economic benefit of the community.

Several measures were taken by the change agent (development practitioner) to enhance the rate of diffusion of the craft intervention. The key mechanism by which diffusion from the local to the district level was facilitated by the change agent through the three cell groups (informal craft training), geographically distributed across the wetland. The cell groups through weekly meetings provided an effective means of transferring the knowledge and skills level of the craft group from the more experienced group members to the less experienced (generally younger) members of the craft group.

To influence actors at the national level, several measures were taken, including the following:

- exchange visits were arranged with craft groups in other parts of South Africa: these provided a mechanism for members of the craft group to pass on their philosophy, knowledge and skills directly;
- information days were arranged for government officials, NGOs and other potential role players to expose them to the initiative;
- items were placed in the popular media, including national television, radio and magazines and
- there was participation in national competitions.

One of the factors that made the organizational development of the group difficult was the steady growth of the group. In March 2004 the craft group had over 100 members. It was suggested in 2001 by the facilitators that the group limit its membership numbers and that new members form a separate group for the following reasons: first to manage the group size; secondly, to maintain the standard and quality of products and thirdly, to be able to assess and provide the intervention required to groups based on their own needs and level of development. However, the group decided against this, based on the fact that it did not want to exclude anyone capable of producing crafts of acceptable quality. As highlighted by the chairperson of the group at the time:

We can't turn people away - they need to feed their families.

This made a valuable contribution to increasing the inclusiveness of the overall project. This was important given that during 2002, the LandCare project received some criticism from Mbongolwane community members for focusing too many resources on a few localized groups.

Through the LandCare Project, the group was assisted in developing a constitution and improving the level of organization of the group as it grew in size. However, the group was still strongly dependent on the LandCare project for support and in order to be more self-sustaining the group needed to increase its organizational and financial management capacity. In particular, the handling of finances needed to become more transparent and all group members needed to be able to understand the basic bookkeeping records to enable group monitoring of the group's income and expenditure.

The phased dismantling of institutional protection by the change agents took place in limited areas. Despite attempting to find a balance between protection and exposure to selection pressure, owing to several setbacks a balance was not achieved, and the project ended up being weighted on the side of protectionism. Attempts were made at building the capacity of the group for undertaking its own marketing but this was not successful, due mainly to the fact that marketing is an extremely complex undertaking. The INR continued to undertake product marketing, initially provided to the craft group free of charge, but gradually, from 2003, phasing-in payment. By the end of 2003, key weaknesses in self-governance and the financial management capacity of the group remained, further adding to the difficulty of dismantling protection. In addition, the group was still strongly reliant on a single product, which added further to its vulnerability. The following section discusses the lessons learned from the Mbongolwane case study in terms of technico-institutional development.

5.6 Lessons learned

Ensuring that community members are capable of self-mobilization is the most vital factor for project success where communities have been historically excluded from participating in provincial- and national-level economic activity. Many people within these communities lack the knowledge and cultural know-how of national-level markets. This implies a high level of involvement and the protection of community members by change agents during the development process. Capacity building is also important at the local level when dealing with conflict within groups. A learning environment serves to ease the potential stress of conflict resolution, because problems are not perceived as 'bad' but merely as constraining the potential achievement of goals.

Using local knowledge and practices as a foundation for technology development within the intervention was thought to be more likely to succeed than the introduction of a new technology. Local practices are an important basis for innovation as they are context-specific, local knowledge is also important as community members are aware of the factors that enable or constrain the adaptation of new technology. A key element of the project was the integration of knowledge from heterogeneous sources. This was particularly significant in the combination of local knowledge and scientific knowledge towards the sustainable use of the wetland resources. Integration of several different elements was an explicit goal in the initiative. At the most fundamental level, the integration of biodiversity protection and catchment integrity with human needs (i.e. livelihoods) was the goal. This is reflected in the philosophy of 'conservation through production'. The project also aimed to integrate knowledge from different sources (see Table 5.2), which was effectively achieved.

Integration of activities of the various stakeholders involved in the management of Mbongolwane was also achieved. The aim of integration at this level was to capitalize on synergies and avoid duplication. The integration at this level was facilitated through a forum for the participating organizations that met at six-weekly intervals.

Experiences from the craft project highlight that when promoting rural-enterprise development from wetland products, the focus should not only be on the local level but also on the district, provincial and national level and the activities required there, to create a more enabling environment. For example, the co-ordination and

development of markets for crafts at a provincial and national level can greatly assist local craft enterprises. It is important therefore, that lobbying is undertaken so that governments and NGOs can assist in this process, e.g. government support could possibly be secured to facilitate the establishment of a provincial or national marketing initiative that has a sound understanding of marketing and distribution and is linked to many local craft groups.

Table 5.2 Heterogeneous sources of knowledge that contributed to the Mbongolwane wetland project.

Local knowledge	*Outside knowledge*
Crafts	
Suitability of different plant species for craft production.	Broader ecological significance of particular species (e.g. their extent at a national level).
Suitability of the different parts of the plant (e.g. leaf blades, stems, etc.) for craft production.	Providing ecological support on the effects of different modes of harvesting.
Correct methods for harvesting, drying and processing the harvested material.	Innovations in combining different methods for developing new products.
Correct timing, supported by traditional belief systems, of harvesting.	Facilitation of institutional development.
Different weave types and their potential for different types of crafts.	Marketing of woven products.
Use of technologies, notably that of the simple handloom, which is used by crafters throughout rural KwaZulu-Natal.	Standardizing for large orders.
Cultivation	
Matching of crop types with microhabitats in the wetland.	Soil conservation measures (e.g. planted lines of vetiver grass).
Timing of practices.	Broader consequences of local activities on catchment water quality and biodiversity.
Cultural practices (e.g. raised beds).	Novel technologies for protecting biodiversity and maintaining production.

The evolution of institutional arrangements within the craft initiative did not keep pace with the technological development. Self-reliance and self-governance required significant development, the extent of which need was perhaps underestimated at

inception of the project. The influence of the craft initiative, despite gaining national recognition, was still relatively weak, and the institutional environment and national policies did not serve to create an enabling environment at the local and provincial levels. To address this, change agents will need a sound understanding of policies, strong political influence and sustained effort.

5.7 Conclusions

Returning now to the original research questions, posed at the beginning of this chapter. The final assessment of the sustainability of craft production at Mbongolwane is undertaken in relation to the three dimensions of sustainability addressed in this case study, namely environmental, social and economic. These also relate to the three different levels of organization considered, namely field, household and district.

Environmental sustainability, which has relevance particularly to the field level, was assessed as high because, for craft production, the wetland is used in its intact and functional state rather than being transformed (e.g. for agriculture) and the harvesting of *iKhwane* is considered to be well within the resource's capacity for renewal. This is due to the fact that: (1) *iKhwane* has a perennial root system and above-ground annual production is harvested near the end of the growing season and (2) only a small proportion of the very abundant available resource is harvested annually.

Social sustainability, which has relevance at both the household and district levels, is currently high, in particular from the perspective of the household. This was due to open participation and the empowerment of the poorest and least empowered members of the local community. At the district level, the intergenerational or long-term sustainability of craft production was dependent on the transparent and effective operation of the craft group. Although the group had faced organizational difficulties, particularly when too much power resided with a single group member, the group resilience was evident from its growing organizational capacity over seven years. However, the group's financial record-keeping system and financial transparency still required further strengthening to minimize the likelihood of a recurrence in the mismanagement of funds. The group's social networks and business relationships, together with its weaknesses in marketing and distribution, contributed to the vulnerability of the continuation of the craft group. The intergenerational social and institutional sustainability are assessed as moderate.

Intragenerational (short to medium term) production levels appeared to be viable given that by the end of 2004, the demand for the group's main product was still increasing. It is predicted that this will be sustained due to the expansion of the conference market in South Africa concurrent with social responsibility in the purchase of conference items (e.g. document folders), and also the fact that Government policy will continue to provide support for small businesses. Although competitors may emerge to undercut the craft group's prices, the group would hopefully have the capacity to respond to this competition. The greatest threat to intergenerational economic sustainability is the fact that the group relies almost entirely on a single product. The economic and institutional sustainability are assessed as moderate.

Finally, it is important to consider the linkages between the components of sustainability. Environmental sustainability, which represents the foundation

component, has a direct link to economic sustainability given the dependency of production on the resource base supplied by the natural environment. If environmental sustainability was low and the resource base over-harvested then the economic activity on which the resource base depends would collapse. However, the evidence presented in this chapter indicates that over-harvesting of the resource is very unlikely.

The linkage between social sustainability and economic sustainability is twofold. Collapse of the social organization of the craft group would destroy the group's capacity to carry out any economic activity, thereby destroying economic sustainability. Evidence suggests that this scenario is possible but it appears more likely that the group has sufficient resilience for it not to occur. The greatest threat to the economic sustainability of the group is its precarious capacity; to access and supply the market, to diversify and develop new products, and to deal with an evolving market in the long term. Although phased breakdown of the protected niche created for the group has taken place to some extent, the group remains reliant on support from service providers. Failure of the group to survive economically could potentially have a high social impact, especially on those households that have come to rely heavily on the income derived from craft sales.

This also highlights the importance of households continuing to cultivate *madumbes* for household food security, rather than seeing the enhanced craft production as replacing *madumbe* production. Maintaining both types of production enhances the resource base of households and their consequent resilience to shocks. The proviso, of course, is that the *madumbe* production should not undermine the integrity of the wetland, and it will therefore require ongoing control to ensure that the overall extent of *madumbe* cultivation is contained. Areas of the wetland, sensitive to erosion, should be excluded from production; and traditional, low-external input cultivation methods should rather be used. Extensive cultivation across the wetland would not only considerably diminish wetland integrity, particularly if more intensive methods of cultivation are used, but would also compromise the supply of *iKhwane* for craft production.

Thus, the continued sustainable use of the Mbongolwane wetland depends on: effective control over wetland cultivation; the sustainable harvesting of the natural resource base; conflict resolution between users of the wetland resources and product development and marketing.

The case of Mbongolwane serves to illustrate a number of essential factors needed for success:

- the awareness by all actors that innovation is a function of both technical and institutional change;
- a protected space for innovative and novel ideas to take root and develop;
- knowledge or practices from heterogeneous sources for innovation development;
- the maintenance of a learning environment and
- the creation and stabilization of a social network.

The sustainability of the Mbongolwane case study and the outcomes of the strategic management of the project are discussed further through comparison with the other case studies in the final chapter, Chapter 7.

5.8 Acknowledgements

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Chapter 6: Heading west
The Suid Bokkeveld and the development of the Heiveld Co-operative

6.1 Introduction

In this chapter, the socio-economic development of a group of rooibos tea farmers is explored. These farmers became established as a force with which to be reckoned, in the field of organic tea production and export. In telling the story of these farmers, isolated both socially and physically, this chapter presents an example of how small-scale farmers, government agencies and other institutions can work together, and also identifies the process involved.

The research for this chapter was conducted in collaboration with a project based in the Suid Bokkeveld region of the Northern Cape Province of the Republic of South Africa (see Chapter 3, Figure 3.2). The overall aim of the project was to empower resource users in the Suid Bokkeveld communities to utilize natural resources to enhance the sustainability of their livelihoods, and in addition, to investigate more appropriate and effective ways of facilitating development in rural communities. The sustainability of the intervention was explored through the following research questions:

Field level

- How sustainable are current tea-farming practices?
- What role do socio-economic and cultural factors play in the sustainable use of the fynbos biome?

Farm level

- Do tea production and sales make a significant contribution to household economy?
- How compatible is tea production with socio-economic and cultural factors?

District level

- What factors within the intervention contribute to the sustainable development of the Co-operative?
- What contribution does the strategic management of the intervention make to the sustainability of the intervention?

The process of formalizing the association of farmers of the Suid Bokkeveld into the Heiveld Co-operative Limited has a number of unique features in terms of practices and achievements in emerging agriculture in South Africa. A number of lessons can be learned from this case, not only by other emerging farmers, but also by commercial farmers who seek a sustainable alternative to established modes of agricultural production and associated institutional processes.

6.2 The place and its people: livelihoods in the Suid Bokkeveld

The Suid Bokkeveld of the Northern Cape Province of South Africa is a harsh and arid region, home to this community of small-scale producers of indigenous rooibos tea (see Box 1). The people of the Suid Bokkeveld faced discrimination and isolation

as 'coloured' people during the apartheid era. ('coloured' refers to people of mixed descent as defined by the Apartheid Government.) The people of this small-scale farming community survived under harsh conditions with poor access to services and markets, they are farm workers, small landowners and tenant farmers (Anonymous, 2000c).

At the time of this study, the main farming activities of the area were the cultivation of indigenous rooibos tea (*Aspalathus linearis* Thun.), cereal cropping and sheep and goat husbandry. Rooibos is essential to the livelihoods of the Suid Bokkeveld community, both cultivated rooibos (*mak tee*) and the naturally occurring wild tea (*veld tee*). For generations, the local people have harvested wild rooibos for domestic use (Koopman, 2002). The existence of wild rooibos is beginning to be threatened by the ploughing of its natural habitat for rooibos plantations, by grazing and by potentially unsustainable harvesting techniques.

Box 1: Rooibos

The rugged sandstone mountains of the Cederberg region of the southwestern corner of South Africa are home to rooibos (*Aspalathus linearis*). It is one of 274 species of the genus endemic to the Cape Floristic region. It occurs naturally in the western interior of the Western and Northern Cape Provinces. Highly variable growth forms allow populations of this genus to contend with adverse growing conditions: acidic, nutrient-poor sandstone soils, frequent fires, low winter rainfall and summer drought.

Rooibos is a legume that plays an important role in the ecology of fynbos. Rooibos has a diversity of root adaptations, such as a long tap root, cluster roots, arbuscular mycorrhizas and nitrogen-fixing root nodules which play a role in helping it survive in the low nutrient soils of its natural environment (Allsopp, 2003).

For centuries, rooibos tea has traditionally been used as a medicine, for the treatment of digestive problems, sleeplessness and allergies. It has a soothing effect on the nervous system and is recommended for stress relief, nervous tension and mild depression. Tea made from rooibos contains trace elements, vitamins and anti-oxidants (Anonymous, 2000c).

The rooibos cultivators of the Suid Bokkeveld were isolated from agricultural assistance by government as a result of the apartheid structures of pre-1994 agriculture. During this time, the government promoted and supported co-operatives for different commodity crops, agricultural extension services and agricultural research institutions all for the exclusive benefit of white farmers. The dominant knowledge of rooibos production at that time arose from the Rooibos Tea Co-operative, which supported white farmers of rooibos tea, through providing technical information, managing the marketing of tea and commissioning research.

Following democratic elections in 1994, the marketing of tea remained largely monopolized by the Rooibos Tea Co-operative, despite the abolition of the control boards, which had acted as sole marketers of commodities. The Co-operative could now admit any members, but did not encourage small-scale farmers, as its minimum quota of tea accepted was more than could comfortably be provided by smaller farmers. As a result the Heiveld farmers had remained largely uninfluenced by the

Rooibos Tea Co-operative, and in the absence of support from the Rooibos Tea Co-operative, the Heiveld producers were forced to rely on sales to those white farmers who had a shortfall in their quota for the Rooibos Tea Co-operative. This was an extremely *ad hoc* arrangement and left the Heiveld farmers with little power to negotiate good prices and the Heiveld farmers thus received low prices for quality, hand-harvested and hand-processed tea. This was also due to the limited experience of the agricultural extension services responsible for servicing the Suid Bokkeveld. These services were based in the arid Karoo sheep-production area further east and had little or no experience with rooibos cultivation, so although the extension workers had extended their services to the Heiveld community since 1994, this had largely involved the erection of infrastructure such as fencing and water points and the institution of rotational grazing for livestock.

Research Methods

Due to the low population density and large farm size, relative to the KwaZulu-Natal case studies, the sample size of farmers who were part of the case study, and who were interviewed was much smaller. A total of six farms and fourteen farmers were included in the interview process and analysed for this case study. Most (96%) of the co-operative members were located on these six farms. Information was gathered from the farmers through informal interviews, discussions held during soil-testing and land surveying field trips; and from discussion held in workshops and meetings. Land size was measured by the Agricultural Research Council of the Western Cape, using Geographical Positioning Systems; and the soil analyses were conducted at the analytical laboratory (FERTREC) of the KwaZulu-Natal Department of Agriculture and Environmental Affairs. All interviews and workshops were conducted in Afrikaans. Information on organizational development was gathered from documentation pertaining to the development project (workshop reports, minutes, annual reviews, and project monitoring and review documents). System tools were used for the analysis of the collected data, and included behaviour-over-time graphs and the use of 'assumption surfacing and testing' in project-management workshops.

Livelihoods in the Suid Bokkeveld

The livelihoods of the Suid Bokkeveld farmers were reliant on the availability of natural resources, especially plants. The plants of the Suild Bokkeveld are a source of fuel for cooking, they provide medicine, building materials, domestic tools (brooms, mats) and food for people and their animals.

Houses are traditionally built of reeds, including the kitchen hut (*kook skerm*). The reeds used by the farmers for building are all of the family Restioaceae, endemic to the Cape floristic region. Reeds are harvested above ground, leaving the root system in place, so that the reeds can re-grow. The reeds of the roof were replaced about every five years, giving the vegetation ample time for recovery before the next harvest.

> *There are many types of reeds here, some are used for the roof, like klipriet, springbokriet and dekriet. We use sonktjiesriet and fluitjiesriet for the walls. We use another kind for brooms, besemriet.*

On some farms, wild animals, in particular small antelope, were still sought after as a source of food.

In winter we cull some of the antelope to keep the population strong. It's also a wonderful source of meat, lean and with a good flavour.

Due to the variation in population pressure between the farms, the status of the natural vegetation and its associated benefits was quite varied. *Protea* species were particularly sought after as firewood, as the trees reach a good age and being slow growing, provide good quality firewood. However, on one farm in particular, financial pressures had led to over-harvesting of the trees.

We collect firewood from the next farm along as there are no Proteas left on our farm. About ten years ago, we had a difficult time and sold most of the Proteas as firewood. There are no trees left now to grow back.

Many of the plants in the Suid Bokkeveld have medicinal uses and were used by the community for common ailments and illnesses, including: colds, influenza, aches and pains, wounds and diabetes. The plants were harvested sustainably as mostly just the leaves are used. The soils of the Suid Bokkeveld are sandy and acidic, ideal for the fynbos vegetation, including rooibos. Farmers were well aware of the ideal soil conditions required for rooibos and selected specific areas for cultivation, based on soil type, aspect and prevailing winds.

Dipgat is better for rooibos than Nicosekop, but both are good for tea. At Dipgat, the soil is good.

There is no naturally occurring rooibos here, that is why I have my tea fields over towards Slangbos, the soil there is ideal and the breeze can come in nicely to the field. Even though it is not ideal soil, we get a good tea harvest.

Land tenure in the Suid Bokkeveld strongly influenced the size of land available to farmers. Areas under cultivated rooibos tea varied from one hectare to 42 hectares depending on the form of ownership. In two cases, farmers who had worked as labourers on white-owned farms were able to purchase the farm from their employers when the farm was put up for sale. Credit to purchase the farms was made available through the Land Bank, a benefit which has been available to all farmers since 1994.

I used to work here, growing rooibos, for many years when I returned from Cape Town. When the owners decided to sell, my brothers and I decided that with the expansion of the Co-operative, it made sense to invest in good rooibos land. We secured a loan from the Land Bank and bought the farm. We got a good price, nobody really wants to live here, it's hard work.

I work for the owner of the farm, he lives about three hours away by car and doesn't really come here. He is happy for me to grow rooibos and keep my goats. He is planning to sell the farm and he has given me first option to buy. I can get a loan from the Land Bank and I think I will buy the farm. I have to leave something for my wife and my son and his family when I die. I'm not young anymore, I must plan for the future.

Ownership on the communal farm was transferred to the families resident there through the Land Redistribution Act (see Chapter 1). However, this did not mean an increase in the amount of land available, it was merely a change in tenure status.

None of us here has much land, we have to share with each other. We have enough for growing rooibos, wheat, rye and keeping some animals. But with the number of people increasing every year, it's getting difficult, at some stage there will not be enough land for everybody to make a living from tea.

The quality of the land available also varied between farms as some farms had been used for large-scale production of wheat and animals, and natural resource degradation had also occurred due to increasing population pressure.

The Suid Bokkeveld is remotely situated and the roads, although not tarred are passable by motor vehicle and bicycle. Despite great distances all of the farms in the case study could be reached by road. Historically, the people of the Suid Bokkeveld relied on natural systems to provide most of the resources required for their shelter, food and other needs. This reliance on natural resources continues today. Due to the dry, drought-prone climate, water is still a precious resource and its availability greatly affects the livelihoods of the farmers. Most of the water used for drinking comes from a borehole or a spring. A local perennial river is used as a source of water for livestock and a number of farms also use the seasonal rivers on their land. These rivers only flow in winter, the wet season.

The worst drought we had before this year was in 1970. Our water dried up and we had to get water from a spring on the farm across the river over there towards the next farm. We lost a lot of animals that year, it was terrible. And then also, the year the rains were late, they only came in August, there were piles of dead lambs, no food for the mothers, no milk.

This is the best spring in the area, it keeps running, even in a drought year like now.

Given the vast distances between homesteads (up to a two-day walk) communication technology is important, and the Suid Bokkeveld community consider telephones an integral part of human habitation. All of the farms had a telephone, compared to only one with electricity.

... don't take the Moedverloor road, take the next road going right, the Paalkraal road. From the kraal, just follow the telephone line it comes to our house.

All farm households relied on wood for cooking food and for heating water, making natural resource use an integral part of the household livelihood.

We collect wood towards the end of summer when it's dry, it's easier to cut and it's not so heavy. We use wood for cooking and making tea.

He'll be here in about half an hour, he apologises for not being here at the time you arranged. He got a message last night that there was wood available at the next farm, so he went to get a load this morning.

Farmers also still used natural resources for building materials. The types of houses varied between the farms with some houses constructed from rock and stone and others from reeds.

This was the original house built on this farm, the stones are from here, my great-grandfather was skilled in stonework. We still use it….

The roofs of the houses were made from reeds or if the farmer grew rye, the roof was thatched with rye straw.

We use rye straw for thatch, scorpions and spiders get in between if you use reeds, and so we use a tight thatch.

All of the households had a kitchen hut (*kook skerm*) separate from the house, made from thick interwoven reeds. The kitchen hut is a social place where the family drink tea and eat their meals.

We use these thick, long reeds for the cooking hut, they make the right shape for going over the fire in the middle.

Most community members in the Suid Bokkeveld had been or were employed as manual labourers. Many were skilled in the production of rooibos tea, the use of medicinal plants and were experienced in animal husbandry. Skilled labour was a rich resource within and between farms in the area.

The co-operative employs three local men to collect seed from the wild tea. They have been doing it most of their lives, their fathers taught them the skill.

We don't like to employ Citrusdal people to cut the tea, they cut too deep and damage the tea, we prefer local people who know tea.

I've learnt, it's better to take longer planting seedlings with local people than to employ people from elsewhere to get the job done quickly. They don't know tea and don't plant the seedlings properly, and then we have to go afterwards and replant the damaged seedlings.

Due to economic pressures, many young people were considering moving to towns and cities to find employment. This caused great concern among the older farmers that the youth would not learn the skills and knowledge of the local environment and tea production practices. The farmers were concerned that local knowledge would be lost once they had died.

These children don't know about the uses of the plants, they just go and get medicine from the clinic. If you know these plants like we old people do, you can look after yourself better than with modern medicine.

The maaitjiesriet *was used a lot in my day, but the younger people don't know how to work with it anymore, they just use the other reeds.*

What concerns me the most is that our knowledge will die with us, we are the last generation of true tea growers. The youngsters would rather learn a trade and work in the cities. I wish we could record all we know so that it's not lost forever when we die. ...That man has a vast knowledge of medicinal plants and nobody is learning from him. It makes me sad to think that such knowledge is going to be lost. How will they know how to look after the veld, and themselves?

Health was considered to be a vital asset in the Suid Bokkeveld and many of the older members of the community attributed their good health to hard work and a moderate attitude in life. Tonics made from local herbs were also considered by many to play an important role in maintaining good health. Few of the farmers suffered from any serious health problems and most of the family members were fit and healthy. However, amongst the youth the effects of HIV infection and AIDS were becoming apparent.

Can you believe he is in his 60s? He is one of the fitter men on this farm.

We can employ the team for the rehabilitation project from the farm, all of the adult family members there are employable, and including the aunt, it makes five.

Go and look at the cemetery in Nieuwoudtville, most of the graves in the last few years are those of young people, people who shouldn't be dead yet. And the worst thing is that their deaths are from alcohol-related violence and AIDS. Can you believe it, we even have AIDS here, in the middle of no-where?

Tenure status of the farmers varied considerably and included communal ownership, share-cropping, private ownership and private share-holder ownership. The difference in tenure status of the farms influenced the availability of employment opportunities within the Suid Bokkeveld. Most of the labourers required for tea production were locally sourced, and people from the communally-owned farm were offered first option as there were few other options for income generation on that farm. Farmers who had share-cropping tenure and also some with private ownership, used family members for labour requirements. Farmers with fewer family members available for labour, employed or traded with local labour. The more commercially orientated farmers with much land under tea were the main employers of local labour. There was a strong moral code within the Co-operative where support for the poorest was the basis for community activities.

We cannot pay our labour what the white farmers are paying their labour per day. We have adequate funds for a fair wage, so let's pay a fair wage. Our community benefits, and that is of benefit to all of us.

The team for the rehabilitation project should, where possible, consist of people most in need of employment within our community.

The community of the Suid Bokkeveld shared a localized history and an environment of which they had a deep knowledge and understanding. This resulted in a strong social fabric and community members readily described the existence of and the need for social cohesion within the community.

If it wasn't for our neighbours, we wouldn't survive. Out here you have to stay together, if there's a problem, we all try to help.

You really need other people out here, you would soon die on your own. If something goes wrong, somebody has to help you.

All members of the Suid Bokkeveld community to some extent played a role in their neighbour's livelihoods whether in the form of employment, labour or other necessary functions.

My husband took the neighbour's daughter to the clinic, she had her baby last night and the midwife was worried, said it should be checked by the nursing sister. My husband had to take her he is the only one here with a bakkie.

(The 'midwife' was a man who at the time, was in his late sixties and was renowned over a large area for his midwifery skills.)

Income in the Suid Bokkeveld was mostly generated from local employment opportunities. Tea-production practices of the Co-operative are labour-intensive and generate significant income opportunities in the area. Other employment opportunities are provided to the south, in Citrusdal a citrus-growing area.

During the tea-making season I work locally, here or on one of the other farms, also at planting time. During the citrus season some of us go to Citrusdal for work. It's hard work picking fruit all day, but its social as we meet people from all over the Cederberg.

Most of the farmers have at some stage worked in cities and large towns, the city of Cape Town, a four-hour drive from the Suid Bokkeveld, was the most popular place of employment.

I used to work for the Cape Town corporation, in the roads section. We did soil sampling just like you're doing now, only we used a different type of auger. I get a pension but it's really not much so I still need to produce tea to get some extra money.

I really like Cape Town, I used to work there as a painter and do basic home repairs. But I love the veld and growing tea, so here I am.

Some of the farmers received financial assistance from family members who lived and worked in a city. These family members were usually well-educated and held good work positions.

My brother is a teacher, he's done very well. He helped us to secure the loan from the Land Bank to buy this farm. Rightfully, he has shares.

This farm belongs to our brother, he's an attorney. We manage it in his absence and he pays us for our labour.

Since joining the Co-operative, members said that they had noticed a significant improvement in their financial resource-base, which was having a positive effect on their standard of living. A number of different farming strategies emerged in response to the registration of the Heiveld co-operative. These strategies were linked to the particular resources available to the farmers and the strategies are discussed briefly for each of the six farms. Details of some of the resources available on each of the farms are presented in Table 6.1.

The largest farm in the case study, with the most land under tea, was purchased by the current farmer from his previous employer. His family bought the farm with assistance from the Land Bank. There was much natural vegetation in good condition on the farm and many, large tea lands, some under production, and others in the process of being prepared for tea growing. The infrastructure of the farm was well-developed, due largely to the legacy of being a previously white-owned farm. The farmer, managing the farm for the family, had a vast knowledge of veldt management and tea growing. He worked his land both manually and by tractor. He received support from his brother, resident on a neighbouring farm, in the form of mechanical skills and tractor hours. He employed people from other farms to assist with various skilled and non-skilled tasks throughout the year. The farmer decided to increase his tea production in order to increase tea sales so that he could increase his income. He was very aware of sustainability (v*olhoubaarheid*) as a guiding principle in natural resource use.

Table 6.1 Details of resources used by and available to Suid Bokkeveld farmers on each of the six farms

farm	cultivated tea (ha)	condition of fynbos	infrastructure	social foundation	tenure
1	37	excellent	excellent	moderate	now private
2	n/a*	moderate	n/a	good	private
3	24	poor	good	good	communal
4	9	good	good	good	private
5	21	very good	very good	moderate	tenant
6	14	very good	very good	good	now private

* Figures are given for 2002/3, at this time no tea was cultivated on the farm.

The second farm had been farmed for many years, for the production of rye and animal fodder. It was difficult to reach by road and there were no buildings on the farm. Some natural vegetation remained, but most has been cleared to prepare new tea lands. Large areas previously under cultivation were severely eroded by wind and run-off. The farm was owned by an absentee landowner but was managed by his family, resident on the neighbouring farm. The farm was gradually being established under tea, with the intention to ultimately gain maximum profit from the land.

The third farm, closest to the town of Niewoudtville was a communal farm occupied by many farming families. This farm had few remaining natural resources, as the families had been living on a limited area of land for many generations. As a result, significant pressure was placed on the natural resources for firewood and building materials. The families resident on the farm were the poorest members of the Co-operative and most of the adults were employed as labourers on other farms in the co-operative. Most families on the farm had some land planted to tea, but the size of the fields was relatively small compared to those of other farms. Wheat and rye were also cultivated and the farmers hired tractors to work the land. Most of the families also had some animals: pigs, goats and sheep.

A fourth farm, historically a family farm, was owned and managed by the youngest of the sons. There was some remaining natural vegetation on the farm, but most of the farm was under cultivation of rye and tea. New lands were being cleared for tea plantations. The farmer used a tractor and tractor-drawn implements for tea and rye production: he farmed in a similar way to his father. The farmer was increasing his tea production to enable more tea sales so that he could increase his income.

The fifth farm was owned by an absentee landlord, the only white member of the co-operative. The farm was managed by the man who worked the farm for the previous owner. The farm had considerable natural areas used by families from other farms for collecting firewood. The manager has considerable skill and experience in growing tea and the tea lands were well-maintained. He also has his own tea lands on the farm, besides managing tea for the landlord. The farm is climatically ideal for rooibos tea and centrally located with regard to the other farms. Old cereal lands had been planted to tea to increase production and maximize profit from the land.

The sixth farm, furthest from the town of Nieuwoudtville is not in an area suited to tea, but due to the skill and experience of the farmer, had successfully been put under tea. The farmer initially worked for the landowner as a manager and was also a tenant farmer on the same farm, he decided to buy the farm when it came up for sale (this was a similar situation to that pertaining to the largest, previously white-owned farm). Despite being white-owned, the farm did not have the same well-established infrastructure as the other previously white-owned farm. However the tenant farmer's own infrastructure was established and well-maintained. He was a retired man, who had worked in Cape Town and on retirement had returned home to work the land. He had considerable knowledge of all plants and their uses and much skill and knowledge in tea production. He continued to farm as his father farmed, using the old methods including land preparation by animal-drawn plough. His philosophy was 'deliberate work with attention to detail produces a quality product'.

Having given an idea of the people of the Suid Bokkeveld and their livelihoods, I will now discuss the processes that led to the formation of the Heiveld Co-operative and other activities during this time that were related to the Suid Bokkeveld community.

6.3 The Heiveld Co-operative

6.3.1 Overview of the development process

The establishment of the Heiveld Co-operative began at a meeting on the communal farm Melkkraal in 1998. The objective of the meeting was to discuss a development process in partnership with two NGOs, the Environmental Monitoring Group and Indigo Development & Change (Indigo). The involvement of the EMG and Indigo as change agents was fundamental to the project. The principles adopted at the initial meeting illustrate the participatory and transparent nature of the process, and are presented below:

- Involvement in any project activity should include contribution from all parties and benefit should accrue to the community.
- People's vision, enthusiasm and contribution should be mobilized to achieve maximum benefit.
- The least advantaged should benefit the most.

- The project should benefit the local community, and the wider community.
- Everybody should undertake to work together in a spirit of mutual respect.

These principles were established not only for the Heiveld community, the EMG and Indigo, but also for other organizations and researchers, including government departments that later became involved in the project.

A comprehensive community workshop, conducted in March 1999, initiated a collective process of community-based economic and social development. The workshop was designed to build a sense of common identity and purpose; enable the expression of a common vision; deepen the understanding of the community's social structure; share information about resources available within the community; and finally identify and analyse common problems and establish a set of objectives for development.

Poverty was identified by the community as being the central problem and rooibos tea as being a key resource by means of which to address this problem. There was initially a lack of knowledge, confidence and insight as to how rooibos could be used to address poverty. Figure 6.1 shows a time-line of key events from the initial meeting with the community to the registration of the Heiveld Co-operative Limited. The desire to form an independent and locally owned organization was expressed on the return journey in August 2000 from the knowledge-exchange visit to the nearby rooibos tea producing settlement of Wupperthal. Before the group reached home its members had agreed that they would form an organization.

The knowledge-exchange process resulted in a realization that collective local knowledge was unique and valuable, and could provide the basis for a potentially successful local business. The decision to form an organization was formalized through discussion and during a workshop with the wider community. The fledgling organization was initially under directorship of the chairman of the *doodgenootskap* (a self-managed collective providing affordable funeral insurance for its members) who was respected for his wisdom and experience. However, once the formal organization emerged in January 2001, the members decided to elect a younger, more dynamic chairman who could manage the affairs of the emerging organization. The former chairman was elected as the vice-chairman where his wisdom and insight continued to play a vital role in key decision-making within the organization. Initially the treasurer conducted the business affairs of the organization through the application of life skills learned in the course of managing his farm. As the organization grew and interactions with the wider institutional environment increased, assistance from the EMG bookkeeper was called for to provide formal training.

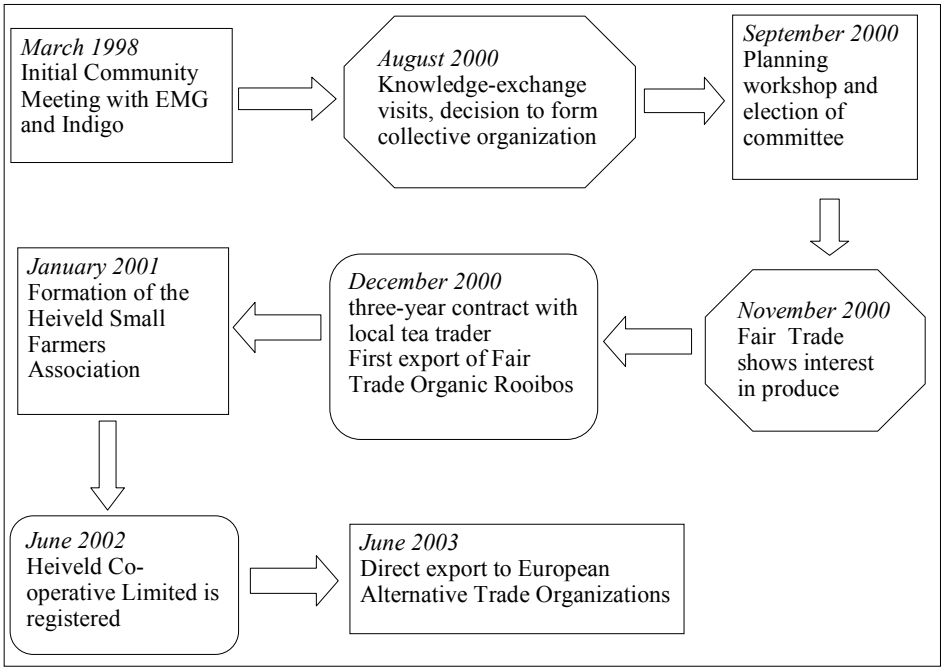

Figure 6.1 Activities leading to the registration of the Heiveld Co-operative Limited

The key consideration that shaped the organization was the desire to establish a democratically-managed profit-making business that would provide benefit to the wider community. A co-operative was selected as being the most suitable legal structure that would enable the members to achieve this goal. The equitable sharing of profits among all members was an essential component of the Co-operative's mandate and showed a value system which expressed the importance of solidarity with, and support for, the less advantaged in the community. However, the Registrar of Co-operatives suggested that a mechanism should be established whereby the profits would be shared on the basis of the amount of business each member brought to the co-operative (patronage proportion). This mechanism was advocated by the State to ensure the economic well-being of a business by giving members a strong incentive to provide their support.

These opposing views were resolved through compromise whereby 70% of the profit would be distributed on the basis of the patronage proportion, and the remaining 30% would be equitably shared among all members. It is believed that this decision encouraged women, often the most economically deprived within communities, to join the Co-operative. From 2001 to 2003, membership of women more than doubled.

For the Co-operative's first season, a basic business plan was established and financial and production targets were set. The decision-making processes of the Co-operative had consistently been designed to make information and management decisions accessible to all. In the first season, the fine quality of the tea produced and the high prices obtained by marketing via the Co-operative allowed it to distribute a small profit to all members. This engendered a sense of pride among the tea producers

and community members and ensured that a sense of ownership prevailed within the Co-operative.

At the field level, a number of formal research projects were in progress. The initial research undertaken in the Suid Bokkeveld in 2001, was the 'Conservation Farming' project funded by the National Botanical Research Institute. Here a number of scientists examined biodiversity; land-use patterns; and ecosystem services and functions within the larger Suid Bokkeveld area and the project included a number of commercial farmers and small-scale farmers. This research was beneficial to the farmers but was not farmer-driven.

My involvement with the Heiveld Co-operative began in March 2002, following a process of Action Research, facilitated by the EMG and Indigo. Farmers had posed research questions to researchers involved with the project, to ensure that the outcomes were of direct benefit to the community and the farmers. Soil fertility issues had been raised at a meeting with the Rooibos Study Group of the Heiveld Co-operative Limited. When I began working on the project, I undertook an exploration into soil fertility with the farmers. Through this project, a deeper understanding of the role of organic matter and the sensitivity of the soil ecosystem in the fynbos biome was reached. This project had other consequences, as most farmers did not rely solely on rooibos tea production for their livelihoods. All farmers, to a greater or lesser degree, produced their own vegetables for home consumption. The soil fertility project assisted farmers to establish soil fertility management systems in their home gardens, contributing to their livelihood strategies through enhanced food security. Subsequently, I assisted the change agents with community workshops, documentation, planning and the production of publications, pertaining to soil fertility and tea production. During this time, I interviewed farmers, researchers and the change agents to better understand the processes of technico-institutional evolution within the Heiveld Co-operative.

At this time, two other research projects were underway, the first concerned natural resource availability and management which included the mapping of available natural resources and past practices of natural resource use. The results of this study would assist land users in engaging sustainable natural-resource-use practices, to ensure the economic success of future generations. Through this research project, ownership of their organic-certification certificate was realised by the Co-operative. Part of the natural-resource-use study involved mapping the current tea production fields, also a requirement of the certification process. This research project was funded and supported by the Agricultural Research Council (Range and Forage Resources), the University of the Western Cape and the South African Netherlands Programme for Alternatives in Development (SANPAD).

The aims of SANPAD included:

- perceived and shared problems relating to sustainable livelihoods based on natural resources should be solved through individual and collective action; and
- collective and individual problem-solving capacity and competence should be developed in the Suid Bokkeveld communities.

The second research project, funded by SANPAD and the Leslie Hill Institute for Plant Conservation at the University of Cape Town and supported by the Environmental Monitoring Group, concerned the seasonality and harvest height of wild rooibos tea. Members of the community voiced concern over the sustainability of wild rooibos utilization, and the harvesting practices in particular. Local knowledge of harvesting was drawn on and ultimately, with experimental results, would arrive at sound guidelines to assist in conserving wild rooibos, a significant resource in the livelihoods of its custodians (see Plates 11. and 12.). This research project was funded by SANPAD and the Leslie Hill Institute for Plant Conservation at the University of Cape Town and was supported by the Environmental Monitoring Group.

In July 2002, a workshop was conducted to introduce the LandCare project, driven by the National Department of Agriculture (see Plates 13. and 14.). An appeal had been made by the EMG to the Provincial Department of Agriculture to assist the Heiveld farmers with challenges faced in their tea production. The Department of Agriculture responded positively by recommending the Heiveld Farmers for the National LandCare Programme (NLP).

The goal of the NLP was to develop and implement integrated approaches to natural resource management in South Africa. These approaches were to be efficient, sustainable, equitable and consistent with the principles of ecologically sustainable development.

The NLP objectives were the:

- promotion of partnerships between communities, the private sector and government in the management of natural resources;
- establishment of institutional arrangements to develop and implement policies, programmes and practices that encourage the sustainable use of natural resources;
- encouragement of skills development for sustainable livelihoods and
- enhancement of long-term productivity of natural resources.

The Provincial Department of Agriculture, the EMG, the Desert Margins programme and the community members were active in implementing the LandCare project that aimed to address the problems of soil and wind erosion in the farmers' fields. Past practices of clearing large areas of fynbos land to plant rooibos and cereals (wheat and rye) resulted in wind erosion of soils and wind damage to young rooibos plants. Farmers were not shy in giving their input and ideas on how the erosion control bunds should be erected, what materials should be used and how much community members should be paid for their labour (see Plates 15. and 16.).

Initially, the Co-operative prioritized the maximization of job creation within the community as being a key desired outcome of its activities. Through successfully linking the high quality of their traditionally made rooibos tea with the strong social justice profile, the Co-operative became known as a premium fair-trade producer.

The World Summit on Sustainable Development in August/September 2002 provided an ideal mechanism for the Heiveld Co-operative to showcase its successful combination of social responsibility and ecological sustainability. The Co-operative was an active participant at the World Summit in Johannesburg, and the video 'Ways of Being on Planet Earth' provided a high-tech platform for the Co-operative to show

itself to the world. At the Summit, the Co-operative launched its wild tea, aptly described as being biodiversity friendly.

The change agents (Indigo and the EMG) were largely responsible for widening the support structures of the emerging Heiveld Co-operative. Through a broad resource base, funding was accessed for the various projects proposed by the community members. For example, building its own tea-making facility was seen by the Co-operative as an important target. Seed funding was raised from the Canada Fund, and following negotiations by the Co-operative, a community member donated land on a 99-year lease basis. The development agencies engaged an architect to draw up plans, and the members came together to begin building the tea court where the rooibos harvest would be chopped, fermented and dried (see Plates 17. to 21.). The Co-operative eventually obtained its own organic certification for the European Union for the 2004 season and through a parallel process was certified with the Fair Trade Labelling Organization (FLO), thus becoming the world's first FLO-certified rooibos producer. These achievements reinforced the Co-operative's slogan: 'Produced with Pride!'

6.3.2 The development of socio-technical practices within the Heiveld Co-operative

Farming is an organized flow of activities through time and thus follows different patterns. These patterns are a function of driving forces (for example relations with markets and technology) and evolve into a specific organization of the farm, through the structuring of the labour process (van der Ploeg, 1994). An evolution of farming activities was apparent during the development of the Heiveld Co-operative. This development will be discussed here in relation to the technical challenges faced by the farmers, and their response to these challenges as expressed in evolving farming strategies.

Towards the end of 2000, motivated by the interest expressed by Fair Trade in organically grown tea, the Suid Bokkeveld farmers signed a three-year contract with a local tea trader and committed themselves to producing organically grown rooibos tea. The farmers were certified as producers of organically grown tea by the tea trader and as a result, needed to conform to the resulting regulations regarding their production methods. This posed a challenge because initially the farmers purchased rooibos tea seedlings grown non-organically, from a nursery for their tea production. As the tea took two to three years before harvest, the processed tea was considered to be organically grown. However, since the expansion of the marketing of their tea to the European market through the FLO, stricter control measures were instated. Under these new measures, farmers then had to use organically grown seedlings for their product to remain certified organically grown. This left the farmers with a number of options: to source organically grown seedlings; to produce their own organically grown seedlings or to return to the traditional method and sow directly from seed. Most of the farmers who were interviewed stated that they would prefer to return to the traditional method of direct sowing. In fact all farmers had at least one piece of land in production that was established through direct sowing.

From the nursery that supplied the non-organically grown seedlings, the farmers learned that producing their own seedlings would impose many challenges including:

- seed scarification (scarification refers to the process (chemical or physical) of penetrating the seed coat without causing damage to the cotyledons. Germination can then continue as water becomes available through the damaged seed coat. The natural process of seed coat scarification is either by fire or during the digestion process in the gut of mammals that consume the seed);
- nursery infrastructure;
- disease control and management and
- access to a plentiful and continuous supply of water.

These challenges were overwhelming considering the challenges that farmers were already facing with the organic certification process. The question of organic seedlings had implications for seed collection. Farmers already collected seed locally for direct sowing. However, if the farmers were to increase the lands sown directly, they would need to either purchase seed or collect more seed themselves. Direct sowing requires more seed than producing nursery seedlings as there is a lower success rate of seedlings in the field than at the nursery. Seed collection was done during the summer months once the seedpods of the rooibos had burst, releasing the ripe seed. The practice of using direct seeding versus seedlings meant less capital outlay for direct seeding, but an increase in time to harvest of the tea by a period of one year. Direct seeding also meant that farmers would use wild rooibos tea as a seed source instead of the Nortier variety supplied by the seedling nursery. Wild rooibos grown as cultivated tea has a longer life span than the variety developed for cultivation and is also hardier once established.

The wild rooibos grown as cultivated tea (mak tee) grows for up to 8 years and is more resistant to drought than the variety grown as cultivated tea (Nortier). The Nortier variety only grows for about 5 years then it has to be replanted. Also, it cannot survive fire like the wild cultivated tea, if wild tea burns, it will just grow back after the rain. Fire kills the Nortier variety.

There were other benefits of using directly sown tea, particularly in drought years or years when the rains were late.

If you order seedlings, you have to plant even if the rains haven't come. It makes planting difficult because the soil is not firm, it's still sandy and loose and the seedlings fall over. Also, every few days you have to water the seedlings. If you sow directly, the seed just sits and waits for the rains and it doesn't need firm soil.

The farmers initially sent their seed to the tea merchants for scarification by sulphuric acid treatment. The traditional method was to scour the seed on rock until the seed coat was damaged. This took considerable time as care was needed not to damage the seed in the process. Farmers were also concerned about the acid treatment, and said it gave poor quality seedlings as the seed was damaged during the treatment

process and it had therefore to be treated with fungicides to prevent fungal infection before germination. Sulphuric acid treatment was not allowed under the organic certification standards and some farmers expressed interest in scarifying the seed through the use of smoke, a practice that was used by their forefathers. In 2002, negotiation began with an agricultural engineer in order to investigate the design and manufacture of a seed smoker.

The resource base and support network of the EMG and Indigo were instrumental in mobilizing funding and technical support for the various aspects of the project. Funding and support were obtained through government departments (National and Provincial Departments of Agriculture, Department of Manpower), research institutions (Agricultural Research Council - Western Cape, University of Cape Town, Wageningen University) and international institutions (United Nations Convention to Combat Desertification, Global Environmental Facility).

Through the natural resource research programme, farmers were able to devise strategies to manage their wild tea, a necessary process since the inception of the Co-operative and the associated increase in harvested product. The research programme on sustainable tea harvesting also informed the management strategies for the wild tea. The LandCare project was only feasible due to the formation of the Co-operative, as traditionally government departments seldom worked with individual farmers, as policy dictates that only farmer associations will receive their assistance. The LandCare project had a positive influence on the sustainable production of tea because farmers addressed issues of wind and water erosion through the LandCare project, enabling better tea production practices. The LandCare project drew on both local and scientific knowledge. The innovative practice of clearing strips of land within a field as opposed to clearing the entire field for rooibos cultivation, assisted in the control of erosion and the retention of critical levels of biodiversity, essential for sustainable land use practices.

In the Suid Bokkeveld, local knowledge of rooibos tea cultivation developed from first-hand experiences of people working on their own land and working as labourers on white-owned farms. Due to their knowledge of tea cultivation and post-harvest handling, the Heiveld farmers were in a position of strength in that they produced a good quality organically grown tea. Although this type of tea was a sought-after commodity, which realized much higher prices than the tea produced under non-organic conditions, the ability of the Heiveld Co-operative members to negotiate in the market-place was not strong. Most of the Heiveld farmers had low levels of formal education, and experiential learning in the workplace had been limited by their predominant experiences as manual labourers. Very few were able to communicate in English, the dominant language of international trade, and furthermore they had little commercial experience to enable them to negotiate in the market-place. The marketing process was co-ordinated and managed by Indigo, with support from the Co-operative's bookkeeper. Ultimately, the heterogeneous sources of knowledge around the organic cultivation of rooibos, post-harvest treatment and marketing took place within a deliberate social learning environment fostered by the EMG and Indigo. The EMG and Indigo had been careful to foster an action-research approach among researchers, which made them more empathetic towards the Co-operative farmers and more willing to listen and learn from the farmers.

Plate 11. Farmer at Blomfontein explaining the correct harvesting height of rooibos, a wild rooibos bush is in foreground

Plate 12. *Die Wurm* (the worm, *Sphenoptera* sp), a significant pest on rooibos that lives in and feeds on the stem of rooibos

Plate 15. LandCare team establishing wind breaks at Melkkraal using locally available vegetation (restios)

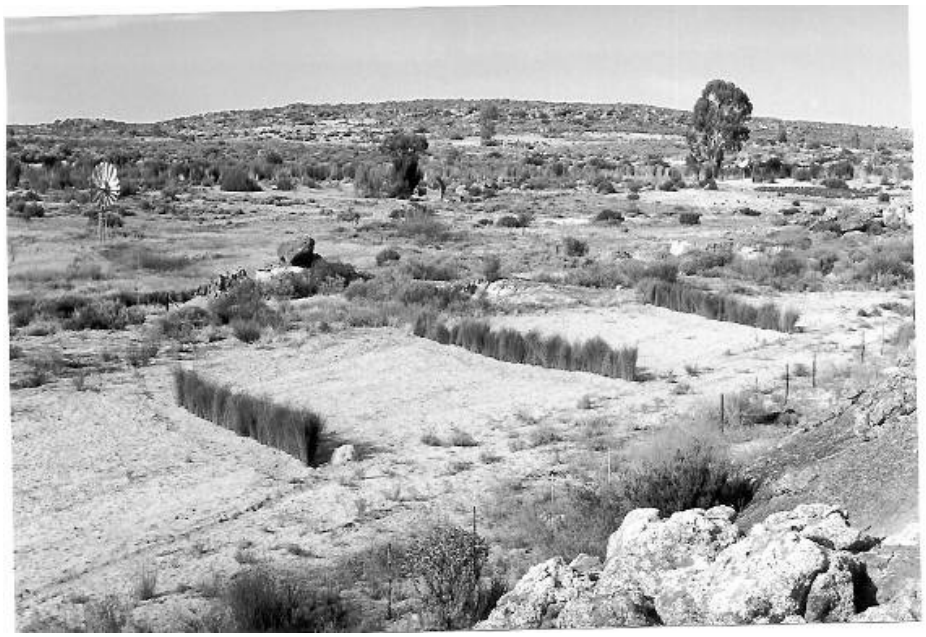

Plate 16. Wind breaks at Melkkraal, in a field to be planted to rooibos

Plate 13. Community workshop at Landskloof

Plate 14. The women's league catering for a community workshop at Landskloof

The rooibos-tea making process

Plate 17. Bundles of cut rooibos await processing at the tea court

Plate 18. Rooibos bundles are dismantled and put through the cutter

Plate 19. The chopped rooibos is gathered up and placed in heaps on the tea court where it is left to sweat for 24 hours, sweating develops the flavour and colour

Plate 21. The dry tea is bagged and the bags are weighed and then transported to a tea processor for sifting and pasteurization

Areas of co-operation between researchers and local farmers included knowledge-exchanges around wind erosion, these exchanges led to testing restoration techniques to protect the rooibos shrubs, and especially the young seedlings. Furthermore this knowledge exchange revolved around cultivating wind-erosion barriers of a naturally occurring reed, which was used locally for thatching and therefore opened up further livelihood options.

A localized approach for economic intervention was used at Melkkraal. Due to past and present population pressures, comparatively little tea is cultivated at Melkkraal. The community at Melkkraal, in particular the women, mainly served as a source of skilled and unskilled labour for farms in the surrounding area. Through facilitation by Indigo, a number of women living on Melkkraal decided to form a league and work towards economic liberation. They have established tourist facilities including accommodation and ablution facilities in keeping with local, traditional methods. They offer the discerning tourist a chance to experience Suid Bokkeveld hospitality. The bed and breakfast facility is popular and includes supper by request. The women's league members also make hand-sewn bags for packing rooibos tea, facilitate the packaging process and offer a catering service for local functions. The Co-operative and the change agents patronise the catering service for meetings, workshops and knowledge-exchange visits. This is an example of how the set of initial ideas of uplifting the poorest of the community was transformed into a specific and localized practice.

6.3.3 Processes of intervention

The developmental processes and interventions in the Suid Bokkeveld case study are largely knowledge-based. Local knowledge is broadened by interaction with scientific knowledge and the knowledge exchange process with the other small-scale rooibos tea farmers prompted the formation of the Heiveld Co-operative and the Rooibos Study Group. At the field level, members of the Co-operative have begun to include scientifically verified practices with their own, traditional practices. Their observation of the value of diversity in nature has contributed to the notion that diversity in knowledge is also of value. Diversity of opinion and a willingness to experiment are evident, and are encouraged by the learning processes of the Rooibos Study Group. The farmers are able to learn effectively from the project as the research approach facilitated input from, and promoted learning by, all partners involved (researchers, harvesters and land owners). The academic interest in the wild tea has contributed to an increased awareness by farmers of the value of their biodiversity heritage and has served to strengthen their sense of pride in the sustainable use of this resource. Development that is farmer-focused reflects the recognition of the value of indigenous knowledge, both for the livelihood security of rural people and as an important source of innovation, and tested solutions to environmental and developmental challenges (Adams, 2001).

Participatory processes used with the community of the Suid Bokkeveld are central to the project, and the approach developed by the EMG is underpinned by the belief that change for the better should be driven by those whose lives are to be improved. It is understood that positive change can result from the conscious application of a learning cycle involving collective reflection, decision-making, planning and action (Kolb, 1984). The participatory processes have led to the building of capacity and an

associated sense of pride within the community. The participatory processes have gradually become internalised by the community and Co-operative members. Initially members felt that the community workshop process was tiresome because they sought immediate action and results, but over time, they have recognized that participatory methods, although time consuming, offered tangible benefits.

A profound shift has occurred, from a process in which meetings were arranged and driven by the service providers, to co-operative members inviting service providers to attend and support meetings. These activities represent the internalisation and expression of capacity development of the Heiveld Co-operative. Asking for assistance is no longer regarded as a weakness, nor perceived to be difficult. The process of capacity development has also allowed for the building of trust between the community members and the service providers as the community members feel more secure about their abilities, achievements and requirements.

The timing of the Heiveld project is crucial to the evolution of the intervention process. The fact that the project has been initiated in post-apartheid South Africa provides a fertile environment for implementing participatory methodologies and for mobilizing international, national and provincial resources to address the needs of emerging farmers. Historically, the absence of state support had allowed local farmers to develop farming practices specific to and mostly in harmony with the environment. These practices are mostly organic and sustainable and as a result the intervention is strongly grounded in local knowledge and skills. The affirmation of local expertise in rooibos cultivation and post-production handling has allowed the Heiveld Co-operative members to concentrate on developing their marketing capacity, a process grounded in a learning environment. As the Indigo facilitator is not an expert in marketing, she is also involved in the learning process.

Knowledge-exchange processes have allowed the farmers to explore problematic areas in the cultivation of organically grown rooibos and to understand the strictures of organic certification. Close working relations between researchers and the community have fostered the development of inclusive knowledge of organic farming. The exchange of scientific and local knowledge of organically grown rooibos resulted in the production of a handbook on organically grown rooibos (Oettle *et al.*, 2002).

6.4 Conclusions and lessons learned

Returning to the research questions framed at the beginning of this chapter. At the field level, the sustainability of the intervention is considered moderate to high. This is due to the indication, by research on harvesting practices of both wild and cultivated tea, that current practices are sustainable. Sustainability of tea production is also considered good due the ecological integrity of the natural resources, and the knowledge and skills of community members in the sustainable management of the natural resource base. Further to this, in cases where the natural resource base is relatively poor, alternative intervention strategies are applied. This is illustrated in the case of Melkkraal, where the intervention focusses on tourism, rather than increased tea production.

At household level, the sustainability of the intervention is also considered to be moderate to high. Factors that contribute to the sustainability of household livelihoods include: the participatory learning and action practices used within the project that

complemented the strong social fabric of the community; the locality-specific nature of the interventions; and the financial resources obtained from outside the community through the sale of tea and the tourism initiative.

At the level of organizational interaction, the district level, the intervention is considered to be moderately to highly sustainable. The sustainability of the intervention at this level is primarily a function of: the learning and participation practices introduced and maintained throughout the development project; the contribution of heterogeneous sources of knowledge to technology development; the establishment of a financial management system; and the shared history and future of place within the community.

The Suid Bokkeveld case represents a success story in South Africa's emerging agriculture. It shows an improved method of bringing historically diverse cultures together for the benefit of all. Induced, top-down projects often ignore and destroy the local knowledge and social organizations on which sound stewardship of ecosystems as well as equitable economic development depend (Rich, 1994). But within the Heiveld Co-operative Limited, because of the learning environment and participatory methods used, there is enhanced local knowledge and social organization of the community, leading to equitable economic development. The use of participatory methods and the creation of a learning environment are two factors that are key to the success story of the Co-operative.

The Heiveld Co-operative process also highlights the four principles underlying endogenous development (Frieberg and Hettne, 1985):

- communitarianism (development rooted in values and institutions of a culturally defined community);
- self-reliance (at different scales within society);
- social justice and
- ecological balance (implying an awareness of local ecosystem potential and local and global limits).

These principles were fundamental to the successful establishment of the Heiveld Co-operative Limited. The process used in the intervention reinforces the value of a learning environment, integration of social and material diversity throughout the project, and making new connections and alignments at all levels of the institutional environment. The environmental, social, economic and institutional sustainability of the intervention will be presented and discussed in Chapter 7 through comparison with the other case studies.

6.6 Acknowledgements

I thank: Dr Nicky Allsopp for sharing with me her vast knowledge on the soils and plants of the fynbos biome; Environmental Monitoring Group and Indigo Development & Change for the opportunity of working with the community of the Suid Bokkeveld; my 'co-researchers' Wiesaal Salaam; Rhoda Louw and Eugene Pienaar for discussion and sharing of experiences; and the people of the Suid Bokkeveld for their hospitality, interest and willingness to participate in the research for this chapter.

Chapter 7: Bringing it all back home
Towards sustainable subsistence agriculture in South Africa

7.1 Chapter content

The case studies presented in this thesis show that the design of sustainable systems for small-scale farming that improve household food security and create new employment opportunities for historically disadvantaged people, is a very complex undertaking. For this reason, the design of sustainable systems requires a multi-level, multi-aspect and multi-actor approach to research. Effective research into sustainability requires the identification of factors that both enhance and constrain sustainability at all levels within the system. To identify the factors that enhance and constrain sustainability, this chapter addresses the three research questions framed in Chapter 3, namely:

- Although sustainability is specific to both time and locality, what general conclusions can be drawn about sustainability through examining development project case studies?
- What role do institutional factors play in the sustainability of technological interventions in the development sector?
- What methodologies are appropriate for research into the sustainability of development projects?

The first question is addressed in sections 7.2 and 7.3 by examining the environmental, social, economic and institutional sustainability of the interventions of the three case studies. The second question is addressed in sections 7.4 and 7.5 by summarizing the technico-institutional dynamics and the contribution of these to the sustainability of the three levels of investigation for each case study intervention; and by a discussion of the factors affecting the environmental, social, economic and institutional sustainability. The practical lessons learnt from the three case studies are presented with a discussion on potential modes of development towards sustainable subsistence agriculture in South Africa. A reflection on the research process is given in section 7.6, addressing the third question. The chapter closes with the lessons learned from the research project.

7.2 System sustainability: a review of the case studies

Within the Valley of a Thousand Hills, the SPUP was using a constellation of promising methods and processes to address household food security for homestead gardeners. At Mbongolwane, a novel approach to wetland conservation through the production of crafts was nurtured within a protected space. In the Suid Bokkeveld, through participatory learning and action, traditional *rooibos* tea production practices were shown to be sustainable and were gaining national and international recognition. The intervention of all three case studies aimed to make a difference at the homestead level, in particular to influence the livelihoods of the community members in a positive manner. The main factors, at each of the three levels examined within the case studies, contributing to the sustainability rating are presented in sections 7.2.1 to 7.2.3. A summary of these sustainability ratings is presented in Table 7.1.

Table 7.1 Sustainability ratings for the three levels of investigation for all case studies

Level	System	The Valley	Mbongolwane	Suid Bokkeveld
Field	Agro-ecosystem	moderate	high	moderate/high
Household	Socio-economic	low/moderate	moderate	moderate/high
District	Organizational	low/moderate	moderate	moderate/high

7.2.1 The Valley of a Thousand Hills

Production output of the agro-ecosystem made a significant contribution to household food security. The sustainability of the intervention was rated moderate at field level because:

- the green manure intervention was useful to a few gardeners;
- the cultivation of traditional, nitrogen-fixing legumes made a positive contribution to nutrient cycling within the agro-ecosystem and
- gardeners readily employed soil erosion control measures which contributed positively to soil retention and soil fertility.

Within the agro-ecosystem, trends indicated that the intervention did not guarantee intergenerational sustainability with respect to both the technology and the participatory processes.

The sustainability rating for the socio-economic system was rated low to moderate because:

- the additional labour resources required for growing the green manure crop each year, would put significant pressure on HIV/AIDS-affected households;
- the green manure intervention contributed to the food security of a few homesteads and
- progress was slowed through ongoing group conflict in two of the wards.

The sustainability of activities within the organizational system was rated low to moderate because:

- learning was not a significant theme in all the groups for the duration of the project;
- the process was effectively participatory and
- limited sources of knowledge contributed to the soil fertility intervention.

The promising pocket of activities of the SPUP with the gardeners in The Valley of a Thousand Hills remained a promise for the following reasons:

- the agro-ecosystem contributed significantly to household food security (although intergenerational equity was not guaranteed);
- the erosion control intervention was adopted by many gardeners;
- learning routines and effective participation within the system of organizations although established, were not maintained and
- knowledge networks (traditional, local, expert) at the field level were not well-aligned.

7.2.2 Mbongolwane Wetland

A significant contribution was made to household livelihoods from ecosystem outputs. The crafters relied on natural resources available in abundance and requiring little management input. The field level sustainability was given a high rating because:

- traditional harvesting practices and beliefs maintained ecosystem integrity;
- the resource was widely available in quantity of which only a small proportion was used;
- the natural resource was very resilient to harvesting and
- the technology used in the intervention was familiar to the crafters.

Both the technology and the intervention process showed predominantly positive outcomes and contributed to ensuring both intra- and intergenerational sustainability. The socio-economic system was rated moderately sustainable, for the following reasons:

- the intervention had a significant impact on household livelihoods, in particular the poor and HIV/AIDS-affected households;
- training within the craft group increased the pool of resources available for income generation through craft production;
- conflict resolution within the group was ongoing;
- financial management and control mechanisms were inadequately established;
- learning and capacity building were key themes at the household level and
- significant financial resources were obtained from outside the community through the sale of locally produced craft.

The organizational system was given a sustainability rating of moderate because:

- marketing and financial capacity in the group was limited and the group relied almost entirely on a single product thereby increasing its vulnerability;
- participation and learning were key themes throughout the development process;
- heterogeneous sources of knowledge contributed to the development process;
- the community had a shared history and future of place and
- production and marketing networks were closely aligned.

7.2.3 The Suid Bokkeveld

The ecosystem and agro-ecosystem outputs contributed significantly to the household livelihoods of the community. The farmers and community members had access to a significant quantity and quality of natural resources. The intervention at field level was rated as moderately sustainable to sustainable because:

- the ecological integrity of the natural resources varied from poor to very good;
- no undue stress was placed on those natural resources in poor condition as alternative intervention strategies were available and
- the technology used for the intervention was familiar to the farmers.

The sustainability of the agricultural and socio-economic system was rated moderate to high because:

- the interventions facilitated by the change agents made a significant contribution to household livelihoods, in particular the poorest people in the community;
- a strong social foundation was enhanced by participatory methods and learning within the project and
- significant financial resources were obtained from outside the community through the sale of locally produced *rooibos* tea.

The organizational system was given a sustainability rating of moderate to high because:

- learning and participation were established as key themes in the development project;
- heterogeneous sources of knowledge contributed to the development process;
- the marketing capacity of the group was limited and the group relied on the change agent to fulfil this function;
- the financial management system was fairly well-developed;
- the community had a shared history and future of place and
- production and marketing networks were closely aligned.

The contribution made to environmental, social, economic and institutional sustainability by the above factors is discussed in the following section.

7.3 Environmental, social, economic and institutional sustainability

In order to examine more closely the sustainability of the case studies, a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was conducted for each case study to highlight the internal and external factors contributing to the environmental, social, economic and institutional sustainability of the intervention in the case studies. Tables presenting the outcome of the SWOT analysis are presented in Appendix C. SWOT analysis examines strengths and weaknesses, which are internal to the system and opportunities and threats, which are external to the system. The factors within control of the farmer are considered internal, and those factors over which the farmer has no control are considered external (Mollenhorst and de Boer, 2004).

The ratings for each of the interventions, in terms of environmental, social, economic and institutional sustainability are presented in Table 7.2. The factors contributing to the ratings are discussed in detail and draw on the internal and external positive and negative contributions to the sustainability of the meta-system presented in Table 7.2, and reflect the sustainability ratings of the three levels presented in Table 7.1.

Table 7.2 Environmental, social, economic and institutional sustainability ratings for the three case study interventions

Sustainability	**The Valley**	**Mbongolwane**	**Suid Bokkeveld**
Environmental	low to moderate	moderate to high	moderate to high
Social	low to moderate	moderate to high	moderate to high
Economic	low to moderate	moderate	moderate to high
Institutional	low to moderate	moderate	moderate

7.3.1 Environmental sustainability

The state of the natural resource base at the time of the intervention, varied considerably between the case studies. For the Valley, the resource base had been highly transformed through generations of agricultural production. At Mbongolwane and in the Suid Bokkeveld, the natural resource base was for the most part in good condition. In the Valley, the sustainability of the crop environment was assured for most gardeners principally through their skills and knowledge of on-farm nutrient cycling (manure use, compost, termitarium soil, soil erosion control) and the contribution of traditional crops to the maintenance and building of soil quality (nitrogen fixation, weed suppression, erosion control). The skills and knowledge of the Mbongolwane community members also contributed to the sustainability of the wetland environment through traditional harvesting methods, manual cultivation of *madumbes* (as opposed to more-destructive mechanical means) and community-based wetland management structures. Similar factors were apparent in the Suid Bokkeveld where the skills and knowledge of farmers, passed down through the generations, contributed to the sustainable management of the fynbos. This was expressed through an understanding of the harvesting limitations of wild tea, the manual cultivation of tea plantations (as opposed to more-destructive mechanical means) and the domestic use of available natural resources from the fynbos.

However, environmental sustainability within the case studies was not assured, mainly due to external pressures. Within the Valley, these threats included increased urbanisation (reduced land availability for cultivation and grazing), soil erosion (in many cases this was also an internal pressure) and reduced labour availability. There were also opportunities that contributed towards environmental sustainability within the Valley, and these included livelihood diversification options where food security was attained through income obtained from craft and beadwork commissions and also through the government's skills development and training initiatives. For a number of gardeners, on-farm nutrient management and erosion control measures ensured environmental sustainability.

At Mbongolwane, the main threat to environmental sustainability was the potential increase in the cultivation of *madumbes* should the craft initiative not be sustained. In the Suid Bokkeveld, the main threats to environmental sustainability were the increased harvesting of wild tea beyond the natural resources' capacity to regenerate, in order to meet market demand and also the increased cultivation of tea lands to maximize returns. For all the case studies, one of the greatest threats to sustainability was climate change. At the local level, periods of drought impact negatively on livelihood activities and the lack of water availability is said to trigger a variety of

adaptation strategies that in turn exert positive feedbacks to accelerate environmental degradation (Scoones, 1996; Vogel *et al.*, 2000). Nationally, projected mean annual temperature increases of 1-2^{o}C are predicted for southern Africa, resulting in mean annual evaporation increases of 5-20% and a decrease in rainfall effectiveness (Tyson *et al.*, 2003). In the eastern part of the country, rainfall events are predicted to become less frequent and to be of much greater intensity (Rutherford *et al.*, 2000). For the Valley and Mbongolwane, this means that erosion control measures will become ever more important in ensuring environmental sustainability. Furthermore, for the Valley gardeners, the resilience of their crop production systems to climate change is affected by the extent to which they practice water conservation methods and also the number of drought-resistant crops that they cultivate. The greater the diversity of crops grown by the Valley gardeners, the more resilient the crop production system will be in coping with the climatic extremes predicted to occur with global climate change.

The two key resources utilized from Mbongolwane wetland are *iKhwane*, used for craft production and land, used for crop cultivation. In terms of food production, the wetland is likely to buffer the Mbongolwane community against the increased intensity of dry periods (aridification) predicted to occur as a result of global climate change. The contribution of wetlands as food security 'safety nets' for crop cultivation during dry periods is well-documented (Duigan, 1990; FAO, 1998; Kotze, 2002). The buffering capacity of the wetland will depend on the level of utilization not exceeding the resilience of the system to gully erosion. Aridification is likely to increase the level of utilization of the wetland for two reasons: 1. Increased aridification will increase the drought-risk to crops cultivated outside the wetland to a greater extent than crops cultivated inside the wetland (a push factor). 2. Aridification will cause some of the most sensitive core areas of the wetland, currently too wet for crop cultivation, to dry-out and become suitable for crop cultivation (a pull factor). Resilience of the wetland to erosion will be further diminished by the predicted increase in the severity of storm events, further increasing the likelihood of erosion. Thus, the strengthening of local governance systems to maintain crop cultivation within ecologically sustainable bounds will become increasingly more important.

Provided that the wetland is not degraded by excessive gully erosion, *iKhwane* (the second key wetland-resource at Mbongolwane) is likely to be resilient, to some extent, to the drying-out of the wetland. This stems for the fact that *iKhwane* has preference for areas of intermediate wetness, not the wettest areas of the wetland. Should the wetland become drier due to aridification, the preferred habitat of *iKhwane* is likely to shift into what would then be the previously wettest areas of the wetland. As a result, areas of *iKhwane* would not be lost, merely re-located within the wetland. Thus *iKhwane* is a stable resource for the associated livelihood benefits gained from its use for craft production. *IKhwane* is less-likely to be severely affected by climate change and the proposed aridification than is the resource of *rooibos* tea in the Suid Bokkeveld.

The threat of climate change to environmental sustainability is greatest for the Suid Bokkeveld as the regional climate change in southern Africa is predicted to cause extensive species loss from the Fynbos biome due to the aridification of the western half of the country (Rutherford *et al.*, 2000). Thus aridification could in fact render the Suid Bokkeveld no longer suitable for *rooibos* tea, both wild and cultivated varieties,

this would clearly have devastating consequences for those farmers depending strongly on this resource as there would be virtually nothing they could do to combat this threat. In all three cases learning and adaptation to a rapidly changing environment will become ever more important to the sustainability of the agro-ecosystems of the gardeners, crafters and farmers.

Another national and regional threat to environmental sustainability is HIV/AIDS, and although the full impact is difficult to predict it is not insignificant. As a result of illness, land may be sold and would no longer be available for food production, areas closer to home could be over-harvested, and the management of natural resources would decline (Khanya, 2002a). Also, water requirements for those affected by AIDS would increase, as patients and bedding require frequent washing. It is a debatable point as to what extent gardeners, farmers and crafters have control over AIDS within the household and what means they have at their disposal to address the threat.

Despite the ability of the gardeners, farmers and crafters to sustainably manage their natural resources to ensure intergenerational equity, the impact of threats external to their systems can ultimately reduce environmental sustainability. For this reason, the ratings for environmental sustainability are not specific to a single category (low, moderate or high), but vary due to the unpredictability of the external threats (low/moderate and moderate/high). The lack of sufficient natural resources at the district level impacts strongly on the number of livelihood options available to gardeners and reduces their room to manoeuvre (Reitsma *et al.*, 1992). Thus, environmental sustainability is also linked to and is affected by social and economic sustainability and ultimately also institutional sustainability.

7.3.2 Social sustainability

The social sustainability in the three case studies ranged from moderate to high, mainly due to networking through community-based organizations (groups) and in the case of Mbongolwane and the Suid Bokkeveld, also due to the shared history of the communities. Within the Valley, support for the poor by other group members was a significant contribution to social sustainability; at Mbongolwane this was expressed through the open membership of the craft group; and in the Suid Bokkeveld social sustainability was expressed through the Heiveld Co-operative's decision to adjust the patronage percentage to assist the poorer co-operative members. The interventions at Mbongolwane and with the Heiveld Co-operative were both based on traditional skills and knowledge and also on localised practices. In both cases this served to engender pride within the community and make a positive contribution to social sustainability. Given South Africa's socio-political history, the value of positive re-enforcement of traditional, social and cultural factors is significant in developing social foundation.

The management of conflict within the groups was an indication of social sustainability and this occurred more readily in the two more-rural groups in the Valley, at Mbongolwane and in the Suid Bokkeveld. In all three of the case studies, change agents (development practitioners) initially facilitated conflict resolution. The mechanisms for conflict resolution became more internally managed over time, making a positive contribution towards social sustainability. Potential threats for all three case studies included non-transparency of fund management, declining equity and the effects of AIDS. Death and sickness erode social networks as attendance and

maintenance of cultural and social events diminish, as does the opportunity to contribute to or learn from shared knowledge and experience. Also, people caring for the sick cannot themselves participate in their own family activities (Khanya, 2002a). From the Valley, it was apparent that the urbanization of rural areas was another threat to social sustainability as social networks were less well-established in peri-urban areas and it took considerable time to build relationships of trust within the homestead-gardening groups. Social sustainability is closely linked to, and also strongly impacts on, environmental, economic and institutional sustainability.

7.3.3 Economic sustainability

The contribution to household food production made by the cropping systems within the Valley also made a contribution to economic sustainability, as money that would have been used for food could be used for other purposes. At Mbongolwane, sales from the crafts made significant contributions to economic sustainability, as did tea sales and income from tourism in the Suid Bokkeveld. National and international sales of crafts and tea also increased the amount of money in circulation within the community, further ensuring economic sustainability. At Mbongolwane, craft making was home-based and natural resources were near the homestead, so crafters did not have to spend any money on transport. Also, crafters who worked from home could care for the elderly, or the sick or supervise children themselves instead of paying somebody to care for the family members. In addition to this, crafting was often one of the few means of economic activity of poor households. Threats to economic sustainability were fickle and uncertain markets, the reliance on a single product, limited capacity for product marketing and the effects of AIDS on household economy (in particular the sale of assets due to limited access to credit).

In the Suid Bokkeveld, the localized approach used by the change agents for intervention was a positive contribution to economic sustainability. Those community members that did not have the opportunity for making their income from *rooibos* tea, generated income by using their skills and knowledge in the tourism and local catering industry. In the light of climate change, tourism and catering could become increasingly more important contributions to economic sustainability. Threats to economic sustainability were uncertain markets, a limited range of products, limited capacity for marketing and the effects of AIDS on household economy and the threat of global climate change to the resource base.

Within the Valley, no significant income could be generated through the sale of fresh produce due to the weak local market. It has been recognised in other studies within the subsistence-farming sector in KwaZulu-Natal, that the prospects for significant remuneration founded upon small-holder agriculture are weak (Vaughan, 1997; Taylor and Cairns, 2001). Thus the economic sustainability of farming systems within the Valley was not likely if based only on agriculture. Ultimately, the diversification of non-agricultural activities by the gardeners and their family members would be the only option for increasing significantly, the economic sustainability within The Valley of a Thousand Hills.

The disinterest of the youth in agriculture is often stated as a negative factor affecting agriculture. However, if considering agriculture as part of a larger system, and sustainability as a measure of the success of that larger system: in the two cases

where the youth were disinterested in agriculture (the Valley and the Suid Bokkeveld), given the threats to the sustainability of the two systems, the disinterest was potentially a positive factor for social and economic sustainability. In the Valley, it is recognised that no significant (or intergenerational) income is likely to be derived from agriculture. The disinterest of the youth in agriculture would thus ensure that they sought alternative or supplementary livelihood options, not based on agricultural production, and thus increasing economic sustainability within the district. In the Suid Bokkeveld, the extinction of many fynbos species due to climate change is predicted to occur within the next 50 years (Rutherford *et al.*, 2000), and would significantly affect the sustainability of systems dependent on *rooibos* tea. The disinterest of the youth in pursuing livelihoods based on tea production is again a positive factor for ensuring economic sustainability within the region, as the youth would seek alternative modes of livelihood security, not based on agricultural production.

7.3.4 Institutional sustainability

The institutional sustainability was rated lower for the Valley of a Thousand Hills case study than for Mbongolwane and the Suid Bokkeveld for a number of reasons. Within the Valley community, social cohesion was not strong and conflict within the community-based organizations was on-going, indicating that the sustainability of the community-based organizations (CBOs) was not guaranteed. Reasons for reduced social cohesion and continued conflict included urbanization and the lack of a positive learning environment. At both Mbongolwane and in the Suid Bokkeveld, group conflict was largely resolved through the intervention of the change agents (development practitioners) and strong social cohesion, due to a shared sense of community and the willingness to lend support to the poorest members of the community. At Mbongolwane, conflict resolution mechanisms and social cohesion were however not as strongly developed as in the Suid Bokkeveld, partly because the community and the group were much larger than in the Suid Bokkeveld and this reduced the opportunity for social sustainability.

The sustainability of the institutional arrangements of the change agent (SPUP) within the Valley was tenuous due to staff illness and dismissals, the limited sources of knowledge used for technology development, and the decline in organizational learning. The programme drew on few external initiatives of benefit to the gardeners (for e.g. skills development and training and technological support). For this reason, institutional sustainability was not assured and the overall rating for the Valley was rated as low to moderate.

The sustainability of the change agents' (development practitioners) institutional arrangements at both Mbongolwane and the Suid Bokkeveld was higher, due to the alignment with other initiatives and organizations able to assist crafters and farmers. Mbongolwane did have problems regarding institutional arrangements (e.g. a high staff turnover within the service provider) but these were not as great as in the Valley. Another factor that contributed to institutional sustainability at district level was the heterogeneous sources of knowledge used for whole-system improvement. In both cases, local knowledge was the basis for the co-production of knowledge with a variety of 'specialists'. The contribution of heterogeneous sources of knowledge has

been recognised as an important contribution to sustainable agricultural development (van der Ploeg *et al.*, 2004).

Change agents at both Mbongolwane and the Suid Bokkeveld were committed to participatory learning and action. As a result, learning became internalised and ultimately led to self-regulation within the CBOs. Furthermore, in both cases, the programmes were strategically managed so as to allow for the sustainable development of the craft and tea organizations. The institutional sustainability for both Mbongolwane and the Suid Bokkeveld was threatened by the limited capacity of the producers for marketing. The change agents and service providers were an integral part of the marketing and distribution system of the two groups. This raised the issue of how to phase out this support while ensuring that the groups were sufficiently self-mobilized in the marketing arena. The phased reduction of this protection of the groups by the change agents was considered critical for long-term institutional sustainability. The institutional sustainability for both Mbongolwane and the Suid Bokkeveld is rated as moderate.

The disinterest of the youth in pursuing agriculture-based livelihood strategies (the Valley and the Suid Bokkeveld) would constrain institutional sustainability where the organizations themselves were agriculturally focussed. However, this would provide social foundation for the formation of new organizations that would have the opportunity for sustainable development. In all case studies, AIDS was the greatest external threat to institutional sustainability.

7.3.5 Sustainability Overview

The central factor within the case studies that affected the overall sustainability was natural resource use. The multitude of resources available to the gardeners, crafters and farmers impacted on the requirements for, and mechanisms of, natural resource use. All internal resources were in turn impacted upon by external factors. Thus, the interaction between the internal system and the external factors determined environmental, social, economic and institutional sustainability. Or viewed from the 'outside' one could state that external factors impinge on natural resource use primarily through their effect on internal factors.

Environmental sustainability was influenced by natural resource use, which in turn was influenced by the availability of other, supportive resources. Internal factors essential to the sustainability of natural resource use were community-based management structures (environmental management), local knowledge, product development and local technologies. External factors included non-local sources of knowledge, market availability and human health.

Social sustainability was influenced by social networks, which in turn was influenced by the available social and human resources. A factor impacting on the human resources was the ability of the household members to manage: the threats and shocks to their livelihoods; networking and support; and the health of household members. External factors included opportunities for skills development and training, capacity development and assistance from development agencies and government departments (e.g. grants, relief programmes, marketing and distribution).

Economic sustainability was influenced by livelihood strategy, which in turn was influenced by the availability of other, supportive resources. Factors contributing to

livelihood strategies included food production (household food security), employment, skills and knowledge. External factors included opportunities for livelihood diversification through the sale of crafts and beadwork, market availability for commodity products (conference folders, wild tea), support for tourism and skills and capacity development.

Institutional sustainability within the community was influenced by social foundation (Galvin, 2005). Social foundation was in turn influenced by the ability of individuals within the community to drive and maintain initiatives (internally and externally) and the ability of groups to manage conflict (self-mobilization and learning). Institutions are closely linked to social process and associated resources, in that they may emerge from it, reflect abundance/lack of it, or generate particular types of it for particular groups. Institutional functioning changes over time, in response to contextual changes or as a result of the adoption of different livelihood strategies, which change institutional rules (Swift and Hamilton, 2001). External factors included the strategic management of the programme and the alignment of knowledge networks.

A major barrier to sustainability within all three case studies is the effect of the apartheid regime on social foundation. This was more noticeable in the KwaZulu-Natal case studies than it was in the Suid Bokkeveld where it was still apparent but to a lesser degree. The impact of almost five decades of apartheid on the social functioning of South Africa's population today cannot be discounted. Under apartheid, thinking and doing for oneself were discouraged. Essentially there was: *no action without permission*. This still has relevance today, where people struggle to take responsibility for their own lives as the indoctrination of the government in prescribing and enforcing action in still ingrained in social behaviour. Even as a white person, I experience this myself and it takes conscious effort to change my mode of behaviour. For those sectors of the population where indoctrination was coupled with enforced poverty, this effort will be even greater.

In KwaZulu-Natal, due to traditional authority structures and modes of law-enforcement, many sectors of the population are still largely embedded in the notion of *no action without permission*. This has profound influence in institutional arrangements, where the top-down approach is rarely questioned and is largely accepted as the norm (there are exceptions, e.g. the farmer who established a mango orchard). This acceptance of the top-down approach occurs not only in government interventions but also with non-government organisations, where project recipients are just that: recipients, and are seldom active participants and even more rarely requestors of project intervention.

This was noticeably different in the Suid Bokkeveld, where at workshops, people actively participated in discussions and the youth were not afraid to give their opinions. Later on in the project, farmers began to actively ask for what they wanted especially with regard to the type of research they wanted assistance with and the knowledge that they needed. Ironically, in the Valley case study, this interaction was foreclosed by the intervention agent, the Social Plant Use Programme. One of the gardeners began using fertilizer in her garden as she could afford it and she also correctly perceived it as being the ideal solution to correcting the imbalance in nutrients in her soil. The SPUP, due to their policy of organic agriculture, refused to

work further with this gardener as her 'aberrant' behaviour would be likely to influence other gardeners in seeking similar solutions. The SPUP did not recognise that their institution's mode of behaviour and the enforcement of what they prescribed was analogous to that of the government departments whose method of prescription they (the SPUP) perceived as limiting to sustainable agricultural development. The rate of transition to a proactive society is thus affected by how rapidly the rules and routines of participatory development are adopted as formal roles by tribal authority, government and non-government agencies.

A number of lessons can be learned from the three case studies to aid in the design and implementation of research programmes for sustainable development and these are presented in the following section.

7.4 Toward sustainable development: lessons learned and key factors

The most striking aspect of the case studies is the difference in reliance by the gardeners, crafters and farmers on natural resource use and the quality of the natural resource base. Despite the variation in location of the projects, the approaches used and the technologies developed, a number of issues and factors that affected the sustainability of the case studies are similar. These are presented as the lessons learned, and as evidenced in the case studies, they make significant contributions towards both sustainability and sustainable development. They are presented in Table 7. 4 for each of the levels researched.

Although the lessons learned have been presented at the three different levels researched, they all contribute to the overall environmental, social, economic and institutional sustainability of the development intervention. At all the levels, the major contribution to sustainability is the focus of the intervention on enhancing local resources and processes. Sustainable use of natural resources was a key element of the development interventions of the case studies and the lessons learned show that both local and scientific knowledge are important in finding solutions for sustainable natural resource use.

Social processes are particularly relevant in the context of development interventions in post-apartheid South Africa and the lessons learned show that participatory processes are essential for sustainable development, as are building trust and pride within rural communities and households. The lessons learned also show the importance of organizational learning and the relevance of institutional ideologies and development frameworks in realizing sustainable development. This supports the notion that sustainability is location-specific in terms of time and place; and that the interactions of elements at all levels are relevant in determining sustainability and sustainable development.

Table 7.4 Sustainable development-interventions: lessons learned from the case studies to inform the technico-institutional design of sustainable subsistence farming in South Africa.

Field level sustainability: • the intervention should build on local knowledge and practices; • the intervention should maintain or improve the resource base; • the evolution of technical and institutional processes should be concurrent and mutually reinforcing and • heterogeneous sources of knowledge should contribute to technology development.
Household level sustainability: • social, technical and organizational networks pertaining to the development of the technology, where these do not already occur, should be created and maintained; • capacity building should be achieved through social and organizational networking and • in the context of the rural poor, the intervention should make a significant contribution to household livelihood strategies.
District level sustainability: • learning should be a key theme in organizational and social interactions; • a space should be provided by change agents for organizational development; • a space should be provided by change agents for technological development and • the intervention should be specific to the locality.

A number of factors, considered external to the system (as they were largely out of control of the gardeners, farmers and crafters), impacted directly and significantly on the sustainability of the technological development. External factors are discussed here as these can be more readily used for system design than internal factors which are dependent on social foundation. These factors represent lessons learnt from the case studies in realizing sustainable development, and include:

1. Opportunities for skills development and training, including access to government initiatives, should be created. These opportunities can help to provide resources for livelihood diversification, where such alternatives are required to enable intergenerational sustainability. Diversification of survival strategies of the rural poor is already increasing and this is realised through craft production, medicinal plant collection, and the multi-purpose use of rangelands and commons. These and other activities are contributing to household incomes to a greater extent than in the past (Cousins, 1998). Opportunities for skills development and training should also be made available for change agents, facilitators and researchers, especially to enable them to deal with the complexities of sustainability and livelihood strategies.
2. The development of capacity, which includes the capacity of all actors in the development process, is an important factor for sustainable development. The development of capacity includes capacity for: conflict resolution, self-

mobilization, marketing, research and participatory processes. From a systems view of social phenomena, all parties in the relationship should contribute to effecting positive change (Kegan, 1994). The identification of what changes are needed among a wide range of stakeholders is required for truly participatory approaches. If the only progress communities see is accompanied by hand-outs they may become convinced that they are not capable of making progress themselves. This creates a feeling of inadequacy and leads to dependency and subservience, which robs people of their self-respect (Bunch, 1995). The process then becomes non-participatory and unsustainable and for this reason, the building of capacity at all levels in the project is important.

3. The creation and maintenance of a learning environment will enable sustainable development, particularly if the learning environment embraces all levels of interaction in the development programme, including organizational learning. Some conflict between people in a development project is appropriate because change is not always a comfortable process (White, 1996) and this conflict will ultimately be resolved if learning is a theme within development initiatives.
4. The strategic management of development programmes to access beneficial resources is crucial for sustainable technology development. Linkages with other programmes, projects and initiatives are valuable in increasing available resources (human, social, physical, economic and technical) for ensuring multi-level sustainability. Local service delivery is unlikely to be efficient or sustainable unless an appropriate development-orientated rural institutional environment is created (Barnes and Morris, 1997). Sustainable development is highly contingent upon the establishment of a sound development- orientated and structured institutional environment capable of delivery. This was most apparent at Mbongolwane and the Suid Bokkeveld, and was possible due to synergies created through involvement of both projects with the LandCare programme.
5. The alignment of knowledge networks to ensure an unobstructed exchange of knowledge within the development programme and also between the development programme and the external environment is another factor critical for sustainable development. This relates to the strategic management of the programme and also to the learning capacity of the organization in realizing the value of heterogeneous sources of knowledge for sustainable technology development. In the problem definition discussed in this thesis, scientific knowledge networks are not closely aligned with local knowledge networks. The challenge to sustainability is to more closely align the two networks, to achieve maximum benefit from heterogeneous sources of knowledge. The relationship between the two forms of knowledge, scientific and local, cannot be assumed to exist in advance. Networks linking these two knowledge-types need to be established and the development of the relationship between them should be facilitated to enable the development of methods to find sustainable solutions at field and household level. In practice the boundaries between the knowledge systems are often unclear. However once interaction occurs between the knowledge systems, the networks linking the two knowledge systems become more stable (van der Ploeg, 1990).
6. A revision of the period of funding provided for development projects is also crucial to enable sustainable development. Most international aid agencies, some

national and provincial government initiatives and tertiary education research programmes provide four-year funding cycles. However, if learning routines and networks are crucial for sustainable development, it is unrealistic to expect that a four-year period is sufficient for these to be established and maintained. This is particularly relevant for development programmes in South Africa given the effects of the apartheid regime on our humanity. Misslehorn (2005), in interviews with fieldworkers, facilitators and researchers found that four-year project funding is considered to be a major policy restraint for development programmes in South Africa. A period of at least six to eight years should be allowed to ensure that learning routines are significantly embedded in organizational structures and that networks are sufficiently established (including government departments), aligned and maintained to be sustainable.

To summarize, some key factors for success include: the provision of opportunities for skills development and training; the development of capacity of all actors; the creation and maintenance of a learning environment; the strategic management of development programmes to maximize synergistic relationships; the appreciation for, and use of, heterogeneous sources of knowledge; and a time-extension of project-funding cycles. The key factors and the lessons learned from the three case studies are considered important for research into leading the transformation of subsistence agriculture in South Africa into viable and sustainable systems. As sustainability and sustainable development are ultimately location-specific, these key factors and lessons learned are not presented as a definitive formula for success. This is in recognition of the multitude of location-specific factors that are important in determining sustainable systems. I will now reflect on the concept of sustainability in the light of the insights gained from the case studies.

7.5 Revisiting Sustainability and strategic niche management: a theoretical and conceptual reflection

7.5.1 Sustainability

Agricultural sustainability is a function of the interaction of processes both internal and external to the agricultural production system. These processes occur at any number of levels and over a period of time. Thus to determine the sustainability of an agricultural system requires the analysis of processes of change and response to change occurring over time at any number of levels (Izac and Swift, 1994). An understanding needs to be gained of technical, social, economic and institutional processes and how they interact to ultimately result in sustainable farming practices and in the sustainable development of the farming system. Sustainability is the outcome of relationships between multidimensional elements, especially as sustainability in agriculture is based on the anthropocentric value judgement that future generations must have the same range of options concerning the use of agro-ecosystems as the current generation (Izac and Swift, 1994).

The view of sustainability as an intergenerational phenomenon can be considered to be coercive as future generations are excluded from decision-making that will affect their livelihoods. The current focus of development programmes on intergenerational

sustainability may also, in some cases dis-empower current generations in achieving intragenerational livelihood sustainability (e.g. the interpretation of LEISA to mean organic reflects the focus on intergenerational sustainability). In the context of South Africa, intragenerational sustainability is a form of emancipation as currently, the rural poor are dis-empowered with regard to sustainable-agriculture systems. Here, building of intragenerational sustainability forms the basis of, and a foundation for, the realisation of intergenerational sustainability. Intergenerational sustainability should ultimately be an aim of development projects, but due to the socio-cultural and politico-economic dimensions affecting sustainable farming practices (van der Ploeg *et al.*, 2004), within South Africa, intragenerational sustainability should, in most cases, be the focus of development programmes (e.g. soil fertility improvement for household food security).

It is widely accepted that the challenges facing sustainable agriculture are not readily solved by technological intervention at the field level only, all the systems are linked and the production system and its links to other systems are also important (Altieri, 1987; Ekboir, 2001; Lawrence, 1997; Rip and Wiskerke, 2000). Thus, understanding sustainability in agriculture requires an appreciation for, and an understanding of, the highly interrelated elements and the nature of the interconnections, which, ultimately requires a new paradigm for research. An understanding of multi-dimensional relationships is essential to understanding sustainability. Research institutions in developing countries that are still largely dominated by reductionism will have difficulty with the concept of sustainability unless they are able to adjust to new methods of research and development. This implies new learning routines and the challenge for agricultural research, extension and planning institutions is to institutionalise approaches and structures that encourage organizational learning. For organizations to become learning organizations, they must ensure that people become aware of their own processes of learning, and learning from both mistakes and successes (Argyris and Schön, 1978). Using intragenerational sustainability as an initial focus of development programmes would be useful here, as institutions would not be completely overwhelmed by the complexity implied by intergenerational sustainability; and through a gradual understanding of the implications of intergenerational sustainability, institutions could develop capacity to ultimately ensure the sustainable outcome of development programmes.

To facilitate this outcome, knowledge should ideally be conceptualized as a network, rather than as the foundation for development. The establishment of networks allows knowledge to travel: for scientific knowledge the networks enable scientific facts and artefacts to span great distances. However, local knowledge is linked to local environments and as it relates to usefulness, it is not easily exported (Latour, 1987). For sustainable technology development, an integration of these two forms of knowledge is required. For intergenerational sustainability to be assured, networks should be established for the continued and expansive movement of hybrid, co-produced knowledge. Innovations arise from the co-production of knowledge where local knowledge specific to locality, can be enhanced by scientific knowledge (e.g. development of internationally recognised craft product using local technology) and *vice versa* (traditional crops for soil nitrogen improvement). The development of innovative technologies is considered a key to sustainable agriculture, and one that

also requires institutional changes (Nelson and Rosenberg, 1993; Röling and Maarleveld, 1999; van der Ploeg *et al.*, 2004). The research conducted on the three case study interventions showed that sustainable development is the outcome of the interaction of multidimensional elements and is affected by multidimensional factors: ideally for sustainability to be an outcome of a system, the processes within that system should also be sustainable.

7.5.2 Strategic Niche Management

The configuration of elements and processes that constitutes the development-interventions in the case studies of this thesis, through embracing sustainability as a mode of development can be considered to be novel. Analysis of the case studies in this thesis showed that sustainability is a mode of development at odds with the current and dominant ideas and methods of agricultural development. The research and development projects presented in the case studies were highly localized and success depended largely on functional ecosystems, community management structures and local knowledge, factors that van der Ploeg *et al.* (2004) considered important in defining novelties.

Within the projects, the ongoing development of the novel practices at the field level and the institutional level was possible due to the 'space' provided by the change agents. This protected space, a niche, made it possible to demonstrate whether the modes of development being effected at the research sites were sustainable. The Valley of a Thousand Hills case study was conceptualised as a 'promising pocket' and the Mbongolwane and Suid Bokkeveld case studies were both actively facilitated as novelties, using the concepts and dimensions of Strategic Niche Management (see Chapter 2).

There are two measures for evaluating the success of niche development: the quality of learning; and the quality of institutional embedding (Hoogma *et al*., 2002). Moors *et al.* (2004) stated that there are different levels of learning: first-order and second-order learning. With first-order learning, the actors within the niche learn how to improve the design, to make it more acceptable to users; and how to create a set of incentives that will accommodate or encourage adoption. With second-order learning, concepts about the technology, user demands and regulation are questioned and explored; not only tested as for first-order learning. Second-order learning also allows for opportunities to emerge for co-evolutionary dynamics, such as the mutual articulation and interaction of technological choices, demand and regulatory options. Successful niche development involves first-order learning in a wide array of areas as well as the occurrence of second-order learning; and for niches to lead to a regime shift, second-order learning is necessary (Moors *et al.*, 2004).

Processes at the initial stages of niche development pave the way for broader change which occurs through a process of institutional embedding (Hoogma *et al.*, 2002).

Institutional embedding has three critical aspects:

1. it gives rise to complementary technologies and the necessary infrastructures, which are beneficial factors for increasing adoption in later diffusion phases;
2. it produces widely shared, credible (i.e. supported by facts and demonstrated successes) and specific expectations and

3. it enlists a broad array of actors (including producers, users and third parties) aligned in support of the new regime.

Successful niche development thus assumes the development of complementary technologies and a broad and strongly aligned network (Hoogma *et al*., 2002).

Within the South African case studies the strategic niche is not extended by the innovator, as it is in 'traditional' Strategic Niche Management, but by the development organization, or more specifically, by change agents within the development organization. Learning within the case-study niches is as a result, initially, largely confined to learning by the gardeners, crafters, farmers and change agents from the development organizations. For the Valley of a Thousand Hills, first-order learning did not include the creation of a set of incentives to encourage adoption. This was to some extent affected by the membership profile of the some of the groups, where the SPUP worked with gardeners who were mentally challenged, and not willing to take risks (adoption of new technology). Second-order learning did also not occur within the project, and as a result, there was negligible institutional embedding; the niche was thus largely unsuccessful in its development and ultimately was an unrealised promise.

Niche development was more successful for the Mbongolwane and Suid Bokkeveld case studies due to the quality of first- and second-order learning; and the quality of institutional embedding. Institutional embedding was most effective in the Suid Bokkeveld case study as a result of: the fact that farmers were already selling their tea to white farmers to fill quotas; the duration of the intervention project; the social foundation of the community; and the technical and institutional linkages that were established and maintained with other organizations and individuals. The technical and institutional networks were in turn facilitated through involvement of the Suid Bokkeveld intervention with the LandCare programme. The intervention project was well-aligned by the time of the beginning of my research into the sustainability of the intervention. Alignment describes a situation in which the actors have developed a stable set of relationships and can readily mobilise additional resources from within their own organizations, because the network has come to be regarded as an important, strategic and credible operation. This is a critical aspect of institutional embedding.

In all three of the case studies presented in this thesis, change agents (development workers of NGOs) fulfilled a crucial role of establishing and maintaining both the technical and institutional arrangements of the niche, around the novelties. This was more apparent in the Mbongolwane and Suid Bokkeveld case studies and is largely linked to the time-frame of the projects. The Valley of a Thousand Hills case study was new in terms of establishing technical and institutional networks and the intervention was not strongly linked with other organizations or technical interventions. For Mbongolwane and the Suid Bokkeveld, the projects were well-established and formal links had been established and maintained with other organizations and individuals supportive of the novelties. For both projects, the organizations included community-based organizations, non-government organizations, tertiary education organizations and government departments. Many of the formal links with the various organizations were established through the LandCare programme. Thus the success and sustainability of the intervention is not only dependent on the quality and condition of the resource base (as discussed in section

7.3.5 Sustainability Overview), but is also dependent on the starting situation, with respect to the establishment of linkages and the maintenance of technical and institutional networks.

Similarly, the success and sustainability of the intervention is also dependent on social foundation and social resources. In the Valley of a Thousand Hills case study, opportunities for capacity development, skills development and training were undertaken to a lesser degree than in the other two case studies where these opportunities had been established and effected. Another factor affecting social foundation and the available social resources is political history. The Suid Bokkeveld community appeared to be less affected by apartheid's '*no action without permission*' policy than those communities in KwaZulu-Natal. This may have been due to the physical isolation of the Suid Bokkeveld community and also the fact that in KZN the notion of '*no action without permission*' is largely re-enforced by cultural norms. Another aspect of the influence of social resources on niche development is the age of the participants. For example, in the Suid Bokkeveld intervention, the children and youth were much more willing and able to engage with the workshop and research processes. By contrast, in the Valley of a Thousand Hills intervention, the NGO engaged with mostly older and disabled people, and very few youth. Also, due to cultural norms, newly married women tended to learn from the older members of the group, and the younger women seldom gave their opinions during discussion. However, the trend in all the case-studies was that some of the gardeners, crafters and farmers took the initiative to try something new and once they had achieved success, the others would also then try the idea. Most of those gardeners, crafters and farmers that took the initiative to try something new were older members of the various groups.

These social factors had a profound influence on the rate of the transition and development of the novelty, especially in terms of the development and expression of personal and collective capacity. The rate of transition and development of the novelty was affected by the ability of the gardeners, farmers and crafters to ask for what they wanted, and not just passively receive it from NGO change-agents. Previous political factors affect this ability and also the realization of the potential ability. To improve the rate of transition and development of the novelty, there is a need to move beyond the notion of *no action without permission*. This need is expressed at a number of levels: individually; socially and institutionally.

The four-year funding cycle of the development interventions of the case studies is also problematic to niche development as four years is too short to effectively establish and maintain new learning routines. For the two case studies where the funding cycle had been extended (Mbongolwane and Suid Bokkeveld), the development of the niche was more successful than for the case study where the funding cycle was limited to four years (Valley of a Thousand Hills). Establishing and maintaining technical and institutional networks and garnering support for the novelty is time-consuming and in South African development programmes is often associated with individuals within organizations, rather than with the organizations themselves. Thus by extending funding cycles, individuals remain active in development programmes and can facilitate the development of the niche through maintaining technical and institutional networks.

SNM was used for two of the case studies (Mbongolwane and Suid Bokkeveld) as a management tool with the aim of contributing to successful niche creation for the identified, promising novelties. The SNM approach puts learning processes to the fore, so it is difficult to be specific about the outcomes beforehand. In retrospect however, the case studies can now be reviewed using the four outcomes of SNM that have been distinguished by Moors *et al.* (2004) for technological niche development:

1. Technological niche remains as such. Follow-up experiments are set up to further test the applicability, relevance/desirability of the innovation. Technical niche gestation may lead to expansion and scaling up of the niche in a context that was not originally accepted.
2. Technological niche becomes a market niche. New experiments are no longer necessary as users start to recognise the advantages of the novel technology and suppliers are willing to invest in production on a small scale.
3. The market niche expands and branches out in new directions, leading to the emergence of new market niches.
4. The extinction of the technological or market niche. The novel technology fails to attract further support and becomes (again) a (this time, less promising) Research and Development option. Niche extinction does not necessarily imply that investments are lost. Spill-over effects, in terms of network development, technical learning and improved reputations are some of the benefits that can emerge from a failed niche.

For the Valley of a Thousand Hills intervention, the technological niche became extinct due to the lack of follow-up experiments, the expansion of and scaling-up of the niche. The niche unfortunately became extinct without many spill-over effects in terms of network development and an improved reputation. Although learning that the development of a certain technology is not desirable is also an important part of SNM, this learning was not effective in The Valley of a Thousand Hills development intervention. The learning gained from the case study remained largely with the gardeners and the researcher and not the development organization.

In the Mbongolwane development intervention, the technological niche ultimately became a market niche to the extent of supplying international markets and also leading to the establishment of an expanded, local craft industry.

The Suid Bokkeveld development intervention also developed from a technological niche to become a market niche, supplying international markets and leading to local expansion of the tea production industry.

In the case of both Mbongolwane and the Suid Bokkeveld, the technological niche arose through experimentation, pilot projects and demonstrations. The specific advantages of the promising new technologies became recognised and accepted by increasing numbers of actors within the network. Once these advantages also became recognised by other producers and users, the technological niches became market niches. For these two case studies, SNM set in motion a transition path that nurtured the promising and sustainable technologies and allowed them to become socially acceptable and institutionally effective.

Niche formation does not automatically lead to regime shifts or radical change. A long process of niche proliferation (i.e. continued protection) can occur, where the

technical and institutional arrangements are not adopted by policy makers and other government departments. The notion of niche proliferation is particularly relevant to the South African case studies where the establishment and the management of the niche are facilitated by change agents and not by the innovators. Niche proliferation would occur where the change agent (development worker of the NGO) is not confident that there is sufficient capacity for financial management and marketing by gardeners, crafters and farmers to dismantle the niche. For both the Mbongolwane and the Suid Bokkeveld case studies there remained a level of niche protection in terms of the financial management and marketing. This protection was effected to a lesser extent for the Suid Bokkeveld case study. The limited capacity of the gardeners, crafters and farmers relates strongly to their perceived non-recognition of personal ability imposed by past political factors. Thus in the context of South Africa, effective participation by all actors is essential for the successful SNM of development interventions.

7.6 Reflection on the research process

The research in this thesis was conducted to understand better the dynamics of sustainable farming practices and sustainable agricultural and rural development. Sustainability theory was used as a conceptual framework and as a methodological tool. This thesis thus concerns the putting of theory into practice. Reflection is a vital part of the research process of operationalising theory, and to fulfil this function I kept a research diary in which I documented activities and thoughts on a daily basis, for all the case studies. At the end of each week, I would read over the week's entries and organize them according to the format of the SPUP's monthly report system. I would then review the activities and learning and reflect on these and on the research process. The monthly report consisted of three parts: [1] a work activity schedule; [2] questions focussed on learning and reflection; and [3] an activity list to record time spent, and reflection on specific challenges. I found these methods of reflection and organization ideal for keeping track of the complexity of the research projects.

All of the case studies presented the co-evolution of societal and natural factors. This co-evolution was 'plotted' using critical systems thinking and was rated according to the new paradigm for its sustainability. In the following section, I reflect on the use of Critical Systems Practice as the meta-methodology for the research project. This reflection is undertaken by examining broadly the research process in light of the three fundamental commitments of Critical Systems Thinking (Critical awareness, methodological pluralism and improvement (emancipation)).

7.6.1 Critical Systems Thinking: a reflection on Critical Systems Practice

The three fundamental commitments of CST are reflected upon here, in the light of using CSP for the meta-methodology of this thesis.

7.6.1. a Critical awareness

Within critical systems thinking, there are three interrelated forms of critical awareness [a] critique of the assumptions that different approaches make about social reality; [b] understanding the social context (in particular, unequal distribution of power) of the intervention; and [c] understanding the strengths and weaknesses of

different systems approaches. My selection of case studies for this thesis was guided by the assumptions that the different approaches to agricultural research and rural development made about social reality. These assumptions were key in determining which case studies were examined for this thesis, the methods I used in my research, and the processes I used in conducting the research. This was illustrated on a number of occasions during my research, two of which are discussed here.

When I started the research project, a case study that initially showed potential was a community garden that was converting to organic agriculture. The garden was serviced by an extension officer of the provincial department of agriculture and the principal horticulturalist for the region where the community garden was located had decided to explore low-input methods in the community garden context. This project started when I was employed by the department of agriculture as a plant pathologist, and I was invited to join and contribute to the project due to my interest and experience in low-input agriculture. The project was, however, not as promising as it originally appeared. The manager for the region, and thus the overseer for the project was not familiar with participatory methods of agricultural intervention and for this reason, the project was planned from the top-down. The community garden was rearranged to incorporate the low-input (organic) treatments that had been arrived at by the horticulturalist and approved by the manager. The community garden members participated through labour input: planting, watering and weeding. I felt very uncomfortable with the way the project was implemented and managed. Every month, the horticulturalist, the manager, the extension officer and I would meet with the community garden members and discuss the outcomes of the trial. The women did not really understand what the trial was about as they had not contributed any of their ideas or experiences to the trial layout. Also, the concepts of cover crops and green manure plants were unfamiliar to them. On what was to be my final visit to the garden, the extension officer was not present, and so no Zulu translation was available for the community garden members. A few members did understand some English, so a discussion, although time-consuming, would have been possible for these actors to understand. The manager however, did not see it this way and discussed the project with the horticulturalist and myself in Afrikaans (the manager's home language). I was really shocked and embarrassed and I decided that I could no longer work on the project. This was one of the first occasions for me when I made a decision in my research, based on my worldview and values.

Objectivity became increasingly difficult to achieve and also to justify, in particular in the Valley case study. And this was the second occasion where I recognised that the assumptions inherent in particular agricultural research and rural development approaches influenced the process of my research. My objectivity was influenced by the fact that I was researching the development process of which I was part. It would have been easier to be objective if I was only researching the development process. For example, the SPUP asked me to validate their technical intervention (green manure crop). As I am also a supporter of LEISA methods, I recognised that their approach was innovative in the context of subsistence agriculture in South Africa. When I started the field trials, I had already anticipated that the outcome of using a green manure would be positive. In the second year of field trials, analysis of the data began to show that the green manure was not performing as well as anticipated. Also,

the two times manure application rate was proving to be the most effective of the research treatments. The field trials results ultimately invalidated the green manure intervention and showed that the recommendation by the department of agriculture was a more valid intervention. Along with this, was the fact that the data on crop diversity from the Valley that I had gathered and analysed, showed that gardeners grew a significant number of traditional (and other) crops that positively contributed to soil fertility management. Given that the green manure intervention was not very sustainable at field and household level, it seemed appropriate to rethink the green manure intervention and focus more on the value of the traditional crops in the farming system, even using one of the crops as a green manure. I shared my findings with the SPUP management but my intentions were misread as a criticism of their approach, which soured the relationship. As a result it became increasingly difficult to conduct further research at the household level (no baseline study and no formal questionnaires allowed). I got the impression that as the results of my research were not validating their approach, it was assumed that I was against their approach. There was little room for discussion and compromise (learning at the organizational level) and unfortunately those who ultimately lost out were the gardeners.

This interaction highlighted what I saw as a critical factor in agricultural research and development: the methods that researchers, facilitators and other change agents use with each other. At times, more than is currently realised, facilitation is required to ensure that interaction at the level of researchers and change agents is non-threatening. Once this is achieved, participatory learning and action becomes possible. Participatory methods are encouraged when working with the rural poor, and no intervention can be fully sustainable unless these methods are also used among researchers, facilitators and other change agents. As we are essentially no different from those we study, why do we not use participatory methods when dealing with each other? It was the community garden organic project of the department of agriculture that first got me thinking that the process of research, the way we work is as important as the artefacts of the research (soil, crops, animals etc.). This was later confirmed by experiences in the Valley. Over time, I had difficulty in understanding how the interpretation of LEISA by the SPUP could result in sustainable farming systems. The rigid interpretation of LEISA to mean organic, ironically foreclosed approaches for promoting sustainability at field level within the Valley (much needed phosphorus could only effectively be provided with inorganic fertilizer). Also, the field facilitators used non-renewable resources (petrol and diesel) for transport to the Valley to work with gardeners. This mixture of organic and non-organic methods used in the interpretation of LEISA highlighted the asymmetry of power relations within the intervention and approach; and strengthened the argument for reflexivity by the change agents in research interventions. Ultimately, from my research it became apparent that the process used for research and development was a key factor in sustainability, not only at the field level with gardeners, crafters and farmers but also at the programme level with change agents and also researchers.

Admittedly, I also made mistakes when dealing with facilitators, managers, gardeners, crafters and farmers. The biggest mistake was in the Valley case study with one of the gardener-groups. Meetings and workshops with the gardeners were limited to one meeting with each group every month. As a result, during one of the soil

analysis report-back meetings, I rushed through the explanation of the results not ensuring that all the gardeners completely grasped the concepts. I assumed that there would be a trickle-down from those gardeners who understood the concepts well, to those gardeners who didn't completely understand. Over time, it became apparent that my expectation of the trickle-down of information had in fact not been fulfilled. Given that participation is a requirement of sustainability methodologies, my behaviour at that time can be considered to be contrary to the paradigm in which I claimed to be conducting my research. This incident in the Valley made me aware that as researchers it is important that we reflect on our own research process and the impact that it can have on the success of the development project and also that it can directly affect the lives of the project-participants.

Critical awareness also implies an analysis of the methods of research, to determine the strengths and weaknesses, and these are discussed in the following section.

7.6.1. b Methodological pluralism

In the broadest sense, methodological pluralism refers to the use of different methodologies and/or parts of methodologies i.e. methods, modes or techniques, from different paradigms in combination, while managing a degree of paradigm incommensurability (Jackson, 1997; 2000). This however supports the view that methodological pluralism is meta-paradigmatic. As Midgley (2000) recognised, this is not possible as any attempt to stand above the paradigms must inevitably involve making new paradigmatic assumptions. I subscribe to Midgley's version (Midgley, 1997) of methodological pluralism where emphasis is placed on mixing methods and interpreting these methods through a framework of methodological principles.

Through systems-thinking theories, methods and tools were available and useful for conducting research into unfamiliar areas (institutional behaviour over time; organizational learning). It was important to gain an understanding of the organisational aspects of the case studies as the organizational aspects had important influence on field-level activities. My training and practical experience of pathosystems was also useful for the research process, in particular for conceptualising the systems and interlinkages of the three case studies. For the social and economic data analysis, and also for the map and aerial photograph interpretation, my university training in social and physical geography, proved very useful. Thus, using theories and methodologies acquired through my training and also those acquired through attending courses in CERDES to build my capacity, were seen as fulfilling the conditions for sustainability, which is recognised as being time and place specific.

At the beginning of the research I had to decide if I would conduct research farm trials or work purely on-farm. As a scientist trained in the reductionist paradigm but then working within the sustainability paradigm I had to examine my motives and decide which approach would ultimately best serve the gardeners of the Valley. I quote here from my research diary of July 2000:

> *Research farm trials do serve a purpose, as it is difficult to effectively monitor on-farm trials for statistical analysis. But, if an on-farm trial is successful, are statistics really necessary? Is the research for the farmer or the researcher? From my point of view, statistics are necessary for both my own peace of mind and for my thesis. I can only feel confident offering a farmer a 'basket of choices' if I know*

the value or constraints of each of those 'choices' that I am presenting. I would feel more confident suggesting something I understand better after trying it myself. I really do think that research farm demonstrations and trials have their place, and on-farm trials are equally important. I see the challenge as finding a balance where both are mutually supportive. Research farm trials will be limited to determining accurate results of specific investigations. Due to variation in climate, political setting and sociological impacts and the different needs of the communities, it is difficult to effectively extrapolate findings at the research farm to every farmer's reality.

As Chapter 4 and Appendix A show, I did conduct research farm trials, and the treatments were designed to reflect the field conditions of the gardeners. It was very useful working in the Valley and doing research trials, as the extension work put the research trials into context and helped to ensure that the results would be useful to the gardeners. Research farm trials are not necessary, nor ideal, for every intervention, but given the contributing factors at field level for the Valley at the time of the research, research farm trials were appropriate to the intervention. A key element of the research process here was reflection, and in particular on my own research-approach. Through the process of reflection I could interpret the outcomes of mixing research methods in terms of the methodological principles of the sustainability paradigm.

The process of reflection also enhanced my research in the Suid Bokkeveld, where the change agents, EMG and Indigo, used participatory learning and action methods. These methods were used for interaction with farmers, researchers and change agents. Documentation and sharing of information was highest within the Suid Bokkeveld case study, which was just as well as it also had the highest number of participating 'specialists'. It was also here that I had opportunity to share some critical systems thinking tools in a workshop environment. The Suid Bokkeveld project provided a comfortable environment in which scientists could develop their facilitation and participatory technology development skills. When I was working in the Suid Bokkeveld, there were a number of other scientists working there. We were able to share ideas for research methods and reflect on our experiences in using them. The process we used with farmers was a relevant topic of discussion as we were all from technical backgrounds and were now including social research in our work. We not only shared methods and ideas, but also information and this was useful in corroborating data.

By comparison, in the Valley, networking was mainly with development practitioners, not researchers. Most of my networking in KwaZulu-Natal was with the Midlands development network (Midnet), and membership was composed primarily of members from non-government and faith-based organisations. Membership also included a number of consultants, but few researchers and no government agents. Within Midnet, sharing of methods and experience was also largely around reflection on our own practice and experience in the field. This was very useful for me in understanding the broader context of my research and in improving my own practice, especially as the process of action research in the Valley became increasingly complicated over time.

The Mbongolwane and Suid Bokkeveld case studies were easier to research as I was more removed from the intervention process, and there were more external actors involved. The other researchers also assisted with data collection for the livelihood analysis, common to all of the case studies. However, from my experience in the Suid Bokkeveld, I think that for effective research and sustainable development, an interdisciplinary approach would be more suitable. In interdisciplinary research, an issue is approached from a range of disciplinary perspectives integrated to provide a system outcome (Bruce *et al.*, 2004), which is a more appropriate approach to researching sustainability.

7.6.1. c Improvement (emancipation)

The point of departure for my project was the conviction that my research had to make a direct contribution to the livelihoods of the gardeners, crafters and farmers that I was researching, and also to contribute to the activities of the change agent facilitating the development. In the Valley, my contribution to the gardeners at field level included plant disease identification, assessment of nitrogen-fixing crop function (I showed gardeners that the colour within the root nodules indicates if nitrogen-fixing bacteria are present and functioning or not), discussions on soil fertility and farming as a system and the intervention of increasing the application rate of manure. Also, I tested all of the gardeners' soil, gave each gardener a copy of the results and I explained in detail the results to each gardener. The potential soil fertility improvements were discussed in a group workshop, for each gardener's results. My contribution to the SPUP was discussion with the fieldwork facilitators about soil fertility management, reflection on our interactions with gardeners and the co-authoring of papers related to our work, for presentation at conferences. At a practical level, my contribution involved giving advice on driving in sand and on wet roads, gearing down on steep hills and changing a tyre; as most of the fieldwork facilitators where young women who had recently acquired drivers' licences and as a result were not entirely confident driving in poor conditions with respect to roads and weather.

At the research farm, I directed the field trials, but the trial was managed as a group as much as possible. Initially I worked with two women whom I had selected from a possible 28 candidates through an interview process. We would discuss what we were doing and what the best methods were to achieve our aims. Both women had considerable experience with cultivation and it was useful to draw on their knowledge and skills. Capacity building was also an aim: my own capacity and also that of the two women. When there was no fieldwork to do, the women would assist me in the office with computer work or they would work with the other disciplines at the research farm (rangeland science, horticulture, animal science) as a means of increasing their skills and knowledge. Both women would accompany me to the Valley for meetings, workshops and field visits to the gardeners, in particular as a means of putting the research farm work they did into context. We also attended workshops, open days and presentations related to our work, in this way, networking played a significant role in contextualizing the research farm trials.

My own capacity building during the research project included formal, tertiary education and a practical ecological agriculture course. I attended post-graduate courses offered by the Centre for Rural Development Systems, and these included:

Learning and Change; Systems Thinking, Systems Practice; and Project Design and Management. The annual seminars of the AGRINOVIM project were also influential in the analysis of the case studies.

Within the Suid Bokkeveld, my contribution to the farmers was soil analysis and the resulting discussions about soil fertility management and erosion control. I also facilitated meetings and workshops and role-played with the women's group around the tourism initiative. English was not widely spoken in the region and my role was to assist the women's group with increasing their confidence with English-speaking tourists. My contribution to the change agents included field visit and workshop documentation, the facilitation of workshops, compiling documents about the initiative and editing the Rooibos Tea Producers' Handbook. Researchers on the project shared transport arrangements (the Suid Bokkeveld was a four-hour drive from Cape Town) and literature related to the development programme.

A key element of emancipation is the development of individuals: rather than being passive recipients in development initiatives, individuals play an active role in shaping their destiny. A crucial part of this is learning, and specifically learning-by-doing. There is a need for continuously testing, learning and developing knowledge and understanding for coping with change and uncertainty in complex and adaptive systems (Carpenter and Gunderson, 2001). This applies to researchers, change agents, facilitators and the people (gardeners, crafters and farmers) who are the focus of the development initiatives.

From the discussion and reflection on the research process, there were a number of factors common to all the case studies that enhanced the research process. These will be presented in the following section.

7.6.2 Lessons learned

From my research experience with the three case studies, a number of factors contributed positively to the research and are given here as lessons learned.

Lessons learned:

- the establishment and maintenance of learning routines (both for individuals and organizations), is vital for effective research. Ideally, participatory learning and action should be a feature at all levels of the development intervention;
- the use of participatory methods at all levels of the development intervention provides a more sustainable outcome for the research project;
- the inclusion of networking as a function in the research project is a valuable (although time-consuming) activity;
- a variety of research methods is more effective than a single method when researching sustainability and
- capacity building is also necessary for researchers, change agents and facilitators.

The influence of development programmes, and in particular the role of institutional ideologies, on the rural poor is often overlooked by researchers and development agents. The influence of development organizations cannot be ignored and there is call for a reflexive research protocol, where functional participation is effected at all levels in the research programme. Researchers and development agents should reflect upon

and critically assess their role and influence in development projects. The methodologies and tools provided by critical systems thinking are valuable in creating an effective and just research and development environment.

7.7 Concluding remarks

The research in this thesis provides insight into the multi-level, multi-aspect and multi-actor approach to understanding the elements of sustainability in subsistence agriculture in South Africa. This was achieved through:

1. the broadening of the field of application of critical systems thinking in rural studies;
2. the specification of intragenerational sustainability as a starting point (where relevant) for institutional intervention in subsistence agriculture systems;
3. the use of a three-level, multi-aspect research approach to address the complexity of the concept of sustainability and
4. the use of participatory methods between change agents, facilitators and researchers.

This thesis also:

1. demonstrates the value of combining different sources of, and approaches to, knowledge production, as well as the added value of methodological pluralism;
2. shows that the alignment of people, nature and objects at different levels is essential to understand better the dynamics of heterogeneous rural networks and
3. indicates that the impact of the past on the present cannot be ignored when researching sustainability.

There was considerable diversity of practice and means among gardeners, crafters and farmers. The factors that contributed to their livelihoods were closely interlinked and understanding these connections better requires rigorous participatory research. Many of the connections were driven by social factors, which were often hidden. The implication here is that interventions should not only focus on technical solutions, but social interventions are also required. Participatory learning and action can make a valuable contribution in understanding the factors affecting sustainability; in particular examining the complexity of farmers' livelihood strategies and understanding better the nature of the connections. Ultimately, both the process and the outcome of agricultural development programmes should be sustainable.

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Appendix A: Soil-fertility field trials conducted at Ukulinga Research Farm

A.1 Introduction

The work of the Social Plant-Use Programme with the homestead gardeners of the Valley of a Thousand Hills was centred on soil fertility management practices. Over time, these practices had emerged as a critical aspect of sustainable crop-production.

Soil fertility decline is considered a major constraint to sustainable small-holder farming in sub-Saharan Africa (Smaling *et al.*, 1996; Vanlauwe and Giller, 2006). The deficiency of nitrogen and phosphorus is one of the key biophysical constraints to food production in southern Africa (Sanchez *et al.*, 1997). This also applies to subsistence farming in South Africa and in particular, the former homelands in KwaZulu-Natal. In KwaZulu-Natal, deficiency of soil phosphorus (P) is a reflection of the low inherent P availability in the soils, the low level of fertilization practised by subsistence and small-scale farmers and the capacity of many of the province's soils to fix P strongly (Manson, 1996; Roberts *et al.*, 2003). Research in the province has indicated that soil nutrient depletion rates are field specific and that these are also dependent on the soil management techniques practised over time (Manson, 1996).

The trials described here, were conducted at the Ukulinga Research Farm and serve to examine the suitability of the recommendations for soil fertility improvement proposed by the Social Plant Use Programme (SPUP) of the Valley Trust and also those proposed by the KwaZulu-Natal Department of Agriculture and Environmental Affairs (KZNDAEA); with reference to the potential sustainability of the Valley's homestead gardeners' soil fertility management.

Two research questions were addressed, namely:

- What can be deduced from field trials at Ukulinga about the potential sustainability of current agricultural practices in homestead gardens?
- Does the SPUP intervention make a significant contribution to the sustainability of agricultural production in homestead gardens?

Site description

The Ukulinga Research Farm (29'40''S and 30'24"E) is located approximately 10km south west of the Pietermaritzburg city centre at an altitude of 775m above sea level. The terrain is uneven and broken, and the dominant feature is a central plateau, a dolerite intrusion, weathered to give characteristic doleritic soil forms on its slopes. The remainder of the farm slopes away from the plateau in three directions, with shale parent material, which has led to the formation of, in particular, the Westleigh soil form and other forms consistent with shale parent material (Laing *et al.*, 1997).

The soil at the trial site is classified under the South African binomial classification system as the Westleigh form (orthic A over soft-plinthic B) and as a Plinthic Acrisol under the FAO classification (MacVicar *et al.*, 1977). The soft-plinthic B horizon develops as a result of an accumulation of iron and manganese oxides and hydroxides in the form of mottles and concretions. This indicates a fluctuating water table or periodic saturation with water. The predominant soil-forming factors are the shale parent material and the topography. The limited run-off and resulting increased infiltration on gentle slopes or flat ground results in the formation of the soft-plinthic B

horizon which has limited water permeability and is thus not suited to cultivation, and in particular, irrigation. The soil is classified as highly erodible (factor 3) and it is considered to be unsuitable for annual cropping due to its limitations for irrigation and its waterlogging during periods of high rainfall (Smithers and Schulze, 1995). Rain at Ukulinga falls predominantly during the summer months (September to March), with the greatest amount of rainfall in December, and with a mean annual rainfall of 708 mm (Schulze, 1997), is readily comparable to that of 772mm (Schulze, 1997) in the Valley of a Thousand Hills.

A.2 Materials and Methods

The area used for the field trial has a history of cultivation, initially as a site for vegetable trials for a horticulture course offered by the University and subsequently as a site for breeding green beans for disease resistance. The site had been fallow for three seasons prior to the establishment of the soil fertility field trials. In the first year of the trials (2000), the soil was ploughed and the plots were established. A summer crop of a variety of vegetables (aubergine, cabbage, Swiss chard) was grown without the addition of any manure. The first year of experimentation at the trial site principally served to reduce the relative soil nutrient and soil carbon accumulation that took place during the three seasons of fallow prior to the field trial. The first season of the soil fertility trials also served to familiarise ourselves with the practicalities and requirements for conducting on-station research. This was considered appropriate in the context of the methodology: the process of action research, through 'learning by doing'. The trials were naïve in terms of crop-production and soil-science research. This is because they served a number of roles within the research project: 1. the field trials were a collaborative effort between members of government services (FERTREC laboratory), a university research centre, an NGO development programme and the homestead gardeners of the Valley of a Thousand Hills. 2. the field trials were used for educational purposes within the university research centre, for students, staff and homestead gardeners, most of whom were unfamiliar with field trials. 3. the field trials were specific to locality and context (the Ukulinga site, my knowledge of field trials and soil science, the services of the FERTREC laboratory, the technical needs of the gardeners for increasing homestead crop production).

A.2.1 Trial design and layout

A randomized-block design was used for the field trials. This design is traditionally used to minimize the effect of variable soil-fertility across the trial site. In the case of the homestead gardeners in the Valley of a Thousand Hills, there was considerable variation in soil fertility (as presented in 4.3.2 Soil fertility management and erosion control) and the trial layout was designed to encompass the variation in fertility across the trial field, to better represent the heterogeneity of the homestead-garden soils. The trial-treatments were randomized within a block-design to increase objectivity during rating of the trial. Six soil-fertility treatments were randomized within five blocks, giving a total of 30 plots for the trial. The six treatments are presented in detail in Table A.1.

The quantity of manure used for the second and fourth treatment represents the median amount of manure applied by 29 gardeners to their gardens for homestead

crop-production. The quantity of manure used by the gardeners was determined through: discussions with the gardeners of manure application rates, at both group meetings and individual garden visits; and through measuring and weighing the amount of manure applied by the individual gardeners to their homestead-garden plots. There was some variation in the quantity of manure applied by the gardeners, due to differences in availability of the manure.

Table A.1: Treatment descriptions and application rate of nutrient input for soil-fertility trials at Ukulinga

Treatment	Nutrient Input	Representation of Valley
1. Control	None	A gardener without livestock and with no access to manure. Or a new garden.
2. Gardener's manure-application rate	Median manure-application rate of gardeners for vegetable-cropping, giving 20:20:100 kg/ha of N:P:K	A gardener with some livestock and/or access to manure. Established or new gardens.
3. Recommended manure-application rate	Recommended manure-application rate of manure for vegetable-cropping (from soil analyses, FERTREC), giving 40:40:200 kg/ha of N:P:K	A gardener with considerable livestock and access to manure. Established gardens and skilled gardeners.
4. Gardener's manure-application and green manure	Median manure-application rate of gardeners for vegetable cropping and a green manure crop, giving an estimate of 40:40:100 kg/ha of N:P:K in year 1	A gardener experimenting with the SPUP using sunnhemp and/or velvet bean. Established and new gardens.
5. Recommended manure-application rate and green manure	Recommended manure-application rate (from soil analysis, FERTREC) and a green manure crop, giving an estimate of 60:60:200 kg/ha of N:P:K in year 1	A gardener with livestock and/or access to manure experimenting with the SPUP using sunnhemp and/or velvet bean. Established gardens and skilled gardeners.
6. Green manure	Green manure crop only giving an estimate of 20:20:0 kg/ha of N:P:K	1. A gardener with poor soil and no access to manure, experimenting with the SPUP using sunnhemp and/or velvet bean. 2. A gardener with high soil K value, experimenting with SPUP using sunnhemp and/or velvet bean to raise N and P levels.

There was also variation in nutrient content between the various manures used by the gardeners. Due to these variations, the median quantity of manure used by the gardeners was selected as an application rate for the trial.

The median quantity of kraal manure applied by gardeners was estimated at 10 tons per hectare, which in turn was estimated, on the basis of its analysis, to supply a total of 20kg/ha of N, 20kg/ha of P and 100kg/ha of K. Goat manure (in 2001) and cattle manure (in 2002) from the animals' night-stalls at the animal science section at Ukulinga were used for the field trial. The nutrient content of the manures was tested prior to their application for the soil-fertility field trial.

Following the practice of the homestead gardeners in the Valley of a Thousand Hills, the manure was applied once, annually, in winter, prior to the planting of the winter vegetable crop. For the green manure crop, the SPUP recommended the use of the locally occurring sunnhemp (*Crotalaria sp.*) and also introduced velvet bean (*Mucuna pruriens*) to the gardeners. At Ukulinga Research Farm, hairy vetch (*Vicia villosa*) was recommended by a seed merchant as an ideal green manure crop for the local climate. Hairy vetch was used as the green manure crop for the soil-fertility field trials and is said to provide an estimated total of 80kg/ha of N and to make 20kg/ha of P available to subsequent crops (McVay *et al.*, 1989).

A.2.2 Soil sampling and analysis

The soil was sampled a total of nine times during the field trials. The sampling times and a description of the trial phase at the time of sampling are presented in Table A.2. The sampling procedure complied with the dynamic assessment method of Larson and Pierce (1994) and the repeated measures approach used in ecological studies (Gurevitch and Chester, 1986). Dynamic assessment compares or evaluates soil quality attributes continuously over time and requires regular surveillance of soil quality attributes or indicators. Repeated sampling reduces the effects on analysis of underlying variation in subjects, and thus is used to examine trends over time (Gurevitch and Chester, 1986).

Table A.2: Sampling times and description of the trial phase at the time of sampling

Sample	Time of Sample	Sample description
1	May 2000	at trial site demarcation
2	August 2000	at preparation of trial plots
3	April 2001	at planting of winter crop, after treatment application
4	May/June 2001	at seedling stage of the winter vegetable crop
5	July/August 2001	at winter vegetable crop harvest
6	January 2002	at harvest of vetch or potatoes
7	April/May 2002	at planting of winter crop, after treatment application
8	July/August 2002	at winter vegetable crop harvest
9	January 2003	at green bean harvest

The samples were taken according to the soil sampling method of the Soil testing and fertilizer recommendations laboratory of the KZNDAEA, FERTREC. Using a soil-sampling auger, nine samples were taken per plot to a depth of 15cm. Three samples were taken for each of the three crops within the plot. The three samples were mixed and a smaller, representative sample was taken from this, for testing. The soil was also sampled at four other depths: 15 to 30cm; 30 to 45cm; and 45 to 60cm. At each

depth, nine samples were taken per plot, with three samples for each of the three crops. A representative sample was taken from the three pooled samples for each crop at each depth. After the first year, due to erosion of the top-soil, there was insufficient soil to sample from 45 to 60cm.

The soil samples were analysed by FERTREC using the methods presented here (Manson and Roberts, 2000). Prior to chemical analysis, soils were air-dried and milled to pass a 1mm screen. Calcium, Magnesium and Aluminium were determined after extraction in **M**KCl, using a soil to solution ratio of 1:10 and a stirring time of 10 minutes. Calcium and Magnesium were determined by atomic absorption (AA) and Aluminium ions by titration to the phenolphthalein end-point with 0.05**M** NaOH. Potassium was determined by AA, and Phosphorus was determined colorimetrically after extraction of both elements with an AMBIC-2 solution containing 0.25**M** NH_4HCO_3, 0.01**M** EDTA, 0.01**M** NH_4F and 0.05gl^{-1} Superfloc N100, adjusted to pH 8.0. The same soil to solution ratio and stirring time as above was used (this solution has been, since 1985, a standard extractant in South Africa for P and K in highly weathered soils and removes quantities of K comparable to those removed by neutral NH_4OAc). Soil pH was determined in **M**KCl using a 1:2.5 soil to solution ratio. All extractions were performed on a volumetric basis. Soil organic carbon and clay percentage were estimated using an infrared analyser calibrated using a set of soil samples analysed by another technique. For organic carbon, the Walkley-Black method was used (Walkley, 1935). Topsoils with low sample density and low total basic cations (S-value) were used in the organic carbon calibration. At the end of the trial period, the microbial biomass carbon was determined using the method of Vance *et al.* (1987).

A.2.3 Crop selection, cultivation and sampling

Gardeners in the Valley of a Thousand Hills invested more inputs towards increasing soil fertility in vegetable gardens than they did in the maize fields (Roberts *et al.*, 2003). For this reason, homestead vegetable production was identified as the key focus area for investigation into the soil fertility management systems used by the gardeners. The autumn growing season (March to May) is a crucial time for vegetable production, although gardeners also use the vegetable garden during the summer months for the cultivation of a single crop-type, referred to here as a cash crop.

The crops were chosen as being representative of vegetables grown in the Valley and as appropriate for the local conditions at the Ukulinga Research Farm. Problems with troops of foraging monkeys from the neighbouring nature reserve affected the choice of crops grown at the trial site. Root crops were chosen for the trial, as they were least interfered with by the monkeys. The field trials were manageable by the available human resources determined by our hands-on experience in the first year.

For the autumn trial, three crops were grown on each plot. The plot size was 6m by 4m giving a total area of 24m^2. Two rows each of beetroot, carrots and onions were planted to each plot. Table A.3 gives the details of the planting method and spacing used for the planting of vegetables in the plots. The spacing between the edge of the plot and the first row of vegetables on both sides of the plot was 75cm, this was done to reduce inter-plot interference. There was also a 1m path between plots which also served to reduce inter-plot interference. The planting of crops within the plots

represented the method favoured by gardeners of using smallish plots with a few rows each of a variety of vegetables.

Table A.3 Planting method, crop cultivars and plant spacing used in the trial plots

Crop plant	Cultivar	Planting method	In-row spacing	Between-row spacing	Between-crop spacing
beetroot	crimson globe	Seedlings	6 cm	50 cm	50cm
carrot	Cape market	direct seeding	5 cm (thinned to)	50 cm	50cm
onion	Texas grano	Seedlings	7 cm	50 cm	50cm

The SPUP recommended inter-planting a green manure crop to a number of gardeners who had already established their vegetable crop for the season. To mimic this situation at the research farm, lupins (*Lupinus albus* L.) were inter-planted with the vegetable crop, where one row of lupins was planted between the two rows of each vegetable. These inter-cropped lupins were the first green manure treatment of the trial. The lupins were incorporated into the soil by hoe at the seedling stage of the vegetable crop. This was done as the health of the vegetable crops indicated that the lupins were competing with the vegetables for water and nutrients. Thus, inter-planting a green-manure crop with a vegetable crop was not a feasible technology for the homestead gardeners. The plots of the green manure treatments of the trial were planted to hairy vetch for the summer season. The recommended mass of seeds for the given plot area was broadcast by hand and covered with soil through raking-in.

The non-green-manure-treatment plots were planted to potatoes (cash-crop) in the first year of the green manure or cash-crop treatments. The variety, *Mnandi*, developed for small-scale farmers, was used planted to 30cm in the row and 1m between rows. In the second year, the cash crop planted was green beans. The green bean variety Tongati (developed at Ukulinga by Proseed for small-scale farmers) was used for the trial and was planted at 5cm spacing in the row with 60cm spacing between rows. High value crops are commonly planted by homestead gardeners during the summer, and are locally referred to as cash-crops as there is usually sufficient yield for home-use and sales.

Yields per plot, for carrot and beetroot were determined using the whole plant. Yields were calculated for ten carrots per bunch and five beetroot per bunch. Ten bunches for each crop were weighed and the mean mass of the ten bunches was used as the value for yield. This sampling method represented the method used by gardeners of The Valley of a Thousand Hills, where carrots were sold with tops in bunches of ten and beetroot was sold with tops in bunches of five. The tops of both carrots and beetroot are eaten and thus the whole plant is considered as part of the yield.

The onion, potato and bean yields were determined per plot. In plot trials, four rows of a crop are planted, with the two outer rows classed as border rows and the inner rows as data rows. For the potato and bean yield, two rows (data rows) out of four

were used to determine yield. The onion was only planted to two rows and both of these were used to determine the yield of the onion crop.

The yield of hairy vetch was determined by weighing the entire above-ground crop removed from the plot. The various crops were sampled at a number of times for nutrient content analysis. Samples were taken at a number of times during the growth cycle for each of the crops. The results of the foliar analyses were highly varied and thus inconclusive and for this reason, they are not presented in this appendix.

A.2.4 Management of the trial

The trial was conducted continuously over two-and-a-half years, equating to five cropping seasons. There were three seasons of summer vegetables, two seasons of green manure and two seasons of winter vegetables. Table A.4 gives details of the cropping cycle used for the trial.

Other than the initial site preparation by tractor-drawn plough, all other crop production techniques (land preparation, planting, weeding and harvesting) were done by manual labour and according to gardeners' practices. For the field trial, all the weeds were removed from the plots and then composted or fed to cattle or goats. This method represents the common practice in most homestead gardens. The trial-site was weeded three times during the autumn/winter vegetable crop season, and four times during the summer cash crop/green manure season, also representing the common practice in homestead gardens. At Ukulinga, as in the Valley, weeding was done by hand if the soil was soft, or with a hoe if the soil was hard.

Table A.4 Crops grown for each of the five cropping seasons at Ukulinga Research Farm

Season	Treatment application	Crops cultivated
1st season summer 2000/1	no treatment	Swiss chard, aubergine and cabbage
2nd season autumn/winter 2001	6 treatments, 5 blocks goat manure, lupins	beetroot, carrots and onions
3rd season summer 2001/2	green manure treatments	potatoes or hairy vetch
4th season autumn/winter 2002	6 treatments, 5 blocks cattle manure	beetroot, carrots and onions
5th season summer 2002/3	no additional treatments	green beans

A.2.5 Analysis of results

The values from the soil test results, plant analyses, yield values and microbial biomass carbon were analysed using GenStat Release 6.1(PC/Windows98) (Lawes Agricultural Trust, 2002). Analysis of variance of repeated measures for the soil test results were calculated to obtain the least significant difference (l.s.d.) of means at the 5% confidence level over the time period of the research trial.

A.3 Results and discussion

This section describes the results obtained from the research farm trials. The details of the crop yield, macronutrients and microbial biomass carbon are given and the trends are discussed.

A.3.1 Crop yield: vegetable crops, cash crops and green manure

A.3.1a Beetroot

The yield was measured to represent one bunch of five beetroot (table A.5), the method used by the gardeners for selling beetroot. In the first year, the *gardeners' manure-application* treatment and the *green manure only* treatment had significantly greater yield of beetroots than that of the *recommended manure-application* treatment [T2; T6 >T3] (Table A.5). These results may be due to the variation in time required for the breakdown of manure and subsequent release of nutrients. In the second year, the *gardeners' manure-application* treatment, *recommended manure-application* treatment and the *recommended manure-application + green manure* treatment yielded a mass of beetroots significantly greater than that of the *control* [T2; T3; T5 > T1].

Table A.5 Yield expressed in grams as the mean for two harvests of ten bunches of five beetroots per plot, under six different treatments

year	control T1	gardeners' application T2	recommended application T3	gardeners' +green manure T4	recommended + green manure T5	green manure T6	CV (%)	l.s.d 5%
2001	726ab*	887a	501b	631ab	739ab	869a	15.9	306.5
2002	777b	1090a	1053a	820ab	1140a	922ab	18.6	260.3

*Differences are significant if they do not share the same letter.

This suggests that the yield of beetroots is linked to the availability of nutrients from animal manure. These yield-effects on beetroots were apparent in the treatments where animal manure was applied [T2; T3 and T5] and did not occur in the *control*, where no animal manure was applied [T1]. The yield of beetroots was significantly higher in the second year of crop-production, than the yield in the first year. This difference in yield between the two cropping seasons, was significant for both the *recommended manure-application* treatment [T3] and the *recommended manure-application + green manure* treatment [T5]. These results further suggest that nutrients are available over time due to the breakdown of animal manure.

The yield of beetroots from the *recommended manure-application + green manure* treatment was significantly greater than that of the *gardeners' manure-application + green manure* treatment [T5 >T4]. The implication of this is that insufficient nutrients were available for both the green manure crop and the beetroot in the *gardeners' manure-application + green manure* treatment compared with just the beetroot for the *recommended manure-application + green manure* treatment.

For Valley homestead gardeners, this means that if they are using a green manure crop for soil fertility improvement, they should apply double the median quantity of manure currently being applied. This would ensure that sufficient nutrients were

available in the soil for both the beetroot and the green manure crop. The results also suggest that gardeners applying the median quantity of animal manure or applying double the quantity of manure would get a significantly greater yield of beetroots than gardeners who did not use any animal manure.

A.3.1b Carrot

In both years of the trial, there was no significant difference in yield of carrots between the treatments. The mean, overall yield for the second year was significantly greater than the mean overall yield in the first year. As for the beetroot, this suggests that there is a sustained release of plant-available nutrients from the breakdown of animal manure over time.

A.3.1c Onion

In the first year, there was no significant difference in yield of onions between the treatments. In the second year, the *gardeners' manure-application* treatment, the *recommended manure-application* treatment and the *recommended manure-application + green manure* treatment yielded a mass of onions significantly higher than that of both the *gardeners' manure-application + green manure* treatment and the *green manure only* treatment [T2; T3; T5 > T4; T6] (Table A.6.). These yield results suggest that insufficient nutrients were available from the soil to attain a good yield from the onion crop and to support the growth of the green manure crop.

Table A.6 Yield, expressed in grams, as the mean of two harvests of onions under six different treatments

year	control T1	gardeners' application T2	recommended application T3	gardeners' +green manure T4	recommended + green manure T5	green manure T6	CV (%)	l.s.d 5%
2001	3293a	3339a	4327a	3965a	3121a	3928a	25.8	1542
2002	4440ab	8692b	6444b	2200a	6600b	2554a	31.9	4346

*Differences are significant if they do not share the same letter.

As in the case of the beetroots, gardeners growing a green manure crop for soil fertility management should also apply manure for the supply of nutrients to the green manure. Should gardeners not apply additional manure, they are likely to have a reduced crop-yield. The *gardeners' manure-application* treatment also yielded significantly more than the *control* [T2 > T1], which means that gardeners using animal manure will obtain a greater onion yield than gardeners not using any animal-manure. The *gardeners' manure-application* treatment yielded a mass of onions significantly greater in the second year than in the first year. This suggests plant nutrients are available over time, from the breakdown of the animal manure.

A.3.1d Cash-Crops

The first cash-crop grown during the summer cropping season (2001) was potatoes. These are commonly grown in quantity in community gardens and homestead gardens for the summer holiday season (Ndlela, 1996). Both the *recommended manure-*

application treatment and the *gardeners' manure-application* treatment yielded significantly more potatoes than did the *control* [T2; T3 > T1] (Table A..7). For the Valley homestead-gardeners, this means that those gardeners who apply animal manure for their winter vegetable crop are likely to obtain a significantly greater yield of potatoes than those gardeners who do not apply any manure.

Table A..7 Mean potato yield, expressed in grams per plot, under three different treatments for the 2001 season

year	control T1	gardeners' application T2	recommended application T3	CV (%)	l.s.d 5%
2001	11422b	19548a	20324a	18.4	6380.8

*Differences are significant if they do not share the same letter.

The second cash crop grown during the summer cropping season (2002) was green beans. However, none of the differences in the yield, between treatments, was significant for this crop.

A.3.1e Green Manure

There was no significant difference between the treatments [T4; T5 and T6] for the yield of hairy vetch.

A.3.2 Soil results: macronutrients and soil carbon

This section briefly describes the trends in the macronutrients (nitrogen, potassium phosphorus) and organic carbon measure in the first 15cm of soil, over the trial period (five crops in two-and-a-half years). Although the soil was sampled up to 45cm below the surface, the results of the first 15cm of the soil are used, as the FERTREC laboratory gives crop requirement recommendations only for the first 15cm of the soil profile.

Within KwaZulu-Natal province, soil densities are very variable. This fact can present difficulties when presenting data in terms of mass. The FERTREC laboratory analyse the soil samples on a volumetric basis and also present the results based on volume (mg/L). In this way the presentation of the results circumvents the complexity of variable soil-density. The results for soil potassium (K) and phosphorus (P) changes are presented here volumetrically.

A.3.2 a Mineral Nitrogen

There are only six results presented for nitrogen (N) owing to the unavailability of FIA equipment at FERTREC for the other three samples. Overall, there was no significant difference between treatments, but at selected times over the sampling period, significant differences did occur between treatments (Table A.8).

At first planting, after the animal manure application both the *gardeners' manure-application* and the *recommended manure-application* treatments realized mineral soil N levels significantly higher than both the *gardeners' manure-application + green manure* treatment and the *recommended manure-application + green manure* treatments [T2; T3 > T4; T5] The differences were likely due to differences in the availability of N from the animal manure.

The maximum amount of N was present in the soil just after the application of the animal manure. This suggests that N is readily available from animal manure in the soil. The trend over the time period of the trial showed a significant decrease in soil N from the beginning of the trial (first sampling time) to the end of the trial (final sampling time).

Table A.8 Table of means for mineral soil nitrogen (ppm) over time

treatment time	control T1	gardeners' application T2	recommended application T3	gardeners' +green manure T4	recommended + green manure T5	green manure T6
start	21.31a	21.37a	16.9a	20.28a	15.63a	19.84a
manure application	20.43ab	25.78 a	25.49 a	19.13 b	17.9 b	22.14 a
seedling stage	12.45a	13.11a	12.9a	10.02a	11.72a	13.22a
harvest of crop	19.33ab	20.46ab	20.6ab	15.97 b	16.26ab	22.46 a
manure application	10.02ab	9.95ab	15.28 a	9.25ab	11.58ab	8.51 b
harvest of crop	9.31a	8.9a	8.64a	9.31a	11.55a	8.8a

Differences are significant if they do not share the same letter, differences are calculated between the six treatments at a specific sampling time and not within treatments over time.

A.3.2.b Phosphorus

The analysis of repeated measurements showed that, overall, the soil P level for the *recommended manure-application* treatment was significantly higher than that of the *control* [T3 > T1]. This difference was expressed at a number of sampling times over the trial period (Table A.9). At the harvest of the first crop, the *recommended manure-application treatment* had soil P significantly higher than the *control*, the *gardeners' manure-application* and the *gardeners' manure-application + green manure* treatments [T3 > T1; T2; T4]. This suggests that for the *recommended manure-application* treatment, P was supplied to the soil through the breakdown of the animal manure over time, and the more animal manure that was applied; the more P was made available.

The results also indicate that less P was available in treatments that included a green manure, probably due to the P requirements for growth of the green manure. After harvest of the green manure and cash crop, the *recommended manure-application* treatment had soil P significantly higher than that of the *control*, the *gardeners' manure-application + green manure* and the *green manure only* treatment [T3 > T1; T4; T6]. For the second year of the trial, the soil P of the *recommended manure-application* treatment was significantly higher than that of the *control* [T3 > T1]. For the *control*, there was a decrease in soil P significant from the start of the trial (after manure application) to the end of the trial (harvest of green beans).

The soil P trends suggest that the *recommended manure-application* treatment gave consistently higher soil P values than any of the other treatments. It also shows a

decline in soil P for the *gardeners' manure-application + green manure* treatment, analogous to the trend in the *control* where no animal manure was applied.

Table A.9 Table of means for soil phosphorus (mg/L) over time

treatment/ time	control T1	gardeners' application T2	recommended application T3	gardeners' + green manure T4	recommended + green manure T5	green manure T6
start	22.4a	25.8a	27.8a	24.4a	27.4a	26.8a
post manure-application	22.6a	28.4a	30.7a	27.1a	25.3a	26.6a
seedling	23.5a	27.3a	28.1a	23.3a	25.3a	24.3a
harvest crop	21.3 b	25.1 b	36.0 a	20.6 b	28.1 ab	27.6 ab
planting of green/cash crop	18.8a	23.8a	25.6a	18.8a	26.0a	24.2a
harvest of green/cash crop	18.5 b	24.3 ab	34.1 a	18.9 b	26.3 ab	22.8 b
post manure-application	19.4 b	24.2 ab	29.6 a	22.6 ab	27.2 ab	23.4 ab
harvest of crop	18.2 b	22.2 ab	29.6 a	20.2 ab	22.4 ab	23.6 ab
harvest of green/cash crop	18.8 b	24.2 ab	29.6 a	22.6 ab	26.0 ab	25.2 ab

Differences are significant if they do not share the same letter, differences are calculated between the six treatments at a specific sampling time and not within treatments over time.

The implication of these results to gardeners is that applying the amount of animal manure recommended by FERTREC (20 000 kg/ha) is of significantly greater benefit in increasing available soil P than growing a green manure crop in conjunction with the gardeners' application rate of animal manure, which was estimated to be 10 000 kg per hectare.

A.3.2.c Potassium

Overall, the *recommended manure-application* treatment yielded soil K significantly higher than that of the *control*, the *gardeners' manure-application + green manure* treatment; and the *green manure only* treatment [T3 > T4; T6] (Table A.10). These differences were apparent at a number of sampling times throughout the trial period.

At planting, after animal manure application, all treatments [T2; T3; T4 and T6] except the *recommended manure-application + green manure* treatment (T5) had soil K significantly higher than that of the *control* (T1). This was likely due to the availability of K from the applied animal manure. The unexpected result of the *green manure only* treatment (T6) also having soil K significantly more than the *control* was probably due to the inherent soil K content of the soil, the sequestering of soil K from the soil profile by the green manure crop or an error in sampling.

At harvest of the first vegetable crop, the *recommended manure-application* treatment yielded soil K higher than that of the *control*, the *gardeners' manure-application treatment*, the *gardeners' manure-application + green manure* treatment,

and the *recommended manure-application + green manure* treatment [T3 > T1; T2; T4; T5]. As with the soil N and soil P results, this suggests that the green manure crop utilizes some of the K available from the animal manure for its own growth.

Table A.10 Table of means for soil potassium (mg/L) over time

treatment time	control T1	gardeners' application T2	recommended application T3	farmers' + green manure T4	recommended + green manure T5	green manure T6
start	165.6a	239.8a	215.4a	208.0a	166.8a	230.8a
post manure-application	149.7 a	286.6 b	320.6 b	241.8 b	225.1 ab	241.2 b
seedling	160.5a	229.6a	239.1a	197.4a	193.9a	215.5a
harvest crop	148.6 b	200.1 b	290.3 a	168.9 b	204.5 b	211.3 ab
planting of green/cash crop	167.4a	157.2a	219.2a	144.0a	174.2a	156.0a
harvest of green/cash crop	136.2 b	203.9 b	318.8 a	165.6 b	222.6 b	171.4 b
post manure-application	100.4 b	140.6 ab	185.8 a	129.8 ab	165.4 ab	130.6 ab
harvest of crop	112.8 b	174.8 ab	250.6 a	152.4 b	179.4 ab	152.2 b
harvest of green/cash crop	97.6 b	140.6 ab	185.8 a	129.8 ab	162.4 ab	136.4 ab

Differences are significant if they do not share a letter, differences are calculated between the six treatments at a specific sampling time and not within treatments over time.

After harvest of the green manure/cash crop, the *recommended manure-application* treatment (T3) had soil K significantly higher than that of all the treatments. For the second year of the trial, the *recommended manure-application* treatment (T3) yielded soil K higher than that of the *control* (T1). These results imply that K is readily available to plants in some quantity from animal manure.

A.3.2.d Organic carbon

The variation in soil organic carbon over the different sampling times indicated an error in the sampling technique. The variation in soil organic carbon between sampling times was too great to represent real change in the soil. This error was reflected in the analysis of the results, where overall, there was no significant difference in soil organic carbon between the treatments. However, there was a significant decline in organic carbon in all treatments over time.

Changes in soil organic matter occur whenever the rates of carbon input (net primary production) and carbon loss (decomposition) diverge. Cultivation enhances respiration relative to carbon input, resulting in the net loss of stored carbon in the soil (Odum, 1969). The highest rates of loss occur usually just after disruption, and the rate of decline abates thereafter (Monreal and Janzen, 1993). As the objective of agriculture is the export of organic products from the ecosystem, arable soils almost invariably have lower carbon return than those in undisturbed systems. Several factors have the potential to generate an overall decline in the level of soil organic matter in

arable soils and none more so than repeated soil tillage (Christensen and Johnston 1997), as experienced in the Valley cropping systems.

Soil organic matter was shown to reach a plateau approximately five years after adoption of reduced tillage practices that conserved soil organic matter content (Janzen *et al.*, 1997). For the gardeners, the implication is that regardless of the soil fertility management strategy used, there would be a steady decline in soil organic carbon over time under the continuous-cropping practices used at the time of the research. This decline would negatively affect soil quality, in particular water-holding capacity, cation-exchange capacity and soil particle aggregation and would result in a gradual decline in soil fertility (Mills and Fey, 2003; Vanlauwe and Giller, 2006).

A.3.2e Microbial biomass carbon

Both the *gardeners' manure-application* treatment and the *recommended manure-application* treatment yielded microbial biomass carbon (MBC) significantly higher than that of the *gardeners' manure-application + green manure* treatment, the *recommended manure-application + green manure* treatment and the *green manure only* treatment [T2 ; T3 > T4; T5; T6] (Table A.12). Also, the *gardeners' manure-application* treatment the *recommended manure-application* treatment and the *recommended manure-application + green manure* treatment, yielded significantly higher MBC than that of the *control* [T2; T3; T5 > T1]. This implies that there were more microbes present in the soil profile where animal manure was used.

Table A.12 Microbial biomass carbon (mg/Kg) present in field-trial treatments at the end of the trial

	control	gardeners' application T2	recommended application T3	gardeners' +green manure T4	recommended + green manure T5	green manure T6
2002	1700c	1957a	1908a	1744bc	1834b	1746bc

Differences are significant if they do not share a letter

A.4 Soil fertility management: implications for sustainable homestead gardening

The yield results of all the crops indicate that there is a sustained release of plant-available nutrients from the breakdown of manure over time and that this release of nutrients has a significant impact on the yield of crops over consecutive cropping seasons. The yield results suggest that the green manure crop uses quantities of nutrients that significantly affect the yield of crop plants and that the application of additional manure will be required to satisfy the nutrient demand of the green manure crop. This means that in the soil fertility management practices of the gardeners at the time of the study, the use of the green manure crop was not beneficial in increasing crop yield and in some cases significantly reduced crop yield compared to that obtained from the gardeners' technology (application rate of 10 000 kg/ha of animal manure). In other words, the advice they had received was incorrect

The results of the soil macronutrient trends show that the FERTREC-recommendation treatments significantly increase the macronutrient content of the soil more than do the other treatments. For the gardeners, this means that increasing the

amount of animal manure currently applied to the soil, would to improve the soil macronutrient status of the soil. The soil-fertility intervention proposed by the SPUP, of gardeners growing a green manure in addition to the median application of kraal manure does not make a significant, positive contribution to the yield of the vegetable crops nor of the cash crops. The FERTREC-recommendation treatment (i.e. twice the median manure application rate) is more likely to increase vegetable and cash crop yields. The results are however not conclusive as the trials were conducted for only five cropping seasons (2.5 years) and Izac and Swift (1994) proposed a time frame of 10-50 years for the evaluation of sustainability in low-input cropping systems in sub-Saharan Africa.

As the mineralization rates of organic matter applied to soil can vary greatly (Sequi and Benedetti, 1995), there is no rigorous evaluation of organic residues for their fertilizer value (Swift and Palm, 1995). In fact, not all nutrients, supplied through organic matter, are available for crops, as losses occur through volatilization, denitrification, leaching, run-off and immobilization (Angé, 1995). Loss of N and K occurs through runoff and leaching, and loss of P occurs through run-off (Roy, 1995; Mills and Fey, 2003). Studies in a number of East African countries showed that N loss through leaching is estimated to be between 25 and 150 kg/ha per year, particularly in areas with steep slopes and erosion (Hillhorst *et al.*, 2000). Soil erosion control measures are thus key to conserving nutrients in the soil and also to the on-farm cycling of nutrients (Christensen and Johnston, 1997). In this regard, the SPUP intervention of Vetiver terraces to control soil erosion on steep slopes is appropriate and many gardeners have implemented soil erosion control measures as advised by the SPUP facilitators.

In studies conducted in Kenya, the removal of harvested product was found to be the strongest negative contributor for all nutrient levels (N, P, and K) (Smaling *et al.*, 1996). The crop-yield results from the field trial indicated that soil nutrients from the applied animal manure, contributed to the harvested product. However, there was also a significant decrease in macronutrients and organic carbon at the trial site over time (between the first manure application and the end of the trial). This suggests that to maintain fertility in homestead gardens under continuous cropping, the gardeners of the Valley of a Thousand Hills will have to continue to apply manure, and in some cases, gardeners will have to increase the quantity of manure that they apply. The decrease in organic carbon over time was most likely due to tillage. Tillage is a cause of decline in soil organic matter as it disrupts the soil aggregates, exposing the organic matter to increased levels of microbial attack (Haynes and Tregurtha, 1999). If tillage and cultivation are practised each year annual green manures will have a negligible effect on levels of soil organic matter (Sullivan and Diver, 2001; Mills and Fey, 2003). For this reason, a significant intervention within the Low External-Input Sustainable Agriculture framework used by the SPUP would be the promotion of reduced tillage methods and the non-removal of weeds from the cropping area. In Kenya, recommendations to improve nutrient supply in traditional systems include the use of green manure crops and animal manure, used with conservation tillage and the mulching of residues after harvest (Lungu, 1999). Other recommendations include reducing nutrient loss from the garden, maximizing the cycling of nutrients and increasing efficiency of uptake (Hilhorst *et al.*, 2000). Leached nutrients can be

recaptured by planting trees in the gardens and fields and by using deep-rooted green manures that scavenge nutrients from the subsoil making them available to subsequent crops (Sullivan and Diver, 2001).

In the case of The Valley of a Thousand Hills for many gardeners, there is insufficient P and N available in the immediate soil profile to provide a continuous and adequate supply for crop requirements (Manson, 1996). Soil fertility can be restored through the integration of nutrient management. This means that most gardeners will have to import P and N, whether in the form of high-quality manure, or fertilizers. Leguminous species within a cropping system are essential for increasing the amount of plant-available N within the system (Giller, 2001). The trials show that sufficient P needs to be made available for both the vegetable crop and the green manure. In fact, P is a major limiting factor of nitrogen fixation and biomass productivity of legumes in cropping systems (Giller, 2001; Mpfumo and Giller, 2001). Gardeners using green manures in their soil fertility management regimes will therefore need to add sufficient animal manure to ensure sufficient P for the growth of the green manure and the subsequent vegetable crops. Some gardeners have very fertile soil and the nutrient levels indicate potentially sustainable crop-production through the use of animal manure and reduced tillage methods. It is essential that homestead cropping systems are sustainable if they are to make a significant contribution to household food security in the long-term. Current levels of nutrient mining within many of homestead gardens and the reduction of soil organic matter over time imply that for most gardeners, soil fertility management at field level is not sustainable in the long-term under continuous cropping.

Appendix B: Resources for livelihood strategies of Valley gardeners

B.1 Resources available to gardeners for the construction of their livelihood strategies

No.	land (ha)	labour	disability	water	buildings	electricity	groups	wealth
1	<0.5	gardener	yes	communal	1	no	1	extremely poor
2	>1.5	women/children	no	own	5	yes	3	not poor
3	0.5 to 1.5	men	no	own	3	no	3	poor
4	0.5 to 1.5	women/children	no	communal	3	no	3	very poor
5	<0.5	women/children	no	communal	4	yes	2	poor
6	<0.5	gardener	no	communal	1	no	2	very poor
7	0.5 to 1.5	women/children	no	communal	5	yes	2	poor
8	<0.5	men	no	communal	4	no	3	poor
9	>1.5	women/children	no	communal	5	no	3	poor
10	<0.5	women/children	yes	communal	3	no	3	poor
11	>1.5	women/children	no	own	5	yes	3	poor
12	<0.5	women/children	no	communal	3	no	2	very poor
13	0.5 to 1.5	gardener	no	own	4	no	2	very poor
14	0.5 to 1.5	gardener	yes	own	3	no	2	very poor
15	0.5 to 1.5	women/children	yes	communal	2	no	2	poor
16	<0.5	gardener	no	own	1	no	2	poor
17	0.5 to 1.5	gardener	yes	communal	2	no	2	very poor
18	<0.5	gardener	no	own	5	yes	3	poor
19	0.5 to 1.5	gardener	no	communal	4	no	2	extremely poor
20	>1.5	women/children	no	own	5	yes	2	poor
21	>1.5	women/children	no	own	5	yes	3	poor
22	0.5 to 1.5	women/children	no	own	5	yes	3	poor
23	<0.5	women/children	yes	own	3	no	3	extremely poor
24	0.5 to 1.5	women/children	no	own	3	no	2	extremely poor
25	>1.5	men	no	own	5	yes	3	not poor
26	0.5 to 1.5	gardener	no	communal	3	no	2	very poor
27	0.5 to 1.5	women/children	no	own	4	yes	2	poor
28	0.5 to 1.5	gardener	no	own	5	yes	3	not poor
29	0.5 to 1.5	gardener	no	own	5	yes	2	poor
30	0.5 to 1.5	gardener	no	communal	3	no	2	very poor

B.2 Correlation matrix of resources contributing to livelihood strategies of Valley gardeners

This Correlation Matrix was generated on GenStat Release 6.1 (Lawes Agricultral Trust, 2002). The Correlation Co-efficient at P=0.05 for 28 degrees of freedom is 0.361 (Howell, 1995).

	Buildings	Craft	Disad	Econ	Electr	Erosion	Food
Buildings	1.000						
Craft	0.144	1.000					
Disad	-0.396	-0.251	1.000				
Econ	0.839	0.082	-0.376	1.000			
Electr	0.722	0.131	-0.418	0.723	1.000		
Erosion	-0.089	0.360	-0.107	-0.167	0.064	1.000	
Food	0.113	0.680	-0.193	0.234	0.237	0.488	1.000
Gov_grants	-0.550	0.144	0.367	-0.637	-0.343	0.246	0.022
Green	0.119	0.432	-0.092	0.019	0.240	0.062	0.377
Groups	0.467	0.265	-0.030	0.460	0.396	0.129	0.389
Knowledge	0.287	0.506	-0.208	0.144	0.241	0.307	0.492
Labour	0.298	0.263	-0.070	0.360	0.334	0.513	0.580
Land_size	0.579	0.348	-0.192	0.475	0.420	-0.034	0.197
Manure	0.061	0.104	0.083	0.075	0.174	0.178	0.176
Networks	0.224	0.439	-0.116	0.195	0.383	0.203	0.545
Salaries	0.620	0.142	-0.325	0.719	0.574	-0.137	0.145
Sales	0.104	0.314	0.000	0.000	0.299	0.671	0.435
Skills	0.341	0.480	-0.131	0.267	0.489	0.410	0.696
Slope	0.365	0.200	-0.319	0.247	0.291	-0.262	-0.069
Soil_Fert	0.015	0.093	0.274	0.019	0.044	-0.068	0.106
Total	0.120	0.721	-0.205	0.198	0.159	0.517	0.942
Trad	0.257	0.545	-0.411	0.269	0.225	0.503	0.701
Transport	0.297	0.045	0.054	0.304	0.209	-0.501	-0.166
Water	0.605	0.094	-0.089	0.767	0.668	-0.080	0.432

	Gov_grants	Green	Groups	Knowledge	Labour	Land_size	Manure
Gov_grants	1.000						
Green	0.105	1.000					
Groups	-0.276	0.173	1.000				
Knowledge	0.149	0.298	0.368	1.000			
Labour	-0.080	0.240	0.515	0.327	1.000		
Land_size	-0.220	0.293	0.221	0.432	0.231	1.000	
Manure	-0.095	0.095	0.162	0.022	0.203	-0.027	1.000
Networks	0.033	0.267	0.508	0.469	0.447	0.260	0.338
Salaries	-0.551	-0.081	0.487	0.048	0.301	0.393	0.276
Sales	0.229	0.229	0.376	0.585	0.640	0.106	0.208
Skills	0.000	0.225	0.492	0.681	0.381	0.349	0.272
Slope	-0.344	0.215	0.121	0.078	-0.085	0.114	-0.241
Soil_Fert	-0.024	0.169	0.137	0.005	0.125	0.196	0.254
Total	0.094	0.400	0.321	0.522	0.544	0.210	0.187
Trad	0.000	0.157	0.350	0.765	0.462	0.190	0.057
Transport	-0.247	0.432	-0.105	0.126	-0.194	0.247	0.022
Water	-0.410	0.308	0.471	0.116	0.364	0.333	0.186

	Networks	Salaries	Sales	Skills	Slope	Soil_Fert	Total
Networks	1.000						
Salaries	0.317	1.000					
Sales	0.437	0.000	1.000				
Skills	0.572	0.278	0.600	1.000			
Slope	-0.005	0.221	-0.234	0.000	1.000		
Soil_Fert	0.178	0.115	0.211	0.276	-0.299	1.000	
Total	0.400	0.110	0.359	0.604	-0.073	0.048	1.000
Trad	0.438	0.077	0.571	0.598	0.013	-0.130	0.674
Transport	-0.063	0.126	-0.179	-0.059	0.358	0.233	-0.121
Water	0.260	0.537	0.075	0.488	0.126	0.236	0.367

	Trad	Transport	Water
Trad	1.000		
Transport	-0.098	1.000	
Water	0.204	0.361	1.000

Appendix C: SWOT analysis of the three case studies

Table C.1 Strengths and weaknesses affecting sustainability of the food production system of Valley farmers

Level	Asset	Strengths	Weaknesses
Field	**Natural**	Crop diversity: food crops; fibre plants; erosion control plants; nitrogen fixing crops; fruit; fodder; and deep-rooted crops. Animal manure. Erosion control measures.	Traditional crop use declining: loss of nitrogen fixation; weed suppression; and genetic reservoir functions. Loss of contribution to house-hold food security. Declining P, N and OM of soil. Erosion.
	Physical	Water, sufficient land available for homestead gardens and maize fields.	
	Human	Skills and knowledge: food and fodder production; erosion control; soil fertility management. Labour: from within household and/or wage-labour.	Agricultural constraints not readily addressed by farmers as part of a system.
Farm	**Natural**	Mixed farming system.	
	Physical	Land, water, infrastructure, housing and fencing.	
	Human	Skills, knowledge and labour: for agriculture and for the diversification of livelihood options. Labour	
	Social	Networks and social cohesion obvious in rural wards.	Networks and social cohesion less obvious in peri-urban wards.
	Financial	Sale of food crops; crafts; beadwork; beer and labour.	
District	**Human**	Knowledge and skills: farmers, facilitators and researchers.	
	Social	Participatory methods and processes. Social networks.	Meetings not attended by all farmers. Unresolved group conflict.

Table C.2 Analysis of the Valley case study: opportunities and threats to sustainability from factors external to the food production system

Level	Assets	Opportunities	Threats
Field	**Natural**	Supply of P and N from fertilizer. Sustainable farming practices.	Insufficient P, N and OM in system due to steep slopes and shallow soils, drought, and erosion. Taste preference of youth resulting in declining cultivation of traditional crops.
	Physical	Available land	Reduced land availability due to urbanization.
	Human	Co-production of agricultural knowledge. Labour	Limited sources of knowledge available. Reduced availability of labour due to HIV/AIDS. Reluctance of youth to assist with agricultural tasks.
Farm	**Natural**	Firewood; water; building materials.	Natural resource availability declining and reduced manure availability due to livestock sales (shock requiring sale of assets).
	Physical	Infrastructure: roads; water; electricity; transport.	Floods; violent storms; and municipal and transport worker strikes
	Human	Opportunities for diversification of livelihoods. Opportunities for skills development and training (crafts, beadwork, weaving). Knowledge and skills of facilitators and researchers.	Lack of interest by youth in agriculture and craft making. Urbanization leading to reduced availability of natural resources and fewer options for livelihood diversification. Insufficient capacity to address constraints as part of a system. HIV/AIDS.
	Social	SPUP works at homestead level. Social networks	SPUP staff-turnover. Government does not work at homestead level. Weakened linkages of social networks due to poverty, illness and urbanisation.
	Financial	Commissions for craft and beadwork. Government grants: pensions; child; disability; medical.	Competitive regional fresh produce market: many commercial and market gardeners in region. Shocks requiring sale of assets.
District	**Human**	Capacity building and skills development. Co-production of knowledge.	Technical intervention by SPUP limited to organic agriculture solutions. Few sources of knowledge.
	Social and Financial	Participatory methods and organizational development. Strategic management of programme (SPUP).	Time consuming; constrained by 4-year-project funding structure. Networks and synergies not strongly aligned.

Table C.3 Analysis of the Mbongolwane wetland case study, investigating strengths and weaknesses affecting the sustainability of the intervention

Level	Asset	Strengths	Weaknesses
Field	**Natural**	Abundant and readily available natural resources.	Erosion gullies in ecologically sensitive areas of the wetland.
	Human	Traditional knowledge and local customs.	
Household	**Human**	Skills, knowledge and labour.	HIV/AIDS
	Social	Social networks.	
	Financial	Home-based industry.	
Ward	**Human**	Knowledge, skills and labour.	Reliance on single product.
	Social	Participatory methodologies. Co-production of knowledge for product development. Social networks and support.	Group conflict.

Table C.4 An analysis of the Mbongolwane wetland case study, investigating opportunities and threats to sustainability of the intervention

Level	Asset	Opportunities	Threats
Field	**Natural**	Erosion control programmes. Abundant natural resources due to good soils and reliable rainfall.	Increased cultivation of madumbes should craft initiative fail. Floods and drought.
Household	**Human**	Capacity building New product development.	HIV/AIDS
	Social	Network alignment.	
	Financial	Expansion of initiative to other areas within catchment.	
Ward	**Human**	Capacity building Skills development and training.	Fickle/saturated markets Weakening local governance systems. Transformation of lands to agriculture.

Table C.5 Analysis of the Suid Bokkeveld case study, investigating strengths and weaknesses affecting the sustainability of the intervention

Level	Asset	Opportunities	Threats
Field	**Natural**	Community-based natural resource management.	Pests, diseases, drought and erosion. Climate change.
	Human	Skills development and training.	HIV/AIDS
Farm	**Natural and Human**	Synergies with other programmes, in particular government initiatives. Youth disinterested in traditional knowledge and skills.	HIV/AIDS Youth disinterested in traditional knowledge and skills.
	Social and Financial	Increased wealth within community.	Poverty.
District	**Human**	Capacity building and skills development	Limited capacity for marketing.
	Financial	Premium prices for equitable and organic practice during production of product.	Fickle or saturated markets.

Table C.6 Analysis of the Suid Bokkeveld case study, investigating opportunities and threats to the sustainability of the intervention

Level	Asset	Strength	Weakness
Field	**Natural**	Sufficient land and natural resources available.	Pests and diseases. Wind erosion.
	Human	Erosion control. Skills, knowledge and labour.	Unskilled labour from other districts (damage to sensitive plants).
Farm	**Human**	Skills and knowledge. Farm-based industry.	
	Social	Commitment to sustainable development Social cohesion	Youth disinterested in traditional knowledge and skills
District	**Human**	Knowledge and skills. Participatory learning and action.	Limited capacity for marketing and sales
	Social	Commitment to sustainable development. Synergies within programme. Heterogeneous sources of knowledge.	Weakened linkages in social networks due to poverty, illness and migrant labour.

Samenvatting

Participatieve technologieontwikkeling in de kleinschalige landbouwsector in Zuid-Afrika staat in toenemende mate in de belangstelling. Daarmee verbonden is er een groeiende aandacht voor duurzame ontwikkeling, in het bijzonder voor landbouwkundige interventies. Grootschalige commerciële boerenbedrijven zijn in Zuid-Afrika altijd gezien als het belangrijkste model voor succesvol boeren en als gevolg daarvan was het vermogen van landbouwkundige dienstverleners om de opkomende sector van kleinschalige boeren te ondersteunen relatief gering. Ecologische benaderingen van de landbouw werden grotendeels ongeschikt geacht als een manier om inkomsten te verwerven. Zuid-Afrika kent echter enkele veelbelovende voorbeelden van duurzame kleinschalige landbouwsystemen. Het voornaamste doel van deze dissertatie is het bepalen van de factoren binnen de ontwikkelingsprogramma's die leiden tot duurzame technologieontwikkeling in de context van huishoudens van kleine boeren. Dit doel wordt bereikt door de principes die zijn ontleend aan het duurzaamheidparadigma in de praktijk op hun reikwijdte en werking te onderzoeken. De daarbij te identificeren factoren kunnen vervolgens worden gebruikt om techno-institutionele ontwerpen voor een duurzame landbouw die voldoende inkomen genereert, te verbeteren.

De huidige stand van zaken van het onderzoek met betrekking tot landbouw- en plattelandsontwikkeling in Zuid-Afrika is bepaald door zowel het vorige als het huidige landbouw- en ontwikkelingsbeleid, door landeigendomsrechten en landhervorming, alsook door de socio-economische factoren die van invloed zijn op kleine boeren. Deze onderwerpen en factoren worden in deze dissertatie besproken met betrekking tot hun invloed op kleinschalige landbouwpraktijken in Zuid-Afrika. Twee benaderingen voor institutionele interventies in ontwikkelingsprogramma's voor de landbouwsector in Zuid-Afrika kunnen onderscheiden worden: overdracht van technologie en participatieve technologieontwikkeling.

Duurzaamheid is zowel een eigenschap van een meta-systeem als van de componenten die onderdeel uitmaken van dat meta-systeem. Een duurzaam ecosysteem is een systeem waarbij de samenhang tussen de eigenschappen van het ecosysteem en het beheer ervan, een eventuele daling van de opbrengsten voorkomt en de groei van schadelijke bijproducten tot staan brengt. Landbouw kan gezien worden als een gemodificeerd ecosysteem waar de onderlinge relaties tussen bodem, planten, dieren, boer en klimaat beslissend zijn voor de te verwachten opbrengst van het systeem. In de ecologische benadering wordt landbouw gezien als een systeem dat gedreven wordt door productieopbrengsten en het menselijke beheer van het systeem. Agro-ecologie is de gezamenlijke ontwikkeling van de sociale en natuurlijke hulpbronnen, waarbij het landbouwsysteem het resultaat is van de constante interactie, wederzijdse transformatie en afhankelijkheid tussen het sociale en het natuurlijke. Onder de sociale aspecten vallen lokale kennis en de mogelijkheid om netwerken te ontwikkelen en te onderhouden, terwijl de plaatselijke specifieke ecologische omstandigheden en de diversiteit van agro-ecologische systemen de natuurlijk aspekten vormen. Om duurzaam te zijn moet een landbouwsysteem dus biologisch,

technisch en sociaal haalbaar zijn, *en* haalbaar op bedrijfsniveau, dit alles binnen een positief en verbeterend extern milieu. Duurzaamheid heeft uiteindelijk altijd te maken met de relaties tussen systeemelementen en het onderzoek naar duurzaamheid in de landbouw vereist om die reden een veelzijdige benadering op verschillende niveaus waarin meerdere actoren een rol spelen. In deze dissertatie wordt het duurzaamheidaspect onderzocht in drie gevallen en op een aantal niveaus: veldniveau, bedrijfsniveau en districtsniveau, waarbij met name aandacht wordt besteed aan de onderlinge interactie. Verschillende aspecten worden onderzocht, waaronder landbouwtechnologieën, huishoudens en organisatorische ontwikkeling. De verschillende actoren die bij het technologische ontwikkelingsproces betrokken waren en die onderzocht zijn in de drie case-studies zijn de boeren, de ontwikkelingsorganisatie, voorlichters, onderzoekers en de lokale traditionele autoriteiten.

Via mijn eigen deelname aan het ontwikkelingsproces gebruikte ik duurzaamheidsmethodologiën om algemene beweringen ten aanzien van duurzaamheid in de drie cases te toetsen. Voor deze dissertatie is gebruikt gemaakt van twee overkoepelende onderzoeksmethodologiën: *Critical Systems Thinking* (CST) en *Strategic Niche Mangement* (SNM). CST ontwikkelde zich als reactie op de realisering dat er geen systeembenaderingen waren voor het kritische onderzoek naar en de interventie in probleemsituaties gekarakteriseerd door een onevenwichtige verdeling van macht en bestaansmiddelen. CST mondt vaak uit in *Critical Systems Practice* (CSP) en is goed te gebruiken voor rurale studies, met name omdat de onderzoeker het ontwikkelingsproces zorgvuldig volgt en documenteert. Bovendien wordt van de onderzoeker verwacht dat hij of zij een praktisch vervolg geeft aan het onderzoek – tenslotte is het uiteindelijke oogmerk van CSP verbetering en emancipatie. CSP kan op allerlei verschillende niveaus worden aangewend en ook worden gebruikt voor een veelheid van interventies. Immers, de keuze van de methodologie hangt steeds af van de aard van de aangetroffen problemen. SNM is gebruikt als analytisch kader maar ook in reflexief opzicht: daarmee was het een belangrijk hulpmiddel bij de realisatie van de case-studies. SNM theorie hielp bij het definiëren van de techno-institutionele duurzaamheid van de denk- en werkwijzen die besloten liggen in de drie onderzoeksgebieden.

In de eerste casus wordt de gewasproductie ten behoeve van de zelfvoorziening in bedrijfssystemen voor kleinschalige landbouw onderzocht. Moestuinen kunnen aantrekkelijke perspectieven bieden voor de voedselzekerheid op het niveau van de familie. De voorlichtingsdienst van de provinciale regering werkt echter niet op het niveau van de individuele groentetuin en veel van de aangeboden landbouwvoorlichting aan moestuinders wordt gedaan door niet-gouvernementele en religieuze organisaties. Veel van deze organisaties gebruiken participatieve methodes en bevorderen duurzame landbouw gebaseerd op geringe hoeveelheden productiemiddelen van buiten het bedrijfssysteem om een lage en teruglopende bodemvruchtbaarheid het hoofd te bieden. Het werk van de ontwikkelingsorganisatie in deze casus werd gezien als een set van veelbelovende activiteiten, een samenspel van technische en institutionele maatregelen die de beloften voor duurzame

ontwikkeling in zich hielden. Het onderzoek toont aan dat de voedselproductie in moestuinen een belangrijke bijdrage levert aan de bestaanszekerheid van de boeren en dat socio-economische en culturele factoren een belangrijke rol spelen in het beheer van de bodemvruchtbaarheid. De resultaten van het onderzoek tonen ook aan dat de landbouwpraktijken die door de ontwikkelingsorganisatie worden bevorderd, zoals de invoering van erosiebeperkende maatregelen, een rol spelen in het behoud van bodemnutriënten. Maatregelen ter verhoging van het stikstofgehalte van de productiegronden droegen echter juist verder bij tot de verlaging van de bodemvruchtbaarheid in de moestuinen. Dit was als gevolg van het feit dat ondanks het gebruik van LEISA-technieken, die naar de overtuiging van de ontwikkelingsorganisatie alleen organisch van aard konden zijn, deze uiteindelijk niet geschikt bleken om een duurzaam resultaat van het landbouwsysteem te bewerkstelligen vanwege de uitgebreide bodemerosie die al had plaatsgehad. Daarenboven was de interventie niet in lijn met de beschikbare regeringsprogramma's voor hulp aan kleine boeren. Ook erkende de ontwikkelingsorganisatie de mogelijkheden niet die lokale en traditionele kennis bieden om duurzame landbouwpraktijken te bewerkstelligen. Dit is te betreuren omdat duurzame groei mogelijk is in gebieden die thans geërodeerd zijn, en met gebruikmaking van vooral interne productiemiddelen, zolang boeren maar volledig betrokken zijn bij alle fases van het technologieontwikkelingsproces. Veranderingen in de productiviteit van akker- en weidegronden hangen net zoveel af van menselijke vaardigheden en vindingrijkheid als van biologische en natuurkundige processen.

De tweede casus betrof een project dat het verstandige en duurzame gebruik van moeraslanden ondersteunde met als doel het bestaan te verbeteren. Het duurzaam gebruik van natuurlijke hulpbronnen is een uitdaging omdat de levering ervan moet samengaan met het behoud van de gezondheid van het natuurlijke systeem dat die hulpbronnen produceert. Dit heeft tot gevolg dat aan wetlands vaak tegenstrijdige eisen gesteld worden voor wat betreft het landgebruik. Moeraslanden bieden de mogelijkheid om de bestaansmiddelen van lokale gemeenschappen aan te vullen en kunnen meerdere voordelen opleveren voor de samenleving als geheel. De ontwikkelingsinterventie voor het moerasland moedigde het duurzame gebruik van het moerasland aan als middel om inkomsten te verwerven aan de ervan afhankelijke huishoudens. Het idee dat aan de interventie ten grondslag lag was de herstructurering van de produktiemethoden door het treffen van stimulerende maatregelen voor minder schadelijke vormen van landgebruik. Tegelijkertijd waren ontmoedigende maatregelen vereist voor minder duurzame produktiemethoden. Het uiteindelijke doel was het combineren van de bescherming van de biodiversiteit en de gezondheid van het afwateringsgebied met de menselijke behoeften. Om dit te bereiken ondersteunde de ontwikkelingsorganisatie een plaatselijke handwerkgroep die had afgezien van het verbouwen van gewassen in het wetland en alternatieve inkomstenbronnen had gecreëerd. Een aantal factoren die als essentieel beschouwd worden voor het succes van de interventie worden onder de aandacht gebracht: de realisatie bij alle actoren dat innovatie afhankelijk is van zowel technische als institutionele veranderingen; een afgeschermd milieu waarin innovatieve ideeën kunnen wortel schieten en zich kunnen ontwikkelen; kennis of praktijken van heterogene bronnen voor de ontwikkeling van

innovaties; de capaciteitsbouw; een leermilieu en het opzetten en onderhouden van een sociaal netwerk. Tenslotte wees het onderzoek uit dat, ondanks dat de interventie had bijgedragen aan de duurzaamheid van het project een verdere gefaseerde afbraak was vereist van de institutionele bescherming verleend aan de handwerkslieden, dit om hun onafhankelijkheid verder te ontwikkelen. Indien dit niet gebeurt, zal de economische duurzaamheid van het handwerkinitiatief in gevaar komen, wat van invloed zal zijn op de onderling verbonden componenten van sociale en ecologische duurzaamheid.

De derde casus onderzocht eveneens een initiatief dat het duurzame gebruik van natuurlijke hulpbronnen onderzocht, in dit geval een *fynbos* ecosysteem. Het doel van het ontwikkelingsproject was om de gebruikers van de natuurlijke hulpbronnen de mogelijkheid te geven om ze duurzaam aan te wenden, om hun bestaansmogelijkheden te verbeteren en, daarop aansluitend, om meer geschikte en meer effectieve manieren te onderzoeken om ontwikkeling mogelijk te maken in voormalig achtergestelde plattelandsgemeenschappen. De *rooibos*-theeboeren die aan het ontwikkelingsproject deelnamen, waren in hoge mate aangewezen op de natuurlijke hulpbronnen en hadden een uitgebreide kennis van en ervaring met hun natuurlijke omgeving. De interventie diende ertoe om een democratisch-geleide winstgevende coöperatie op te zetten waarvan de gehele gemeenschap zou profiteren. De interventie was hoopgevend voor wat betreft ecologische, socio-economische en institutionele duurzaamheid. De analyse van het interventieproces wees de factoren aan die bijdroegen tot die duurzaamheid. Deze factoren waren onder andere: de gezondheid van de natuurlijke hulpbronnen, de kennis en vaardigheden van de leden van de gemeenschap met betrekking tot het duurzame beheer van de hulpbronnen; de toepassing van een alternatieve interventiestrategie daar waar de natuurlijke hulpbronnen waren achteruitgegaan; de participatieve leer- en actiemethodes die in het project gebruikt werden, en de sterke sociale verbanden binnen de gemeenschap. Het onderzoek wees uit dat de ecologische duurzaamheid op lange termijn ernstig bedreigd wordt door regionale klimaatsverandering en in het bijzonder het uitsterven van *fynbos*-soorten. Deze bedreiging van de ecologische duurzaamheid zal uiteindelijk van invloed zijn op de onderling verbonden componenten van economische en de sociale duurzaamheid.

Ondanks de verschillen in locatie, gebruikte benaderingen en ontwikkelde technologieën kunnen verschillende algemene voorwaarden die leiden tot vergrote duurzaamheid worden afgeleid uit de drie case-studies op de drie onderzochte niveaus.
Op veld niveau wordt de duurzaamheid verbeterd wanneer:

- de interventie is gebaseerd op lokale kennis en praktijken;
- de interventie de hulpbronnen in stand houdt of verbetert;
- de ontwikkeling van technische en institutionele processen hand in hand gaan en
- heterogene kennisbronnen bijdragen aan technologieontwikkeling.

Op het niveau van de huishoudens wordt de duurzaamheid verbeterd wanneer:

- sociale, technische en organisatorische netwerken worden gecreëerd en gehandhaafd die betrekking hebben op de ontwikkeling van de technologie;
- de capaciteitsbouw van alle deelnemende actoren, essentieel voor duurzame ontwikkeling wordt bereikt door sociaal en organisatorisch netwerken en

- de interventie een aanzienlijke bijdrage levert aan de overlevingsstrategie van huishoudens.

Op districts niveau wordt duurzaamheid verbeterd wanneer:

- leren het sleutelthema is in organisatorische en sociale interactie;
- ontwikkelingsorganisaties ruimte creëren voor organisatorische ontwikkeling;
- ontwikkelingsorganisaties ruimte creëren voor technologische ontwikkeling en
- de interventie is aangepast aan de locatie in kwestie.

Interacties op alle drie de niveaus beïnvloeden en dragen bij aan de algehele duurzaamheid van de ontwikkelingsinterventie, en dit onderzoek ondersteunt de breed geaccepteerde conclusie dat de uitdagingen voor de landbouw niet simpel kunnen worden opgelost door technologische aanpassingen op veldniveau alleen. Veeleer is een begrip vereist van de veelzijdige relaties tussen de factoren (zowel van binnen het productiesysteem als van daarbuiten) die in werking zijn tussen de verschillende niveaus (veld-, huishouds- en districtsniveau). Daarom is een geïntegreerde onderzoeksbenadering vereist om de technische, sociale en institutionele factoren aan te pakken die zich ontwikkeld hebben gedurende de participatieve technologieontwikkeling, een benadering die grensoverschrijdend is in zowel horizontale (het vakgebeid betreffende) zin als in verticale (tussen onderzoekers, practitioners en producenten). De notie van de onderzoekster als een actieve deelneemster aan het ontwikkelingsproces in plaats van als een afstandelijke observant onderschrijft deze benadering.

Summary

Participatory technology development within the subsistence-farming sector in South Africa is receiving increasing attention. Linked to this is an interest in sustainable development, particularly for agricultural interventions. Historically, in South Africa, large-scale commercial farms were seen as the predominant model for farming success and as a result the capacity of agricultural service providers to support the emerging sector of small-scale farmers has been relatively low. Ecological approaches to agriculture have largely been considered unable to provide a route for income generation. However, some promising examples of sustainable small-scale farming systems can be found in South Africa. The main aim of this thesis was to identify factors within development programmes that led to sustainable technology development in the context of subsistence farmers' livelihoods. This objective is achieved through exploring practically, the concepts derived from the sustainability paradigm. The identified factors could then be used to aid the technico-institutional design of remunerative and sustainable farming systems.

The current status of research into agricultural and rural development in South Africa has been shaped by both previous and current agricultural and development policies, land tenure and land reform, and also the socio-economic factors affecting subsistence farmers. These issues and factors are discussed in this thesis with reference to their impact on subsistence farming practices in South Africa. Within the agricultural sector in South Africa, there are now two recognised paradigms for institutional intervention in development programmes: transfer-of-technology and participatory technology development.

Sustainability is both a meta-system attribute and a property of the components that constitute that meta-system. A sustainable ecosystem is thus one where the co-production of the ecosystem properties and the management activities results in non-declining trends in outputs and by-products and non-increasing trends in those by-products detrimental to the system. Agriculture can be viewed as a modified ecosystem where the inter-relationships between soils, plants, animals, farmer and climate are crucial to the expected output of the system. In the ecological approach, agriculture is viewed as a system, which is driven by production output and the human management of the system. Agro-ecology is the co-evolution of societal and natural resources, where the farming system is the result of the ongoing interaction, mutual transformation and dependency between the social and the natural. The social aspects include local knowledge and the capacity to develop and maintain networks and the natural aspects include local ecological specificity and diversity of agro-ecological systems. To be sustainable, a farming system should thus be biologically, technically and socially feasible and viable at farm level, within a positive and enhancing external environment. Sustainability ultimately concerns the relationships between system elements and for this reason researching sustainability in agriculture requires a multi-level, multi-aspect and multi-actor approach. Sustainability was explored in three case studies in this thesis and at a number of levels: field level; farm and district level, including organizational interaction. Different aspects were researched and included

agricultural technologies, household livelihoods and organizational development. The various actors involved in the technology-development process examined in the three case studies included farmers, change-agents, researchers and local traditional authorities.

Through participation in the development process, I used sustainability-methodologies to validate general sustainability statements in three specific case studies. Two meta-methodologies were used for the research in this thesis: Critical Systems Thinking and Strategic Niche Management. Critical Systems Thinking (CST) evolved in response to the awareness that there were no systems approaches for critical inquiry and intervention into problem situations characterized by asymmetry of power and resources. CST is applied as Critical Systems Practice (CSP), and is useful for rural studies, as the researcher observes and documents the development process and is also expected to act in some way in response to the research, as the key aim of CSP is improvement, or emancipation. CSP can also be used at any number of levels and also for any number of interventions as the choice of methodology for research and implementation is governed by the nature of the problem situation.

In the first case study, homestead crop production in subsistence agriculture farming systems is investigated. Homestead food gardens offer the opportunity for family food security. However, provincial government extension agents do not work and homestead level and much of the agricultural extension offered to homestead gardeners is by non-governmental and faith-based organizations. Many of these organizations use participatory methods and at the field level promote low external-input sustainable agriculture methods to address issues of poor and declining soil fertility; which are considered the major biophysical constraints to sustainable subsistence farming. The work of the development agent in this case study, was conceptualized as being a pocket of promising activities, a configuration of technical and institutional arrangements that held promise for sustainable development. The research shows that food production in homestead gardens makes a significant contribution to the livelihoods of the farmers and that socio-economic and cultural factors play an important role in soil fertility management. The results of the investigation also show that the farming practices being promoted by the development agent i.e. the introduction of soil erosion control measures, play a role in conserving soil nutrients. However, the intervention to improve the nitrogen status of the farmers' soils does, in fact, contribute further to the degradation of the soil fertility status within homestead gardens. This is due to the fact that although using LEISA techniques, the development agent had narrowly interpreted these methods to mean only organic solutions, which ultimately were not favourable in assuring a sustainable outcome of the farming system, due to extensive degradation of the soil nutrient resource that had already taken place. Further to this, the intervention was not closely aligned with government programmes available to assist subsistence farmers. The potential of local and traditional knowledge in securing sustainable farming practices, was not acknowledged. This is unfortunate, as sustainable growth is possible in currently degraded areas, using low-input methods, provided that farmers participate fully in all stages of the technology development process, as changes in the productivity of

agricultural and pastoral lands are as much a function of human capacity and ingenuity as they are of biological and physical processes.

The second case study investigated an initiative supporting the wise and sustainable use of wetland resources for livelihood improvement. Sustainability of natural resources is challenging because the supply of natural resources need to be sustained concurrent with the maintenance of the integrity of the natural system delivering the resources. As a result, wetlands are often subject to conflicting land-use demands. Wetlands have the potential to support the livelihoods of local communities and to generate multiple benefits to society. The development intervention at the wetland promoted the sustainable use of the wetland, as a means of providing resources to households dependent on its services. The philosophy underlying the intervention was the re-configuration of modes of production through creating incentives of more benign land-uses. Simultaneously, disincentives were required for less sustainable modes of production. Ultimately, the integration of biodiversity protection and catchment integrity with human needs was the goal. To this end, the change agent supported the development of a local craft group that had refrained from cultivating the wetland and had created alternative sources of income form it. A number of factors are highlighted as essential to the success of the intervention and include: awareness by all actors that innovation is a function of both technical and institutional change; a protected space for innovative ideas to take root and develop; knowledge or practices from heterogeneous sources for innovation development; capacity building; a learning environment; and the creation and stabilization of a social network. Finally, the research revealed that although the intervention had contributed to the sustainability of the case study project, further phased breakdown of the institutional protection provided to craft producers was required, in order to develop their self-reliance. Failure to do so will place the economic sustainability of the craft production initiative under threat, which is likely to impact on the interconnected components of social and environmental sustainability.

The third case study also examined an initiative supporting the sustainable use of natural resources, and in this case concerns a fynbos ecosystem. The aim of the development project was to empower resource users to utilize natural resources sustainably, to enhance their livelihoods, and in addition to investigate more appropriate and effective ways of facilitating development in previously disadvantaged rural communities. The rooibos tea farmers participating in the development project were very reliant on natural resources and held vast knowledge and experience of their natural environment. The intervention served to establish a democratically-managed profit-making co-operative that would provide benefit to wider community. The intervention was promising in terms of environmental, social, economic and institutional sustainability. Through an analysis of the processes of intervention, factors were identified, that contributed to this sustainability. These factors included: the ecological integrity of the natural resource base; the knowledge and skills of the community members towards the sustainable management of the resource base; the application of an alternative intervention strategy where the natural resource base was degraded; the participatory learning and action practices used within the project; and

the strong social fabric within the community. The research revealed that long-term environmental sustainability is severely threatened by regional climate change, and specifically the extinction of fynbos species. This threat to environmental sustainability will ultimately impact on the interconnected components of economic and social sustainability.

Despite differences in the location, the approaches used and the technology developed, several general conditions leading to enhanced sustainability can be drawn from the case studies at the three levels examined.

At the field level, sustainability is enhanced when:

- the intervention builds on local knowledge and practices;
- the intervention maintains or improves the resource base;
- the evolution of technical and institutional processes is concurrent or mutually reinforcing and
- heterogeneous sources of knowledge contribute to technology development.

At the household level, sustainability is enhanced when:

- social, technical and organizational networks pertaining to the development of the technology are created and maintained;
- capacity building for all participating actors (essential for sustainable development) is achieved through social and organizational networking and
- in the context of the rural poor, the intervention makes a significant contribution to household livelihood strategies.

At the district level, sustainability is enhanced when:

- learning is a key theme in organizational and social interactions;
- a space is provided by change agents for organizational development;
- a space is provided by change agents for technological development and
- the intervention is specific to the locality.

Interactions at all three levels influence and contribute to the overall sustainability of the development intervention and this research supports the widely demonstrated conclusion that the challenges faced by agriculture will not readily be solved by technological interventions at the field level alone. Instead, an understanding is required of the multidimensional relationships amongst factors (both internal and external to the production system) operating across several levels (field, household, district). Therefore to address the technical, social and institutional factors that co-evolve during participatory technology development an integrated research approach is required, one that crosses boundaries both horizontally (across disciplines) and vertically (across researchers, practitioners and producers). Supporting this approach is the notion of the researcher as an active and self-reflective participant in the development process, rather than as a detached observer.

Curriculum Vitae

Samantha Adey was born on the 24th June 1970 in Welkom, in the Orange Free State Province of the Republic of South Africa. She completed her schooling in Verwoerdburg in the Transvaal, in 1987. In 1988, she worked in the Geomechanics Laboratory of the Council for Scientific and Industrial Research on the Lesotho Katze Dam project. She attended the University of Natal in Pietermaritzburg and obtained a Batchelor of Science degree in Botany and Plant Pathology in 1992, a Batchelor of Science Honours degree in Epidemiology and Mycology in 1993 and a Master of Science degree in Mycology in 1996. She was a consultant, research assistant and part-time lecturer for the Department of Microbiology and Plant Pathology from 1996 to 1998. From 1998 to 2000 she was the diagnostic plant pathologist of the KwaZulu-Natal Department of Agriculture. From 2000 to 2004, she worked as an AIO for the Rural Sociology Group of Wageningen University, conducting research into agricultural and rural development in South Africa.